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INTERNATIONAL SCIENTIFIC CONFERENCE ON ICT AND E-BUSINESS RELATED RESEARCH

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SCIENTIFIC COMMITTEE

INTERNATIONAL SCIENTIFIC CONFERENCE ON ICT AND E-BUSINESS RELATED RESEARCH

Electronic version

ABOUT SINTEZA 2016

It is our great pleasure to introduce the Proceedings of the International Scientific Conference on ICT and e-Business-Related Research entitled **Sinteza 2016**, which was held on April 22, 2016 at Singidunum University in Belgrade.

Sinteza 2016 provides an ideal platform for the exchange of information and dissemination of best practices, advancements in the state-of-the-art and technical improvements in the domain of ICT and e-business related research in today's ubiquitous and virtual environment. Rapid advances in information and communication technology (ICT) in recent decades have had a huge impact on numerous facets of everyday life and have created tremendous opportunities for economic, technological and social gains at a global scale. New technologies and scientific breakthroughs have altered the working and living environments making them safer, more convenient and more connected. The conference gathered academics, researchers and industry professionals presenting novel research on all practical and theoretical aspects in the field of ICT and their applications in a range of business and research fields.

As a conference that is being organized under the auspices of Signidunum University for the third time, it has become one of the most valuable and important assets of our university. The organisation of this year's conference has also been supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia. Sinteza 2016 places special emphasis on the use of ICT with the aim to present the results in all scientific fields related to the conference themes. The official language of the conference was English and all papers have undergone a thorough review and editing process. The scientific committee comprised 28 professors from Serbia and 40 professors from 37 reputable universities worldwide.

A total of 125 papers was submitted to Sinteza 2016. Upon the review and editing process, 99 papers were included in the Conference Proceedings, four of which are abstracts. A vast number of foreign authors took part in this year's conference, mainly from Bosnia and Herzegovina, Montenegro, Libya, Greece, Lithuania, Germany, Norway, Romania, Switezrland and Unite Arab Emirates. Out of the total number of submitted papers, 44 is from Singidunum University, while six papers are treated as invited.

All accepted papers are published and made publicly available within the Conference portal. Each paper is assigned its DOI number, reference on Google Scholar, and Conference Proceedings have an ISBN number. The most innovative papers shall be published in the European Journal of Applied Economics and the Serbian Journal of Electrical Engineering.

Esteemed readers, on behalf of the Scientific and Organizing Committee of Sinteza 2016 conference, we would like to express our deepest gratitude and appreciation to all participants for their considerable contributions. We sin-cerely hope that you shall take part in the next year's conference, with a new theme and innovative scientific papers.

Sincerely,

Organising Committee of Sinteza 2016

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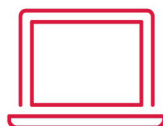
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ABSTRACT PREVIEW

INFORMATION & COMMUNICATION TECHNOLOGY

COLLABORATIVE DEVELOPMENT OF INFORMATICS CURRICULA BASED ON SEMANTIC TECHNOLOGIES

Milinko Mandić[1],
Zora Konjović[2]

[1] University of Novi Sad,
Faculty of Education,
Sombor, Serbia

[2] Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

In order to keep pace with the ongoing changes in ICT and increasing common IT competencies requirements, informatics curricula at secondary school level and, consequently, curricula educating informatics teachers must be frequently changed to ensure necessary competencies. This paper proposes collaborative development of informatics curricula assisted by a software tool for compatibility analysis of secondary school informatics curricula and curricula by which teachers of informatics are educated. The proposed software tool relies upon semantic technologies, *i.e.* ontologies for representation of competence-based curricula and ontology alignment for compatibility analysis. The secondary school informatics curriculum ontology was built to comply with the ACM K12 standard, while the teachers' curriculum ontology was built based on the selected existing curricula. The paper presents a brief description of the software tool and the results of the domain (informatics) segment of teachers' curriculum offered by the selected Serbian university and the standardized ACM K12 compliant secondary school informatics curriculum.

Key words:

education, informatics, curriculum, ontology, ontology alignment.

1. INTRODUCTION

The intensity and speed of change in the ICT field require continuous improvement of the informatics curricula, which calls for curriculum representation facilitating its simple and fast creation, modification and maintenance. Curricula creators, authorized ministries, accreditation bodies, teachers, *etc.* should also have THE opportunity to collaborate in curricula compliance monitoring and verification.

The current literature (Chi, 2009; Demartini *et al.*, 2009; Elsayed, 2009; Fernández-Breis *et al.*, 2012) indicate that ontologies and Semantic Web technologies are increasingly used for curriculum representation.

Ontology matching is the process of finding correspondences between entities of compared ontologies. Ontology alignment is a set of correspondences between two or more ontologies (Euzenat and Shvaiko, 2007) and represents the output of the matching process.

There are numerous techniques and strategies for ontology matching applied to different systems such as (Li *et al.*, 2009; Cruz *et al.*, 2007; Jean-Mary *et al.*, 2009). However, to our best knowledge, only (Mandić, Konjović, and Ivanović, 2016) provides the implementation of the system

Correspondence:

Milinko Mandić

e-mail:
milinko.mandic@pef.uns.ac.rs

that utilizes ontology alignment for determining education curricula matching.

This paper presents the software platform for semi-automatic determination of compliance between informatics teacher education curriculum and secondary informatics curriculum. Since the curricula are firstly represented by ontologies, techniques and algorithms for ontology matching are applied to check compliance of the curricula, whereby the users can change the results of ontology alignment.

The paper comprises five sections and the list of references. The second section is about ontological models of the curricula, the third one briefly describes the architecture of the software tool, the fourth one presents the results of the compatibility analysis obtained by applying the proposed software tool to the domain (informatics) segment of teachers' curriculum offered by the selected Serbian university and standardized ACM K12 compliant secondary school informatics curriculum. The last section concludes on the achieved results and elaborates on further research.

2. ONTOLOGICAL MODELS OF THE CURRICULA

The aim of this research is essentially to provide software tool that should give a hand in determining whether a teacher gains competencies to teach informatics in a high school upon completion of a study programme, as prescribed by the secondary school informatics curriculum. For that reason, models of teachers' and secondary schools' informatics curriculum are based on competencies. The principal class of ontological model of both teacher education and secondary school curriculum is *Competence*. Competence model is presented in detail in (Mandić, Konjović, and Ivanović, 2016; Mandić *et al.*, 2013; Mandić, Konjović, and Ivanović, 2015).

The ontological model of a secondary school informatics curriculum is created on the basis of the ACM K12 CS proposal, which is the standardized curriculum accepted worldwide. This ontology is minutely described in (Mandić, Konjović, and Ivanović, 2015).

In this paper, we choose the teacher education curriculum "Technics and Informatics" offered by the Faculty of Technical Sciences in Čačak for the analysis. This curriculum has been chosen for the following reasons: detailed information about the study program is available on the official website; integrated studies last for 5 years and give a master's degree; studies have been accredited in both of

the accreditation processes carried out in the Republic of Serbia. Additionally, Faculty of Technical Sciences (2013) (Standard 1): "study program has been founded on the tradition in education of teachers of technical disciplines at the Faculty of Technical Sciences in Čačak" and "is a continuation of the study programs for the education of technical education teachers (implemented since 1975), technics and informatics teachers (implemented since 1993), informatics teachers (implemented since 2006)".

Upper classes of ontological representation of the chosen curriculum are modeled in accordance with the ontological representation of competencies based on IEEE RCD standard, described in detail in (Mandić, Konjović, and Ivanović, 2015). Following the reference teacher education curriculum proposed in (Mandić, Konjović, and Ivanović, 2016), class *Knowledge* has 5 direct subclasses (Figure 1).
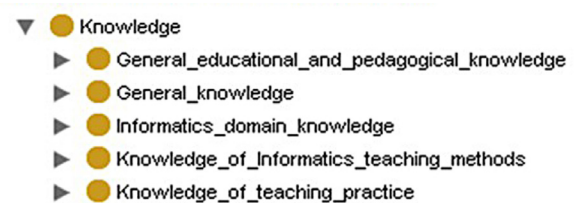
Fig. 1. Direct sublclases of the *Knowledge* class

All courses (compulsory and optional) specified in the Standard 5 of accreditation materials (Faculty of Technical Sciences, 2013) are mapped in the ontological model. The courses are categorized into one of the five general fields: general knowledge, general educational and pedagogical knowledge, informatics domain knowledge, knowledge of teaching practice, and knowledge of informatics teaching methods. The principle of mapping the curriculum courses in the ontological model was as follows. Because of the need that the terms contained in the curriculum are, as much as possible, "machine understandable" and comparable to the terms contained in other created curricula, all the courses' titles, as well as the courses' outcomes and content, were first translated into English. The titles of courses were mapped to the subclasses of classes that represent appropriate general curriculum fields, depending on the domains in which they were classified. Thus, for example, the classes *Physics* and *Probability_and_Statistics* were mapped to subclasses of the *General_knowledge* class; the classes *Pedagogy* and *Psychology* became subclasses of the *General_educational_and_pedagogical_ knowledge* class, *etc.*

The subclasses of the *Informatics_domain_knoweldge* class are shown in Figure 2.

The next step in creating the ontological model was to represent topics described in the course content as subclasses of classes that correspond to courses. If a topic contains several other topics/subtopics (often presented as enumeration), then all the listed subtopics are mapped as its subclasses. Also, if some topic is further described, further clarification is mapped to its label. In the last phase of creating the ontological model, course outcomes are mapped in accordance with (Churches, 2008; Heer, 2012; Krathwohl, 2002) to the appropriate subclasses of the classes represented by Revised Bloom's taxonomy and connected via *hasKnowledge/hasSkills* object properties with the class corresponding to the course they belong to.

Fig. 2. *Informatics_domain_knowledge* class architecture

The ontological model of informatics teacher education curriculum is available at www.pef.uns.ac.rs/ SerbianInformaticsTeacherEducationCurriculum/index.html.

3. SOFTWARE ARCHITECTURE

Software components

Figure 3 shows software architecture of the tool based on Semantic Web technologies, which is aimed to assist curricula synchronization. The software tool was developed in the programming language Java.

The software architecture is based on the architecture of the AgreementMaker system proposed in (Cruz *et al.*, 2007). The basic components of the software are:

- Ontology converter
- Ontology alignment system
- Export of results
- Graphical user interface
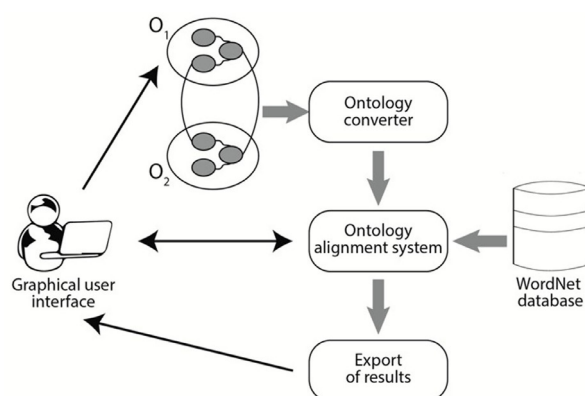
Fig. 3. System architecture for curricula synchronization

Ontology converter

This component enables converting OWL/RDF ontological models of curricula into appropriate classes in the Java programming language. Ontology converter is the software tool component that provides reading and manipulating of input ontologies, and therefore is the point where collaboration in development of ontologies can take place.

Ontologies are converted by using Protégé OWL API (http://protegewiki.stanford.edu/wiki/ProtegeOWL_API_Programmers_Guide) and Jena API (https://jena.apache.org/).

Ontology alignment system

The semi-automatic system provides an alignment of input ontological models by applying ordered sequence of algorithms for calculating firstly the terminological similarity (using WordNet database), then taxonomic structural similarity and finally relational similarity. Possible relations between compared ontologies classes are the following ones: equivalence, superclass, and subclass.

Once the tokenization is performed, terminological similarity is determined by comparing the obtained tokens contained in classes' local names and labels by using Lin (1998) and Jaro-Winkler measures (1989, 1999).

Taxonomic structural similarity of the observed classes takes into account similarities of all superclasses (not just the direct one), similarities of all subclasses as well as previously calculated terminological similarity.

Relational similarity is based on the principle that if two classes that represent the domain of object property (relationship) are similar, and if object property is similar, then the range classes connected with domain classes via that object property are similar.

All algorithms are described in detail in (Mandić, Konjović, and Ivanović, 2016).

Export of results

This component provides tabular and statistical display of the obtained results. It provides the basis for further collaborative (domain experts, professional bodies, ministries, informatics teachers) analysis and curricula improvement. Export of results should enable converting the results into recommended formats (Euzenat and Shvaiko, 2007) for displaying the results of harmonization (such as Alignment format, the OWL *etc.*), which has not been implemented in the prototype software yet.

Graphical user interface

Graphical user interface (GUI) allows users an insight into the structure of ontologies in the side-by-side view, the properties of the classes, and results of the matching. In the next section of the paper, GUI is shown through examples of displaying system's characteristic results (Figures 4, 5 and 6)

4. ANALYSIS OF RESULTS

This section presents the results of aligning the secondary informatics curriculum and the selected teacher education curriculum. Presentation, which contains the characteristic results and their analysis, follows the steps executed after the terminology alignment already took place.

Taxonomic structural similarity

As an example of the system output, part of the matched classes after the application of the first taxonomic structural similarity algorithm is shown in Figure 4.

The columns "Source class" and "Target class" contain classes' local names of the ontological representation of

the secondary school and chosen teaching curriculum, respectively; column "Type of relation" means the type of connection between the classes ("Equivalence", "Superclass" or "Subclass"), while "Similarity value" contains calculated value of similarity between matched classes. The threshold value was set to 70%.

Row	Source class	Target class	Type of relation	Similarity value
1	Algorithms_and_data_structures	Data_types	Equivalence	87.91%
2	Applications	Computer_applications	Equivalence	79.2%
3	Computer_networks	Computer_Networks_and_Co...	Equivalence	87.87%
4	Connections_Between_Mathematics...	Mathematics_of_Informatics	Equivalence	84.14%
5	Data_Structures	Complex_Types	Equivalence	72.96%
6	Databases	Databases	Equivalence	90.08%
7	Fundamentals_of_Hardware_Design	Memory_Systems_and_Techn...	Equivalence	85.19%
8	Internet_elements	Internet	Equivalence	79.44%
9	Multimedia	Multimedia_systems	Equivalence	79.01%
10	Object-oriented_programming	Object-Oriented_Programming	Equivalence	94.22%
11	Operating_Systems	Operating_systems	Equivalence	88.32%
12	Parts_of_a_Computer	Practicum_in_computer_archit...	Equivalence	75.64%
13	Principles_of_computer_organization	Computer_architecture	Equivalence	82.05%
14	Programming_Languages	Programming_Languages	Equivalence	85.15%
15	Programming_and_software_engine...	Introduction_to_programming	Equivalence	73.15%
16	Relational_database_design	Relational_databases	Equivalence	82.23%
17	Representing_Information_Digitally	Information_Technology	Equivalence	70.99%
18	Standard_software	Classification_of_Applications	Equivalence	75.21%
19	Structured_programming	Control_Structures	Equivalence	82.22%
20	The_major_component_parts_of_the...	Languages_Pascal_and_C	Equivalence	72.12%

Fig. 4. Part of the matched parent classes

Here, one can observe that similarity of classes' pairs with the same or very similar names is not necessarily close to or equal to 100%. Typical examples are pairs of classes shown in rows 2, 6, 9, 11, and 14 of the Figure 4. The reason for that is the participation of subclasses and superclasses similarities, if any, in the overall similarity of the observed parental classes. Thus, the pair of classes {*Applications, Computer_applications*} (line 2, Figure 4) has a similarity below 80% due to the differences in structure and subclasses names (Figure 5). For example, database topics in the teacher education curriculum is represented by a detached course, not modeled as a subclass of the *Computer_applications* class.

Figure 4 contains pairs of classes that can be considered inadequate, the typical example is the pair of classes shown in row 20.

On the other hand, classes *Fundamentals _of_Hardware_ Design* and *Memory_Systems_and Technologies*, although with different meanings of local names, have been properly matched (Figure 4, line 7). After examining the hierarchical structure of the compared ontologies (Figure 5), it can be seen that the class *Fundamentals_of_Hardware_Design* includes subclasses corresponding to subclasses of the class *Memory_Systems_and_Technologies.*

Analogous conclusion can be drawn for the pair of classes shown in row 12, Figure 4.

The final percentage of the matched *Knowledge* subclasses obtained at this stage is 62.99%.
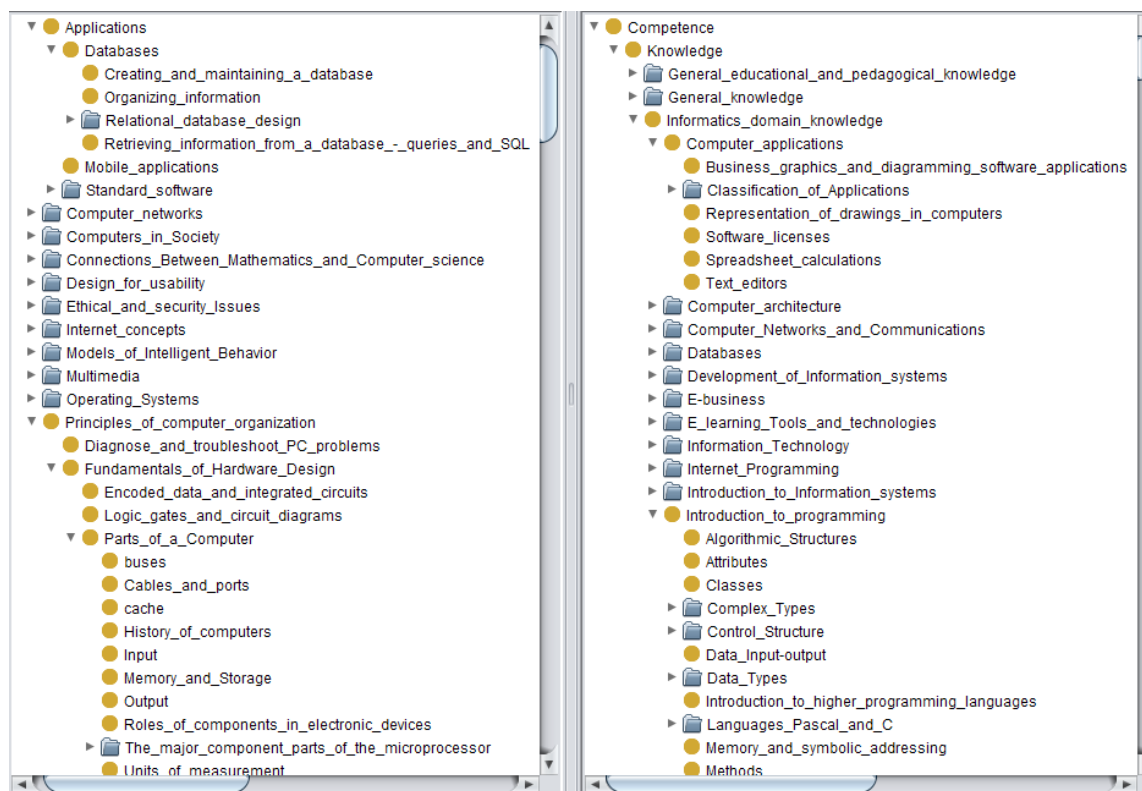
Fig. 5. Fragments of hierarchical structures of the secondary school and teacher curriculum models

Fig. 6. Examples of matched *Skills* subclasses

Relational similarity

Since the *Skills* class has quite poor structure and classes' names and labels in this part of ontology usually contain a large number of words, lower values are obtained for similarities between *Skills* subclasses. Therefore, threshold is here set at lower value (55%). Some of the pairs of *Skills* subclasses obtained by using an algorithm for determining the relational similarity is shown in Figure 6.

The column "Bloom" in Figure 6 contains ⊤ mark if the level of skills in the teaching curriculum is higher (which is desirable) than the required level in the secondary school curriculum or the mark ⊥ if that is not the case. Figure 6 shows that one can observe that this matching phase also gives classes pairs that can be construed inappropriate. This refers, above all, to pairs of classes shown in rows 2, 3, 12 and 17. Namely, the classes *Connect_a_computer_to_a_network* and *Diagnose_and_fix_ faults_in_the_network* (row 3, Figure 6) are associated with subclasses *Computer_networks* and *Computer_Networks_and_Communications* of the class *Knowledge* respectively, which are matched by algorithm for determining the taxonomic structural similarity (row 3, Figure 4). Therefore, at this stage the appropriate class

for the source class *Connect_a_computer_to_a_network* is obtained by searching the set of *Skills* subclasses with which the class *Computer_Networks_and_Communications* is connected. However, the corresponding outcomes indicate the need to manually intervene in automatically obtained results.

Examples of classes pairs where class of secondary school model represents the outcome of a higher level of Bloom's taxonomy than the level to which appropriate skills (class) of teaching curriculum belong are shown in rows 11, 13, 19 and 20.

The percentage of matched *Skills* subclasses is 51.66%.

System evaluation and main conclusions

Software platform validation has been carried out by the team of educational experts formed to represent the profiles of potential users of the system. The team is made up of 4 university teachers (elected to the position of informatics teaching methods), 2 employees in School Administration (Ministry of Education, Science and Technological Development) and 2 secondary school teachers of informatics. Their task was to determine the expected class pairs (reference alignment) for input curricula ontological models. On the basis of the reference alignment and the obtained system output, precision, recall and F-measure are determined.

Based on the received percentage of matched *Knowledge* and *Skills* subclasses (with a precision of 0.63, the recall of 0.58 and F-measure of 0.60), it can be concluded that the teacher education curriculum "Technics and Informatics" does not envisage the study of a number of important topics of secondary level ACM K12 standard such as the constraints of computing, the principles of artificial intelligence, ethical and security issues, the principles of creating user friendly interfaces, as well as the deeper study of the principles of problem solving and algorithms.

Part of unmatched classes is the result of different taxonomic structure of secondary model and the analyzed teacher education curriculum. This is especially true for the topics of robotics and connections between mathematics and computer science, which are mapped to the classes that correspond to non-domain knowledge in the chosen teaching curriculum model.

Based on the results of the unpaired *Skills* subclasses, one can conclude that the analyzed teacher education curriculum does not include outcomes such as: describe major applications of artificial intelligence, differentiate between ethical and legal issues, evaluation of algorithms

based on their efficiency, accuracy and clarity, evaluation of usefulness of the user interface, testing program code, *etc.*

Matched *Skills* subclasses of the model of the chosen teaching curriculum that represent inappropriate level of Bloom's taxonomy are usually related to programming skills. They are often described using verbs that do not correspond to the highest level of cognitive dimensions of the Revised Bloom's taxonomy. Examples of such outcomes in teaching curriculum (those mapped on the subclasses of the classes *Apply* or *Remember-understand*) are: "knows about the basic types and data structures", "understands and applies the work with arrays and structures" (the course 'Introduction to Programming'); "knows the concept of object-oriented approach, and uses classes and objects in the programming language C ++" (the course 'Programming Languages'). It is possible to derive two main conclusions based on the described inconsistencies. The first one appertains to the improvement of the ontological model of the curriculum, and the other one to the improvement of the teacher education curriculum aimed at providing competences that better satisfy needs of a secondary school curriculum. Within the context of improving the ontological representation, it is possible to reconsider the manner of representation of certain outcomes so that the verbs that describe the outcome do not represent the key criteria for mapping to subclass of Bloom's taxonomy within the created model. In the case of the outcome "use classes and objects in the programming language C++", it is therefore necessary to decide whether the use of classes and objects in the specific object programming language is the essence of programming (which belongs to the highest level of Bloom's taxonomy). If yes, the specific outcome should then be mapped to the appropriate subclass of the *Create* class. Another conclusion that can be derived from described inconsistency is the improvement of curriculum so that it contains outcomes that, in the field of programming, correspond to the highest level of Bloom's taxonomy.

CONCLUSIONS AND FUTURE WORK

The results obtained for curricula matching and the results of the system evaluation show that the software tool developed and presented in this paper can facilitate harmonization of the standardized secondary school curriculum and teacher education curriculum. As shown by the case study, application provides users with clear and useful information on the knowledge and skills/outcomes missing in the selected teacher education curriculum.

On the other hand, it also provides information useful for better description of the curriculum, *e.g.* outcomes in the field of programming that correspond to the appropriate level of the Revised Bloom's taxonomy. The obtained incorrect matching justifies the need for manual intervention in the alignment results, which particularly refers to the *Skills* subclasses. Better matching in this part of ontologies calls for better standardization in defining curricula learning outcomes.

Although the research subject opens a large space for further work, we mention only two directions here. The first one (more technical) is development of software components for collaboration (*e.g.*, standardized formats for data exchange, *etc.*) enabling users (IT experts, teachers, administrative officials, *etc.*) to take part in collaborative changes of the alignment results. The second one, which is substantially important, is further improvement of curricula models and ontology alignment component (*e.g.*, competence model improvement, introduction of more sophisticated alignment algorithms, *etc.*).

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USER DEFINED NAMED PLACEHOLDERS FOR REGULAR EXPRESSION SEGMENTS IN COMPLEX REGULAR EXPRESSIONS

Milan Tair

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

This paper describes an own implementation of a regular expression pre-processor written in PHP. It extends the regular expression functionality by allowing users to define named segments. These segments include custom character classes, matching groups *etc.* The pre-processor allows for writing complex regular expressions that are simpler to maintain. In addition, this paper presents a use case of the practical utilisation of the pre-processor. Furthermore, it includes a comparison of expressions written with and without user-defined segments.

Key words:

regular expressions, user defined segments, php, pre-processor, language extension.

1. INTRODUCTION

Regular expressions are helpful tools that are implemented in many applications and solutions. These solutions include business applications, web crawlers, content indexing engines (Sulzmann & Zhuo Ming Lu, 2016). They are also used for data transformation in preparation for migration (Kuznetsov & Simdyanov, 2006), as well as data cleaning (Dasu & Johnson, 2003) *etc.* Many programs use regular expressions that are very complex (Friedl, 2006). Complex regular expressions tend to be hard to maintain and edit. This is especially the case for regular expressions edited by programmers who are not familiar with the purpose of specific regular expressions. Because of this, long regular expressions are commented and documented (Curioso, Bradford, & Galbraith, 2010). However, this may only add to the overall length and complexity. Instead, this can be done by simplifying expressions while retaining original purposes and matching capabilities. One way is to use symbolic representations instead of somewhat complex sections of an expression. These symbolic representations include character class indicators which replace character groups in regular expressions (Friedl, 2006), which are the most frequently used, alongside Unicode properties. Such constructs are supported by most regular expressions standards. However, even with the helpers available in standardised regular expression implementations, regular expressions tend to remain too complex to be able to maintain easily. Instead of using only standard, predefined symbolic placeholders for regular expression segments, this paper presents an own implementation of a concept that extends this philosophy. It introduces user defined regular expression

Correspondence:

Milan Tair

e-mail:

milan.tair@gmail.com

segments which can be used in traditional regular expressions. Such regular expressions need to be run through a pre-processor, which replaces these custom placeholders with lengthy regular expression segments wherever they may occur. This enables programmers to write seemingly shorter regular expressions that are easier to read by programmers and are hence easier to maintain and edit.

2. BACKGROUND

Definitions and problem description

Regular expressions are series of characters, some with special meaning, sometimes abbreviated as regex, that form a search pattern used for pattern matching within sections of a string or for matching an entire string (Li, *et al.*, 2013).

Most useful regular expressions used in large information systems and applications that are used for either searching through data, transforming or validating it (Sulzmann & Zhuo Ming Lu, 2016) are complex (Friedl, 2006). As explained in the introduction section of this paper, some solutions exist that aim to make such regular expressions easier to maintain. This is done either by making them shorter and therefore easier to read and understand or by adding comments and documenting sections or entire expressions. The aim of this is helping the maintainer gain additional insight and understanding of the meaning behind some of its parts (Curioso, Bradford, & Galbraith, 2010).

A sample of a complex regular expression for finding occurrences of a postal address written in a standard format defined by the Serbian Postal Services (Post of Serbia) in Latin or Cyrillic scripts for the Serbian language is shown in Listing 1.

```
/(\t*([A-z\u0080-\u00FF\u0100-\u017F\u0180-
\u024F\u0400-\u04FF\u0500-\u052F\u1E00-
\u1EFF\u2C60-\u2C7F\uA720-\uA7FF\ \-']+[\
]?\n)(\t*([0-9]+\.\ )?([\.A-z\u0080-
\u00FF\u0100-\u017F\u0180-\u024F\u0400-
\u04FF\u0500-\u052F\u1E00-\u1EFF\u2C60-
\u2C7F\uA720-\uA7FF\ \-'])+)(([0-9]+)|(bb))?(((\
+stan\ +)|(\ +стан\ +)|(\ *\/\ *))[0-
9]+)?(\n\t*[A-z\u0080-\u00FF\u0100-\u017F\u0180-
\u024F\u0400-\u04FF\u0500-\u052F\u1E00-
\u1EFF\u2C60-\u2C7F\uA720-\uA7FF\ ]+\n)?(\t*[0-
9]{5}\ *)([A-z\u0080-\u00FF\u0100-\u017F\u0180-
\u024F\u0400-\u04FF\u0500-\u052F\u1E00-
\u1EFF\u2C60-\u2C7F\uA720-\uA7FF\ ]+\n))/
```

Listing 1. A regular expression for matching postal addresses written in the official Serbian address format.

The sample from listing 1 does not cover all conditions explained in the instructions (Post of Serbia). Nevertheless, it does cover the majority or addresses instances that occur in the postal system of Serbia. Military addresses, PO Box users' addresses and addresses without street names, such as those in smaller settlements, are not always matched by this regular expression. Nonetheless, it can be used to match the majority of Serbian postal address.

Even though there are much more complex expressions that are used frequently in larger specialized applications, this example is used to define the problem whose solution is explained in this report.

Existing solutions

A number of solutions exist that aim to increase the maintainability of long and hard to read regular expressions. The Perl programming language provides a mechanism of spreading a regular expression along multiple lines (Conway, 2009). It also supports adding comments. This method increases readability, which in term increases maintainability of the regular expression code. However, it does not reduce the length of the regular expression. Instead, quite the opposite, the length of the expression additionally increases. The lack of abstraction in regular expressions (Erwig & Goponath, 2012) is one of the key deficiencies. It causes scalability problems that result in regular expressions growing quite large quickly. Also, much of the regular expression code is sometimes redundant (Dasu & Johnson, 2003). A combined explanation for the date expression presented in (Erwig & Goponath, 2012) gives an interesting method of explanation. This method can easily be transformed in an SQL-like language. This language can be used for defining regular expression. However, asides from a presentation in the mentioned paper, no implementation has been reported to this day. Similar concepts exist in modern web applications developed using the Model-View-Controller pattern. This is particularly the case in the area of request routing, where the router component allows for defining route constraints. Segments of the route are named and later defined using regular expressions (Microsoft Development Network).

3. DISCUSSION

The user defined named regular expression segment placeholder pre-processor is written with the aim to provide programmers with a way to make otherwise complex and long regular expressions shorter. Thus,

this would also make them easier to read and interpret. This increases maintainability of the regular expression. In addition, named or symbolic segments can be shared between programmes across many different projects. Additionally, the implementation has two modes of writing and organising the expression code. The first is the multiline mode where all whitespaces before and after the line including line breaks are ignored. The second is a standard single line expression. The multiline mode supports adding comments at the end of the line, where a comment starts with the hash sign character and ends with the line feed. Each regular expression segment can be assigned a name. This is analogous with defining a custom type in some programming languages. The named segment is stored in its own file. These files exist in the segments directory with the extension .nrexss. The extension is an abbreviation of named regular expression segment source. The pre-processor is written in the PHP scripting language in form of a final class. The pre-processor code is contained in a single class file. Nevertheless, future revisions and expansions of the pre-processor functionalities might result in the code being refactored and organised into a complete PHP library. The pre-processor needs to be instantiated before use in the program and a sequence of methods with adequate arguments needs to be called before the pre-processor object is ready to compile a regular expression, which includes named segments that will be replaced with the corresponding full-length regular expression code. An example of a PHP code snippet that illustrates the use of the pre-processor is shown in Listing 2.

In the code shown in listing 2, the $pattern variable's value represents a regular expression with embedded named segments. The pattern still matches postal addresses identically to the one shown in listing 1. But, it is much easier to read and understand as well as to maintain and expand. The named segments are defined as plain text files with the .nrexss extension and stored in the ~/rxns/segments/ directory. The file names match the segment name between braces.

When the pre-processor's matchAll method is called with a reference to an array as an argument, the pattern is first normalised so that all whitespaces at the beginning and the end of each line are trimmed off and all lines are joined together into a single continuous line. After this operation is completed, a regular expression matching of all embedded named segments is performed. The method filters out duplicates. Names of the matched segments are extracted and a regular expressing named segment file with the matching filename is looked up in the defined segment directory path. All mentions of the embedded named segment are replaced with the trimmed content of the selected file. This is repeated for all named segments. If at least one named segment remains embedded in the pattern string due to its corresponding file not being found, the method will throw an object of a custom class FileNotFoundException. This class extends PHP Exception. If no error occurs and the pattern is prepared, regular expression matching is performed and the result set is normalised and transformed into a single numerically indexed array returned by reference.

```php
<?php
$pattern = '(
  {Personal name sr}
  (
    {Street name sr}
    {Building number}?
    {Apartment section sr}?
  )?
  {Municipality name sr}?
  {Postal code sr}
  {City name sr}
)';

$bigText = file_get_contents('big.txt');

$pp = new RexExpPreprocessor();
$pp->setSegmentPath('~/rxns/segments/');
$pp->setPattern($pattern);
$pp->setSubject($bigText);

$matches = [];

$pp->matchAll($matches);

print_r($matches); # Show matched data
?>
```

Listing 2. Sample PHP code showing the use of the regular expression named segment pre-processor class for extracting postal addresses written in the official Serbian address format.

As seen in listing 2, after calling the pre-processor object's matchAll method, the $matches array is printed to screen for review. The output is a human-readably formatted array (Zend Technologies).

4. A USE CASE

Originally, the user defined named regular expression segment placeholder pre-processor was developed as part of a project to extract postal addresses, phone numbers and other structured information from large collections of plain text documents. These documents were created by running scanned pages of printed media through object character recognition (OCR). The aim of the project was to collect above-mentioned information for creating a database for marketing activities for an electronic marketing solutions software development company from Kragujevac, Serbia in 2008. Initially, the useful data extraction software used moderately complex regular expressions for matching certain standardised formats of different structured information. Over time, the complexity of regular expressions had increased. Also, the structure of the development team frequently changed and a need for a way to make regular expressions easier to maintain was recognized. The initial idea for the implementation explained in this report was presented and tested. The performance impact of an additional regular expression pre-processor was not evaluated in detail, but some ad hoc measurements had shown that it was inconsequential to the overall performance of the data extraction application. Likewise, it did not impact the schedule of the project.

Initial results

The initial results of using the pre-processor were positive. Regular expression coders had increased output. Also, they had moved up the useful data structure matcher pattern development schedule much faster than before. The learning curve was steep. Thus, the impact of the introduction of a new technology was almost of no consequence to the productivity of the development team. The final result was a beta version of the application that was fully automated. It extracted useful structured information from scanned pages as they entered a stack after being scanned. Document scanning was the only manual job in the system. Future solutions were to implement an automated book scanning hardware. Unfortunately, the company was closed in 2010 and no further development of this application has been done.

Known deficiencies

During the implementation and development process, some deficiencies of the initial design were identified. The first was the lack of recursive properties of the named segment replacement. This was both in the pattern and in other named segments was a major deficiency of the design. This resulted in many identical pattern segments being used redundantly in many segments. Preferably, they should have been written once as a small segment and then embedded in other segments. This deficiency was never solved even through the solution was proposed. It was due to the lack of approval from the project management. The second deficiency was the lack of a naming convention for segments. As for this use case, the development team structure changed frequently. This and the lack of a naming convention caused a situation where multiple programmers had written segments with different names that have matched the same pattern. After it had become obvious and began slowing down development a naming convention was introduced. The naming convention was changed multiple times during the development process. Ultimately, the final version was established. The segment was to be named as short as possible while still regaining enough information to clearly identify the purpose and the pattern it was supposed to match. All segments had to include a two-letter ISO 639-1 language code (Codes for the Representation of Names of Languages) at the end of their name to indicate which language they were specialised for. Named segments that were not specialised for any language, but were used for general pattern matching, such as e-mail were not to be suffixed at all. The third deficiency that was recognised early during the development process was the lack of the ability to group named segments into categories or namespaces. In this particular use case, the number of created named segments was greater than one hundred and was hard to organise by naming alone. A naming convention revision was suggested to attempt to deal with this issue, but was never approved.

5. FURTHER DEVELOPMENT

Official development of the pre-processor was halted in 2009. It was intermittently continued over the years for personal use by the author. There is some aspiration to publish a completely rewritten version of the pre-processor as an open source project. Hopefully, most of the unsolved deficiencies will be solved by design instead of convention.

6. CONCLUSION

This paper aimed to present an example of the use of regular expressions in an own implementation designed to extend the original functionality of the regular expression engine integrated into the PHP language. It had shown a use-case where this extension was used and examples of how these new features were designed and applied for solving the specific problem. The problem that was illustrated was the matching and extraction of postal addresses in the official format for the Serbian language from bodies of text. The main contribution of this implementation is the ability to write complex regular expressions that are simple to maintain by creating aliases and expression groups with symbolic names. These segments were shown in examples provided for illustration purposes.

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THE VALUE CHALLENGE OF INTERCONNECTEDNESS IN CYBERSPACE FOR NATIONAL SECURITY

Dragan Ž. Đurđević[1],
Miroslav D. Stevanović[2]

[1]Academy of Nacional Security; Belgrade, Serbia

[2]Security Information Agency, Belgrade, Serbia

Abstract:

The current phase of the information age is characterized by more intense and more comprehensive interconnection in cyberspace. This feature of technology promotes changes at the societal level, including consequently the value model. These changes require adaptation of national communities and, thus, represent a challenge for the national security.

This paper starts from the observation of parameters of interconnectedness of things, people and processes in cyberspace, and their impact on social organization within the technologically advanced states. That impact is analyzed in regard to the stability of the common value concept of nation-states.

The interconnectedness in cyberspace manifests the trend of multiplication in scope. In the leading technological countries, centralized development centers are emerging. This results in attracting financial flows towards the most developed countries, and the rise of the technological elite as an actor in the social power structure.

Adapting to the interconnectedness (and the speed) in cyberspace requires improving the individual capacity of perception, which can be achieved through value-oriented education. Re-composition of social power within the community requires implementing democratic mechanisms in cyberspace, and the precondition for this is a strategic national approach to protection and normative regulation of critical information infrastructure.

Key words:

interconnectedness in cyber space, the Internet of things, start-up technological center, capacity of perception, national cyberspace protection strategy.

1. INTRODUCTION

The development of information technologies has enabled a global network of interconnected users, but also a global network of interconnected, uniquely identified objects (Internet of Things, IoT) [1]. The exchange of data between things, as well as between things and people, in cyberspace requires the standardized "language" of communication, an internet connection as a means that enables communication, and an internet protocol with adequate capacity to span an unpredictable number of potential participants in communication (IPv6 address).

A global network of two global networks (the Internet and the IoT) will necessarily induce changes in at least three aspects of human environment: firstly, more extensive and more intensive networking of people and things, secondly, in organization of management of human communities,

Correspondence:

Dragan Đurđević

e-mail:

djurdjevic.dragan@gmail.com

in bureaucratic as well as within the urbanization concept, and thirdly, business and services.

Global network, however, remains in the domain of tools, resources and means that increase human possibilities. As such, in order to ensure improved quality of life and sustainable development at the state level, which is the basic form of organization of political communities today, it requires an adequate normative regulation in the number of areas, such as the protection of personal rights and transparency in the management process.

From that standpoint, the implementation of global networks and advanced information technologies contains challenges related to network security, protection of personality and democratic mechanisms, as well as the basic values of the state itself, *i.e.* national security. Facing these challenges involves mastering new dimensions of speed and quantity of information.

In the global network of networks of increasingly interconnected systems, people and things, we are faced with a growing number of sensors and users (especially through the IoT), including the number of points of entry into the system. This is why computer security becomes the value of interest for national security. Within this concept, the flow of information in its environment necessarily becomes dynamic and changeable [2], and thus, the perception in cyberspace is also becoming more challenging.

An additional challenge from the aspect of national security is due to the fact that in the space of decentralized communication, the state has no sovereignty over the Internet, in which that space exists.

2. THE CURRENT INHERENT CHALLENGES IN NATIONAL CYBERSPACE

In the first stage of internet communications, accessible content was static and there was a segregation of participants on creators and consumers of the contents. The second stage is characterized by overcoming of this division, in the sense that each user can simultaneously create and consume contents. Today, in the beginning of the third stage, the participants are becoming things (*e.g.* vehicles, kitchen appliances, lighting, medical equipment, buildings, clocks, nuclear reactors *etc.*), that can share information about itself and the environment on the network with other things or people. The capability of networked things is beyond the scope of computers and mobile phones and becomes the internet of interconnected things, which is finding an increasing application

in healthcare, pharmaceutical industry, transport, energy, food industry, military industry, *etc.* From the technological aspect, the application of IoT enables qualitative changes, such as "personal robots", "smart homes and buildings," or other "smart" things, but also a better observation of global natural phenomena in meteorology, oceanography, geology, *etc.* In the research and commercialization of its results, vast resources are being invested by the largest actors in the market of information and communication technologies.[1]

Without the consent about the uniform code of communication (standardization) at the international level, IoT cannot realize the potential in implementation. Since there is an objective risk that standardization could be imposed by a dominant company or country [3], it represents a challenge in relation to the protection of rights of individuals and states.

Standards provide that different information systems can mutually exchange information. The most powerful participants, both commercial and national, attempt to impose their products or services as a de facto standard. But, they can simultaneously try to make them incompatible with products and services of other participants, thereby narrowing or disabling the choice [4]. In connection to this, the interoperability of the system also represents the protection against the dominant position and monopolistic behavior. Since, for example, the IoT is based on a number of different technologies and devices, whose capability and use are still not possible to hint from the aspect of national security, the challenge is also the standardization remains a challenge in certain areas. In this regard, the trust can be provided by the use of a transparent, open source code, and the regulation of the correct behavior of participants.

Many security issues of information systems on which the IoT is based might be relevant for individuals (*e.g.* electronic monitoring of patients) and for the states (*e.g.* monitoring critical infrastructures). A state, as one of the largest consumers and investors, can directly favor certain characteristics, and thereby improve transparency as well as the confidence and protection of personality [5]. The way in which the system of trust will be built depends on the legislator. The growing needs for data, rapid flow of information, the mass use of information and communication technologies require functional models of protection of privacy and personal data of citizens. Considering that many pieces of information of sensitive character are in circulation, IoT has the potential effect on the private and the public sphere.

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1   Cisco - "Internet only", Ericsson - "Networked society", IBM -"Smarter Planet", Intel - "Intelligent systems", *etc.*

The systems for data collection and processing are designed to prevent the loss or damage of data and the period in which the devices monitor and store information is unlimited. Because of this, there is the risk of abuse of IoT in the field of surveillance in real time, in terms of interference in the private sphere of individuals or populations, and even in the physical integrity of citizens [6].

Limited availability also has the consequences in terms of individual cognitive processing, which are manifested in the form of tendency of users to, due to the benefits of constant availability, forget the information, and the need for constant suspicion [7]. Therefore, the application of technology, which by nature is not flexible enough and not learning from mistakes, should be regulated and functionally allocated to ensure the protection of personality.

Today's security methods are inadequate for the requirements of a vast system that the IoT should represent. The attacks, such as denial of service, unauthorized access, control over IoT device to insert corrupt information and manage the facilities, in contrast to the effects of the same attacks today, pose a risk to the entire system [8], and must, therefore, be anticipated before implementation.

3. THE VALUE NATURE OF CHALLENGES IN NATIONAL CYBERSPACE

Security, as a political value, is related to individual or societal value systems. As a concept, security is ambiguous and elastic in meaning. In an objective sense, it measures the absence of threats to acquired values, and in a subjective sense, the absence of fear that such values will be attacked. In international relations, security is conceived as an outcome of a process of social and political interaction, whose essential part are social values and norms, collective identities and cultural traditions, and from this perspective, it is necessarily intersubjective.

New uncertainties, however, introduce a challenge of a different type. Namely, they do not origin from individuals or social groups which can be prevented by the police and/or political measures, but rather from social risks, as a threat. This implies that security does not represent the situation without the (perception of) risk, but an ex-ante insurance, as a risk management technology, becomes the dispositions of social management. Diverting to insurance in the context of abstract risks results in security becoming the general social idea about value, and the universal normative concept, which is often used with different meanings.

In terms of security, threats, challenges, vulnerabilities and risks of a global network of networks require, on one side, a more precise defining, which would enable achieving a consensus on the new concepts and practical policy measures aimed at achieving agreed goals, and, on the other, a systematization of threats, challenges, vulnerabilities and risks of military, diplomatic, economic, social and environmental interests, as well as human security, food, health, energy and living conditions [9]. The perception of security in the application of nets network should include the value implications of control, data volumes, data access, data storage, the cost of security, data management, preferences for online presence and type of security staff and security checks [10].

Personal security, as one of the core values in the concept of national security, enjoys the protection in cyberspace, at the international level through two processes. First is the legal delegitimization of uncontrolled use of personal data, such as the prohibition of sending them to countries that do not provide adequate protection of privacy.[2] Publication of data on the Internet, however, is not considered as sending information to another country, although the approach is global, and they are available in the countries to which such information should not be sent. The second is related to the processing of personal data and protection of confidentiality of communications. Thus, for example, EU Member States are required to guarantee the confidentiality of communications by adopting national legislation which prohibits unauthorized interception, connecting, storing or otherwise intercepting communications, and individuals have the right to opt out of printed and electronic directories of telecommunications in relation to the processing of personal data and the protection of privacy in the telecommunications sector.[3] Concrete measures to reduce the obligations of operators to publish information regarding the use of personal data, including on how they will be treated, whether the site is monitored and the risks to privacy and data protection. These directives are not implemented when it comes to the interests of public security, defense or prosecution of crimes, which is the result of the compromise between the interests of protection of personal integrity and the need to provide an environment, prevent the commission of an offense,

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2   *Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data*, Official Journal L 281, 23/11/1995.

3   *Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector*, Official Journal L 201, 31/07/2002

or catch the perpetrators. When, however, it's of concern of a potential threat to national security, countries are generally prone to interpret these restrictions are very narrowly.

In the upcoming phase of the information age, the issue of privacy protection is even more complex. The IoT, namely, unlike the communication between the users and the user and machine, involves much wider and more autonomous scope of communication between machines (such as the tag communication), which is why in the conditions of existence of the state, in addition to protection of the value system based on the human individual, it necessarily implies the national defining of standards that are of interest to the defense and security.

4. INFRASTRUCTURAL ASPECTS OF THE CHALLENGES OF IOT FOR NATIONAL SECURITY

The number of devices and sensors that could potentially fall within the IoT, from traffic control, health care, security to various levels of administration, grows even more in developing countries. In the extent that IoT implies, with the devices and equipment that are installed and produced by millions of producers, it seems impossible to provide security and due to that, the control and management and the security are the fields of IoT that require additional costs. The global annual cost of internet security breaches has by the beginning of the XXII century reached 115 billion dollars (Symantec, 2012). Sensitive applications, such as for the government, security services, and the finance, remain challenges for ensuring the security of supply. Functionally, *i.e.* in the field of mobility, IoT network represents a greater security risk from the point of the recipient than the transmitter, since security, encryption, and other services related to IPv6 do not have a major impact. It is a matter of ensuring the situation that the information that is directed in any direction leads to a reaction only of the user that is programmed to receive it. The first level of protection is a combination of markers and classification of the public categories. The only way to protect the terminals is by increasing the number of points to be controlled. A rational solution seems to be providing integration functions at the local level, as the devices themselves will have an access to a much wider range of devices [11].

The aim of classification and authorization of the receivers is to enable that the challenges concerning the network, relating to the separation of communication and access control near the terminal, are faced with in

the three aspects of communication between machines: reaction in real time, deterministic performance and security. The point is that the systems in the cities use cameras and sensors for the safety and security purposes, and at the same time, in management, they have to meet the criteria concerning data privacy and security. Individual systems relating to control of the Cloud, in the cities (as well as in healthcare, energy, transportation, manufacturing, education), and consequently also to defining of groups, authorization and authentication, are mainly developed by companies.

As societies and networks become more complex and advanced, they become exposed to new risks and threats, and thus more vulnerable, national security, as well as public safety, become increasingly urgent requirements. In terms of the outreach, IoT may extend the range of business domains and value chains, including in the open environment [12]. What is emerging as a priority is the need to provide technological solutions for trust in the security of online networks. This requires anonymity of private data, but also the access of those in charge of national security and public safety.

In addition to trust, national security before the IoT infrastructure sets the requirements related to the rational decision making. IoT is already developing, and "smart" sensors and devices are collecting the statistics for mechanical decision-making and process, without actually being noticed, and the exponential growth is limiting human intuition and the expectations. Along with that, the computers are reducing in size so much that they are becoming things. Linking the physical world with the real world can not pass without consequences for the social organization, if for no other reason, then due to a higher available input of information and time consumption. This includes the basic components of decision making: data collection; data transmission and data analysis. It is impossible to evaluate whether the automatism of some decisions will enable the removal of heuristic, or if it only cause a bottleneck in the decision-making process. Concerning these potential developments, however, it is certain that the security aspect in general, and especially in relation to decision-making, is further compounded because of the risk due to greater opportunities for hacking and connectivity.

The interconnection in the network includes a number of security issues of the network itself: monitoring, control, collection of data, distributed control systems and other systems that perform the control function. Cybersecurity, and above all of the hacking, requires the standards, among which a key challenge is an access

to the content anytime and anywhere, especially in the application of Wi-Fi, which is a low level of protection [13]. The fact is that companies launch their security innovations, but it is debatable if they have an interest and scope to encompass all the challenges of IoT for national security since they have a primarily their own commercial interest.

Security passage ("smart" passages, like in health care or household protection) provides a point of entry into the network of the operator and that where the authentication is provided. Security, however, should also cover the manipulation with the data to be entered, such as certificates for passage that the operator issues, and which validates the entry. The problem is that this area users do not understand, and those functions must be provided in advance and automatically. Hence, security aspects such as confidentiality, integrity and authentication, must be included in the development phase of centralized solutions [14].

Public administration performs certain functions established by the law, including the national security. Some cyber systems have the potential to optimize the use of processing and storage, such as virtualization (running applications from the underlying hardware) and Cloud technologies (based on a virtualization), and allow the division between different administrative entities. From the standpoint of national security, the challenge is hosting authorities of the Clouds, which are beyond the institutional and democratic control.

Another problem is of legal nature, and it is concerned with the functional challenge that arises from omnipresent infrastructure environment (standards of openness and model data, hardware, computer power and network architecture) that IoT implies. Today, we are facing: new 'smart' systems currently available, new social media replacing old, Cloud computing, which is graded, flexible and everywhere; huge data sets, which are used in science, health, economy and everyday life. Secure and private Internet becomes a legal problem that is difficult to edit ex-post. The problem, from the aspect of national security, is the normative protection of values in relation to the interconnected networks, which could, according to some estimates, by 2040 be connecting in real time 50 to 100 trillion objects,[4] *i.e.* virtually everyone and everything. This will necessarily alter the basic norms of communication, which are today still anthropocentric, in a way that is difficult to anticipate.

Cloud goes beyond the current web system. Entities that operate autonomously perform tasks on behalf of other users or programs, and can thus modify the way of accomplishing the objectives. In the context of service-oriented network architecture, security challenge poses the fact that artificial intelligence enables solving some concrete problems, including the decision-making process, *i.e.* positions the physical and virtual entities that autonomously generate goals and objectives, which poses a risk to security and privacy in certain fields of application, especially relating to health.

5. THE CHALLENGES OF IOT FOR NATIONAL SECURITY IN A MATERIAL SENSE

In its specification, IPv6 includes security, such as encryption and authentication of sources in communication. However, when designing the architecture of interconnecting, and at the same time "smart", objects, specific challenges arise, such as networking between different technologies and domains, as well as the usability in terms of manageability, security, and privacy. In this regard, particular highlights are on the safety aspects of using sensors in chemistry, biology, radiology, and nuclear sector, in which context specialized bodies are formed to deal with network and information security at international level, like *European Network and Information Security Agency*). On the other side, surveillance system are being developed in large cities, like in London, where during 1990's a security monitoring system was introduced, called The Ring of Steel[5], or in New York, where in 2007 a plan was announced to install a system of antennas, radars, and roadblocks, in order to combat terrorists, named The Lower Manhattan Security).[6] From the aspect of value challenges of interconnectivity, the threats arise from the connection of "smart" data for the purpose of military control [15]. Due to the potential consequences of militarization of urban architecture, and in a broader sense also the fact that, because of flooding by applications, suppliers and stakeholders, existing standards are difficult to adjust, in order that the whole system is interoperable [16].

Interoperability is a special area of risk for safety, for themselves, for two reasons: firstly, because of the dissonance between the demands imposed by management and engineering, and, secondly, due to the perception

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4   Becker, Albrecht; Sénéclauze, Grégoire; Purswani, Purshottam; Karekar, Sudharma; Internet of Things, Atos White Paper, 2013, p. 8. http://goo.gl/W29zDp (02.02.2016).

5   http://www.mascontext.com/issues/22-surveillance-summer-14/ring-of-steel/ (03.02.2016.)

6   http://www.nyc.gov/html/nypd/html/pr/pr_2009_005.shtml (03.02.2016.)

of decision makers and practical applicability of the developed forms do not provide a reliable solution. If security is viewed isolated, it seems to be contrary to the very idea of interoperability, which aspires to global inclusiveness and so equally globalized and challenges for the individual and national security of the states [17].

After Edward Snowden's revelations about the campaign of mass surveillance by the U.S. National Security Agency, the relation between cyberspace and human rights raises questions of national and international policies and the governance of the Internet, related to the resistance of sovereignty, the interests of national security and the shifting of the balance of power. Cyber espionage is a threat to national security because individual countries cannot respond to the global threat of terrorism, violation of human rights or environmental cooperation and coordination, even when they threaten international peace and security. In this sense, cyber defense entered the NATO strategy in 2002, and the cause were defensive operations in cyberspace against this organization during the illegal bombing of Yugoslavia in 1999 (especially through the state televison, RTS, whose building was bombed, even though it was a civilian object). This organization, as currently the only military alliance in the world, offers to the Member States and partner countries different mechanisms of "crisis management" and the help to strengthen national cyber defense capabilities. This way, it is introducing them into a uniform, practically collective mechanism of cyber defense of value concept on which the organization itself is based: freedom, common heritage and civilization of their peoples [18].

In the framework of the UN Security Council and other UN bodies, the issues of cyber security are only superficially addressed and, so far, there has been no indication that in the framework of international organizations working on an integrated and shared achievement of maintaining cyber security. Cyberspace is, in fact, often presented as a non-legal domain and conceptualized as an open, decentralized and participatory. However, the report of the UN Group of Governmental Experts confirms that international law, in the context of international security, in particular, the UN Charter, applies to cyberspace, and that the sovereignty and international rules and principles apply in relation to the behavior of the ICT and ICT infrastructure jurisdiction on the territory of the country.[7]

From the standpoint of national security, *ergo* in terms of the basic values, cyberspace can be perceived in two levels:

a) as a global domain within the information environment whose character is framed by the use of electronics and the electromagnetic spectrum, to create, store, modify, share and use information through independent, interconnected networks using information communication technology; [19] or

b) as an interconnected network of information technology infrastructures, that includes the Internet, telecommunications networks, computer systems and embedded processors and controllers in critical industries[8], which is generally accepted to comprise the virtual environment and interaction between people.

One can observe three levels of cyberspace: physical (computers, integrated circuits, cables, communications infrastructure, *etc.*); software logic; and packs of data and electronics [20]. In that space, on one hand is a process of territorialization of cyberspace and cyber activity, in terms of territorial jurisdiction and powers, and on the other, deterritorialization, in terms of regulatory responsibilities from the extraction of certain territories.[9]

As the cyberspace permeates every aspect of modern society and is also the domain and the media through which the activities in the field of economy, public safety, civil society and national security are carried out.[10] The States have an interest that networks which support their national security and economic prosperity are secure and resilient. The reason for this is that the Internet can be used in a hostile interest at international level. As an examples of such use, the literature cites cases of massive and coordinated hacking in 2007 that stopped the economy and the administration of weeks in Estonia,

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7 UN General Assembly, *Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security*, UN doc. A/68/98 (24 June 2013), pp. 19-20.

8 National Security Presidential Directive 54, also Homeland Security Presidential Directive 23 (NSPD-54/HSPD 23).

9 Brolmann, Catherine, Deterritorializating International Law: Moving Away from the Divide between National and International Law, in: *New Perspectives on the Divide between National and International Law*, Nijman, Janne; Nollkaemper, Andre (eds.), Oxford: Oxford University Press, 2007, pp. 84-109. An example is the Internet Corporation for Assigned Names and Numbers (ICANN), which incorporated into the legal order of the United States, the contract with the Secretariat of the economy, but is independently responsible for keeping the Internet secure, stable and interoperable.

10 The White House, *Cyberspace Policy Review: Assuring a Trusted and Resilient Information and Communications Infrastructure*, 2009. https://goo.gl/uUlxBx, 03.02.2016

and significant delay in development of Iran's nuclear program caused in 2009 by the infection with computer virus "Stuxnet" [21], as well as the action on the social networks with the aim to change the legal outcome of elections in Russia in 2011 [22].

Mass production of digital recordings creates opportunities for extensive public and private storage, processing, analysis, use and control, leading to initiatives to access and search for commercial, procedural and national security interests. The protection of privacy, cyber crime and espionage, make necessary protection of the Internet flow and reservoir digital records from unauthorized access and exploitation, even more complex. States, in many cases, restrict and censor content on the Internet, without any legal basis or on the basis of broad and vague regulations, without justification or need for that. In the field of expression the measures are applied, such as: blocking or filtering of content, including on social media sites; criminalization of political, social or religious content; imposing of liability for ISP that host or omit to block illegal content; disconnecting of users; cyber attacks on websites; monitoring of online activity; manipulation of online communications via commentators and spreading misinformation.[11] The legitimate purpose of these measures includes monitoring for prosecution, counterintelligence and national security while procedural requirements include a mandate in terms of the legal basis for surveillance, approval to conduct surveillance (*e.g.* a court order) and the necessity of control, or invasion of privacy proportional to the goal. The publicized revelations by Edward Snowden, in 2013, launched an issue of direct threats to civil rights, but at the same time, US President, Barak Obama, marked the cyber threats as "... one of the most serious challenges to national security".[12] In that sense, there is a need to protect confidential information and national infrastructure, primarily through the national security strategy, but also in relation to transnational threats for the common values of the international community [23].

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11 UN Human rights council, *Report of the Repporteur on the Promotion and Protection of the Right to Freedom of Opinion and Expression*, UN dok A/HRC/17/27 (16 May 2011), para. 24; isto, Human Rights Committee, *General Comment 34 on Article 19: Freedom of Opinion and Expression*, UN dok. CCPR/C/GC/34 (12 September 2011) paras. 21-36.

12 Obama, Barrack, Taking the cyberattack threat serious, *Wall Street Journal*, 19.07.2012. http://goo.gl/U72pBx (03.02.2016); also, UK Government, *A Strong Britain in an Age of Uncertainty: The National Security Strategy*, Presented to Parliament by the Prime Minister by Command of Her Majesty, October 2010. https://goo.gl/xFN61f (04.02.2016)

6. PROBLEMS IN THE APPROACH TO THE VALUE CHALLENGES IN CYBERSPACE

The original idea of communication between the devices was to meet the needs of the commercial exchange of information in real time. This has led to a situation where the communication in proximity can be misused for sharing content in an unauthorized spectrum. Ensuring that the end device can connect to the network, and the rest are disabled, has imposed the need to define national standards for interoperability in the field of security. It seems that aute problems of information security must be addressed in local networks [24].

Trends in access, availability, speed and recursive simplicity have implications on the relations between people in terms of the empowering of individuals and the organization of public dimension. Expanding of the range of participants and situations that have the capacity, in terms of interconnections in cyberspace, to compromise the value system of societies, without necessarily military threats. The organization of national security, with the primary aim to prevent distortion or destruction of basic national values and property, implies a multidimensional conflict and defense. Governments alone can not ensure national cyberspace, but they are responsible for it. This leads to problems of where the line of defense stops, the limiting of participants, or expanding the security model (such as preventive attacks, which has led to the spread of covert operations and military actions against state information systems) [25]. Today, the emphasis is on public diplomacy, as a tool of national security (especially on social networks).

The changes that interconnection brings in the concept of conflict, the role of government participants, the doctrine of preemptive action, the relationship between high-tech versus low-technology, have led to changes in the concept of the Internet, in terms of involvement of fields of possible abuses and distortions. National security includes the decision-making process, which now involves a problem of perception and human capacity to capture details; as well as the power, which is now going through a phase of reformulation and redistribution, as soft and smart power and involves research centers and companies [26], but also redefining foreign policy objectives, in terms of restrictions, privacy and access.

7. CONCLUSIONS

The number of participants, information, and potentially objects, intensity, quantity and rate of exchange, in cyberspace, make it impossible to reliably and accurately

determine the potential value challenges that countries will face in the efforts to preserve their fundamental values, *i.e.* their national security. This is especially emphasized in the new historical situation, in which the process of globalization is taking place alongside with the digitalization.

In order to face the anticipated risks, the executive branch necessarily has to establish the control over the risky sectors, with which citizens, the economy, public administration, as well as all students who violate the fundamental values of society, come into contact.[13] At the broadest level, the responsibility of the state to its citizens imposes the necessity of establishing a national strategy in the field of information development, on the basis of which it would be possible to establish norms in the national cyberspace in order to protect the fundamental values of the community.

Adjusting the current and the future needs and challenges of interconnected cyberspace requires training of individuals. On one hand, through the educational system, in order to value the education of personality capable of rational perception of content in cyberspace.[14] On the other hand, it also includes professional training of users at all level, of public administration for safe participation in cyberspace.

In addition to planning and training on the national level, it is necessary to ensure the protection of infrastructure and personalities, including legal regulation of the parameters before the application of new technologies, since due to the extreme global inclusiveness, cyberspace is almost impossible to regulate subsequently, without prejudice to the interconnected participants.

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A MULTI-LAYERED IMAGE FORMAT FOR THE WEB WITH AN ADAPTIVE BACKGROUND LAYER SELECTION ALGORITHM

Milan Tair,

Aleksandar Mihajlović,

Nikola Savanović

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

In this paper, we present a proposed multi-layered image format for use on the web. The format implements an algorithm for selecting for rendering one of two or more layers adaptively. The selection process depends on the weighted average brightness of the underlying web page background within the image bounds. The proposed image format supports multiple image layers with adjoined thresholds. Depending on these thresholds and the underlying background, a layer will either be shown or hidden. The selection algorithm takes into account the background brightness and each layer's adjoined threshold values.

Key words:

image format, layers, selection algorithm, website.

1. INTRODUCTION

Ever since the early days of the Internet, programmers have been inventing new ways of including multimedia into web pages. As connection speed used to be slow, image formats were designed with limitations to conserve space. This also helped reduce the impact of loading extra content into the page over the network. Some formats introduced colour indexing (Miano, 1999). This provided a way to use a greater number of colours without restricting them to a 8-bit colour scheme. Other compression algorithms are designed on the fast Fourier and discrete cosine transformations (King, 1995). Nevertheless, both of these formats still had major limitations despite providing smaller file sizes. Among these limitations was the lack of the alpha channel. Indexed colour image formats, such as the Graphics Interchange Format (GIF), introduced binary transparency. This feature provided the ability to use limited transparency capabilities in image formats. That was the first step before the introduction of full alpha channel implementations. Subsequent Web media formats, such as the PNG format, introduced four values per pixel. Three values are for the red, green and blue colour components and the fourth is the alpha channel (Powers, 2008). What all these formats have in common is the fact that they are all single layer image formats. Layered image formats exist and are commonly used in print and pre-press (Gatter, 2005). These formats have not seen much use on the Web. This is because of limited browser support (Comparison of web browsers - Image format support, 2016) and inconsistent image layer rendering techniques. This results in

Correspondence:

Milan Tair

e-mail:

milan.tair@gmail.com

unpredictable displaying across different browser engines (Chang, Yen, & Hsu, 2008). Even formats with alpha channel support have the issue of contextual adaptability. Layered image formats are rendered in such a way that all layers are placed one on top of another. The result would be the same as in the case when the image was created within a pre-rendered single layer image, stored with multilevel an alpha channel.

2. PROBLEM DEFINITION

The aim of this paper is to introduce a new image format. This format attempts to resolve a problem of low image content to background contrast. This problem occurs when images with alpha channels are placed on variable brightness backgrounds.

For example, there is an image of a certain company's logo. The logo contains text in a custom type and a certain graphical component. The content of the image is predominantly in a darker colour scheme. This image implements alpha channel transparency. All pixels that do not contain logo text and graphical components are transparent. Such an image is placed over a predominantly bright background. In that case, the content would be easily distinguishable on the page. However, if the web page section on top of which the image was to be placed is predominantly dark, the image contents would be hard to distinguish. The content would be unrecognisable due to low contrast between the background and the content. In such cases, designers would need to create a new logo with predominantly light text and graphical components, which requires more time and professional engagement. In addition, designers should be equipped with an additional document that describes the proper use of different colour versions of the logo. This way, the contrast between the logo and the background can be high enough. Otherwise, the designer may choose to introduce an underlying bright wrapper that would exist within the image itself. This container would surround the main textual and graphical components of the logo. When such an image is placed on a dark background, the surrounding container would be visible. The logo would now remain distinguishable. On the other hand, if such an image were to be placed on a bright background, the container would not increase the visibility of the logo. Instead, it would create a visual obstruction of the underlying background. Also, companies often insist on a minimum clearance margin around the logo and other elements, which can be predefined and added to the file. These are all important parts in creating an automated

file that will ensure the proper use of orporate logo in accordance with all defined guidelines. For companies and organisations, this issue is a key element for ensuring proper brand identity and the immediate representation of the company. A valuable corporate asset must be used consistently in the proper, approved forms to ensure corporate marketplace recognition. Thus, this issue is identified as one of the major issues in the domain of marketing.

Illustration 1. Comparison of rendering a random company logo with opacity via alpha channel on light and dark backgrounds

As can be seen in Illustration 1, the logo is distinguishable on the light background. However, on the dark background, the logo is hard to recognise. Currently available image formats, either single or multi layered, do not provide a solution for this scenario. The current best practice is to create two images and load one or the other depending on the background.

3. PROPOSED SOLUTION

As explained in the previous section, current multi-layered image format implementations do not provide a method of having one or more layers algorithmically selected to be displayed depending on the underlying background. The image format proposed in this paper attempts to solve this. We also describe a simple algorithm for deciding whether a certain layer should be rendered on the page. The algorithm takes a number of arguments for layer selection.

Image format description

The proposed image format is based on the PNG image format. It implements the concept of using an additional value for mapping pixel opacity at a certain point in the image matrix. Also, the format introduces layers with additional meta information and image data. Each layer is described by an optional layer name and two

mandatory brightness threshold values. The algorithm for the layer selection procedure, described in this paper, uses these values. Image data for each layer consists of a complete PNG image with same dimensions as the image. Image format packaging is based on a ZIP archive (Saxena, 2009) with a predefined file structure. The root of the archive contains a JSON (Ecma International, 2011) formatted file manifest.json. The manifest contains plain text description of the package.

```
{
    "format_version": "0.1.0",
    "author_name": "Forename Surname",
    "made_with": "DEMO image editor",
    "use_algorithm": "default-1",
    "dimensions": {
        "width": 165,
        "height": 85
    },
    "properties": {
        "margins" : [ 5, 5, 5, 5 ]
    },
    "layers": [
        {
            "min_brightness" : 0.0,
            "max_brightness" : 1.0
        },
        {
            "min_brightness" : 0.0,
            "max_brightness" : 0.3
        }
    ]
}
```

Listing 1. Sample content of the manifest.json file in the archive root

Listing 1 provides the basic information about the image. Available information includes layer thresholds and dimensions of the image. The number of elements in the layers array determines the layer count. In addition, the use of the algorithm property defines which algorithm should be used for layer selection. Introduction of this property reflects the design decision for future implementation of alternative algorithms. Currently, only algorithm 1 is available and described herein. The format version property identifies which renderer engine should handle image rendering.

Alongside the manifest.json file, each layer is stored as an PNG image. Layer images are stored in the root of the archive and are named layer_01.png, layer_02.png, layer_03.png *etc.* There can exist up to 99 layers according to the current version of the proposed format. The enumerated part of the layer filename corresponds to the index in the manifest objects property layers.

Another important element in the manifest is the properties object and its margins value. This value represents an array that can be used to force the rendering engine to allow a clearance margin around the image content. Array values are margins listed in the following order: top, right, bottom and left, *i.e.* clockwise from the top margin, measuring in pixels.

Our solution requires a method of analysing the image clipped from the page background content bounded by our image format destination rectangle bounds. There are many methods of analysing images and processing them in order to determine their properties. In this implementation, we have used an image-processing algorithm that has shown, through experimentation, that it is adequate for the task. We have used a technique of comparing images based on their properties layer by layer and identifying image brightness as well as patterns in the image. Upon identifying patterns, we have clustered them into a weighting matrix used to weight the actual segment of the background in relation to the logo layer stored in the image format.

Layer selection algorithm

In this proposed image format implementation, the drafted layer selection algorithm is relatively simple. It uses the image analysis algorithm mentioned above. First, it finds the average background-brightness-intensity. That value is used to determine which layer should be rendered. This decision depends on the defined image layer thresholds and the underlying background.

The min and max brightness properties stand for the smallest and the largest percentage of the background brightness. If the background brightness is between these values, the layer is rendered. Threshold values are inclusive if there is a layer that has the min. brightness set to 0.0 (0%) and the max. brightness of 1.0 (100%). That particular layer will be shown regardless of the calculated background brightness intensity. As per the manifest example given in Listing 1 for the second layer threshold values, the situation is different. That particular layer will be rendered only if the underlying background brightness intensity is between 0% and 30%. The value 0% is the darkest intensity in the colour scheme. The value 30% is a point, which is at one tenth of the total distance between the darkest and the brightest brightness intensity. More precisely, this layer is set to be displayed only when the image is placed on top of dark backgrounds.

The procedure for calculating the background intensity according to the algorithm 1 implemented for testing this proposal can be described with the following steps:

- Finding the average opacity of each point in the mask matrix for each alpha channel point of image layers. Equation (1) defines each layer's alpha channel as a matrix of real values of width and height w and h. Each point in the matrix is a value between 0 and 1.

$$L_i = \mathbb{R}^{w \times h}, i = 1 \dots n, n = 2 \dots 99 \qquad (1)$$

Equation (2) defines the method of determining values for average opacities of each point in a mask matrix L_α with the same size as layer matrices L_i to L_n:

$$L_a = \frac{\prod_{i=1}^n L_i}{256 * n}, L_a = \mathbb{R}^{w \times h} \qquad (2)$$

- Capturing the rendered web page content as a raster image bounded by the size and position where the image is supposed to be displayed. In the current test implementation, this is done using a screen capturing technique based on the third party software (Sofer, 2008).

- Creating a new matrix whose each point represents the greyscale value of each point in the captured raster image of the background. This matrix will be referred to as L_g in the rest of the document.

- Creating a matrix which is the weighted background-worth-matrix calculated by the following equation.

$$L_b = \frac{L_g}{L_a} \qquad (3)$$

- After the weighted background worth matrix, its mean is calculated (4) and used as the average background intensity value. We use the mean of this matrix instead of the greyscale background matrix. We value segments under transparent regions more than those under opaque regions of the image layer.

$$a = \overline{L_b} \qquad (4)$$

- All layers whose min. brightness thresholds are ≤ and max. brightness thresholds are ≥ the calculated value are selected to be rendered within the image bounds.

After the selection procedure is done, selected layers are rendered. Layers are rendered one on top of the other within the image element bounds. The first layer is the bottommost.

Active adaptation

The currently proposed image format implementation does not support active background monitoring. It does not include the means of actively calculating the average background-brightness-intensity. Thus, continuous selection of layers to be displayed and hidden on screen is not possible at the time. Future implementations may provide such a mechanism at greater cost of resources such as memory and processor time.

Predefined image rotation

The proposed image format takes into account the fact that the image can be rotated using CSS3 styling properties. If the rotate property is not applied or is set to 0.0, the rotation procedure is not executed. If the remainder of division of the rotation angle with 360 were to be greater than 0 and less than 360, the rotation mechanism should be executed. This mechanism follows the outlined procedure:

- After the L_α matrix is calculated, its weighted centroids is calculated as explained in (5) and (6). Equation (5) defines the method of determining the x coordinate of the matrix and (5) defines the method of determining the y coordinate of the alpha channel mask matrix.

$$c_x = \frac{\sum_{i=1}^n x_i L_{a_i}}{\sum_{i=1}^n L_{a_i}} \qquad (5)$$

$$c_y = \frac{\sum_{i=1}^n y_i L_{a_i}}{\sum_{i=1}^n L_{a_i}} \qquad (6)$$

- When the coordinates of the weighted alpha channel centre are found, a new matrix is created. The new matrix width and height are calculated upon applying rotation. The rotation is done around the calculated coordinates. New bounding box coordinates are the minimum and maximum x and y coordinates after applying the original corner point transformation and organising them into new coordinate vector points. A simple coordinate transformation function is given in (7) for the x coordinate of a point. The same method is used for the y coordinate.

$$x_i = x_0 + (x - x_0) * \sin \alpha + (y - y_0) * \cos \alpha \qquad (7)$$

In (7) x_0 and y_0 are coordinates of the point around of which the image is being rotated and α is the angle.

- After the new bounds are calculated, the layer selection process can continue from (1). All layer matrices are rotated and fit into the new bounds.

As explained in this section, the main feature of the proposed image format is the ability to define many auto selectable layers. These layers would enhance the visibility of the main content of the image. This way, the image format allows more layer to exist that would be

rendered when the image is placed above the background of a certain brightness. However, the format allows for a different usage derived from the image format design. Such derived usage allows designers to create at least two different images. For example, these may be logo designs. Designers can choose which logo is optimal for different backgrounds. The designer can set the logo, which is optimised for bright backgrounds into a layer set to be rendered when the image is placed on a bright background. Likewise, he or she can set the logo optimised for dark backgrounds into a layer set to be rendered when the image is placed on a dark background. This way, one image package can contain two completely separate images. Each layer contains an optimised logo for the dark and light backgrounds. This method can be used to create one image for more than two situations for different grades of background brightness.

4. USE CASE

In case of the image containing a company logo shown in Illustration 1, at least one solution can be found for resolving the low contrast issue. One method relays on adding a permanently visible surrounding logo holder that would be visible on all backgrounds. This method would be the only applicable in case of PNG images that are the most used image formats on the web, , which fully support the alpha-channel (Web Technology Surveys, 2016). In this section, two methods of resolving the aforementioned issue are given.

The discerning container method

The first method uses the proposed image format that has two layers. The topmost layer contains the company logo as seen in Illustration 1. The second layer contains a drawing of a certain shape designed to fit the logo visually. It is designed to be an adequate surrounding container of a light colour combination. It is set to become visible for background brightness of 60% or less. The result of the rendering is shown in illustration 2.

Illustration 2. Comparison of rendering a random company logo with opacity via alpha channel on light and dark backgrounds with the use of the proposed image format with a second adaptively selected layer seen on the right.

As can be seen in Illustration 1, the rendering shown on the right is a result of the second layer being shown in the finally rendered image. This is because the background brightness is less than 60%. The image on the left shows the same logo without the second layer shown. This is because its underlying background, although coloured, is not within the defined threshold range of 0% to 60% for that layer.

The selective content method

This image format also provides the derived use. Initially, this use was not considered. Later on, it was recognised as a potentially good practice. It is characterised by using two or more different image contents for each layer. In addition, layers have threshold values set in such a way so that no more than one layer is shown at one time for one background brightness intensity. For example, this selective content method allows the designer to define two modes of the same logo. Each logo can be optimised for two selected background brightness ranges (Koyani, Bailey, & Nall, 2004). In the example given in this use case, the original company logo has another version adapted for dark backgrounds. The image is packed with two layers. Each layer contains the full logo. Thresholds are set to 0.0 and 0.59999999 for the first layer, which contains the dark background optimised logo and 0.6 and 1.0 for the second layer, which contains the light background optimised logo. The resulting rendering of an image packed in that way is shown in Illustration 3.

Illustration 3. Comparison of rendering a random company logo with opacity via alpha channel on light and dark backgrounds with the use of the proposed image format with two seelctively displayed intepedant contet layers.

The method used to render the logo shown in Illustration 3, can *i.e.* be used for creating a range of more than two logos. Each logo can be fitted for more than two background brightness intensity ranges. By designing such an image, almost all scenarios can be accounted for. This way, inadequate contrast issues are resolved with just one file loaded into the web page. This is especially useful if the web page design changes themes for each user according to the personalised design (I-Hsien & Hui-Ju, 2009).

Comparing layer images and identifyng their peoperties

Each layer image is matched against the background and the appropriate thresholds are identified. The thresholds are selected by identifying dissimilarities between the image and the background. Proper thresholds are identified by measuring the recognisability and similarity of positions of certain peaks.
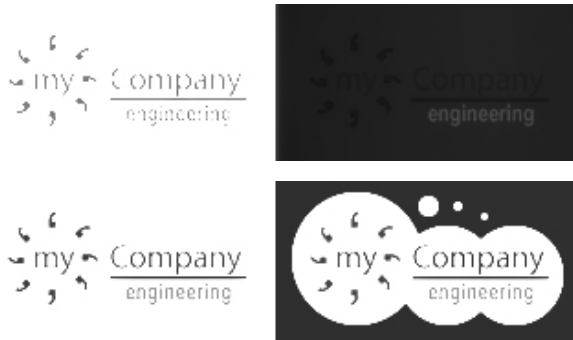
Illustration 4. Comparing peaks β and β' in order to identify patterns within the image resulting from overlaying a layer image over the target background

Parameters that are used for comparison are colours, textures, contours and peaks. Multiple parameters are chosen for comparison because it yields better results. We have compared frequencies for each colour j in the background β and the overlaid image β' based on the coherent pixels for the same colour rounded by the following formula (8).

$$dist(\beta, \beta') = \sum_{j=1}^{J} \left(\left| \frac{\alpha_j - \alpha'_j}{\alpha_j + \alpha'_j + 1} \right| + \left| \frac{\beta_j - \beta'_j}{\beta_j + \beta'_j + 1} \right| \right) \qquad (8)$$

In (8) α and β are coherent and incoherent pixel colour histograms, respectively. The presented method was used to calculate the distance between colours.

First, we used a monochromatic version of the resulting image with different brightness levels (grey and white), which were automatically iterated through to create all possible toeholds. In such images, we looked for negligible and regular variations of the distance from the midpoint colour value (grey) and we recorded all repetitions. With these results, we formed a matrix with rows and columns representing all shades of the image and the number of identified peaks. By iterating through this image, we have identified thresholds with the maximum number of smallest coherent peaks. Finding peaks allows for finding the outline of the shape of the rendered image.

After putting the logo over the background, we use the following method:

$$K = \sum_{a=0}^{N-1} \sum_{b=0}^{N-1} (a - b)^2 g(a, b) \qquad (9)$$

In (9) a and b are indices of the formed matrix and g is the matrix. Value K is the resulting average colour intensity of the entire matrix.

When we utilize these methods to analyse images for all thresholds in the matrix and their corresponding calculated K values, we found the number of pixels of the matching K value, thus finding all peaks. These peaks are counted for each threshold.

For logos overlaid on over a pure white background, the following peak representations are found:

Illustration 5. Comparison of the number of identified peaks at two neighboring threshold values for the logos over a white background

In Illustration 5, we show the peaks for threshold values 45 and 46. The number of peaks at threshold 45 is 1, which is also the minimum useful threshold value, where the image on the right shows a much larger number of peaks found for the threshold value 46.

Illustration 6. Comparison of the number of identified peaks at two neighboring threshold values for logos over a white background

In Illustration 6, we show the peaks for threshold value 48. At this threshold value, the first image on the left shows a smaller number of peaks, while the image on the right has more peaks, but the image has become unusable because the background had covered the entire surrounding of the logo.

When the designer does not specify proper thresholds or wants the application to suggest proper thresholds for the newly designed and packed image, this method is

used. Essentially, we attempt to find the minimal threshold that yields the maximum number of peaks, which are usable. In this way, we identify which of the layers (images) should be used for a predefined set of backgrounds partitioned based on the total number of layers packed in the image of this format. For example, if the image has two layers, we test layers against the white and the black background. If there are three layers, we test them against black, mid-way grey and white.

5. CONCLUSION

As described in this paper, the proposed solution helps solve some issues that occur with image formats used on the web. The key problem solved by the proposed image format is the insufficient content to background contrast distance. It occurs on web sites that change their design based on the user personalisation philosophy. This is especially true in the domain of colour and contrasts of the surrounding context. The low contrast issue is currently solved by creating multiple files. Appropriate files are loaded through CSS depending on the known colour of the background. This solution is flawed in cases when the background is not a known colour. In such cases, the yielding visual impression, derived from its combination with the image is not predictable. Such cases may occur from backgrounds comprised of photographs *etc.* The solution detailed in this paper presented a way of using the proposed image format. By supporting multiple layers with additional meta data comprised of threshold values, the rendering engine determines if a layer should be displayed or not. In addition, three related scenarios were presented that illustrate situations where a random company logo is displayed on bright and dark surfaces. Scenarios with a common PNG image format and the proposed image format are shown. The new image format is presented by using two suggested design techniques to help one image file adapt to both background surfaces better. With both techniques, designers can set additional Meta data that would ensure proper use of the logo in accordance with the predefined rules and guidelines. This would result in a decrease of improper use of corporate logos by third parties, because companies depend on their logo being used in accordance with their defined guidelines for branding as one of the key elements of marketing.

6. FUTURE WORK

The current implementation of the image format uses third party software in order to completely implement the concept. This software requires that the HTML of the web page is copied and remotely converted into an image. In the future, the development of a method for obtaining the underplaying background will be researched even though there is no pending implementation of such a functionality in web browser cores. In addition, future work will explore more methods of implementing support for vector image layers. Another important part of our future work will be to identify or develop a better method of identifying optimal layer threshold values.

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USE OF INTERNET IN THE JOB SEARCH PROCESS: GENDER PERSPECTIVE

Marina Savković,
Slavko Alčaković,
Nemanja Đorđić

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Bearing in mind the slowdown of the global economy and modest potential for job creation, job seekers are in a vulnerable position. This particularly applies to the young people who are looking for the first employment. That has led to a growing interest in analyzing the ways in which candidates look for a job, and effectiveness of certain tools. In the last fifteen years, the Internet has been widely accepted as a job search tool. Therefore, the authors have placed special emphasis on the Internet job search activities of young people in Serbia and possible gender based differences. The results have shown that there are no gender-based differences in behaviour of young job seekers. In addition, it can be concluded that the Internet job search activities are very intensive and recognized as one of the main job search tools, with the international trends in behaviour of job seekers.

Key words:

job search activities, the Internet, young job seekers, job search intensity, gender-based differences in behaviour of job seekers.

1. INTRODUCTION

Young people are faced with difficulties at labor market. That particularly refers to the job search period, possibilities of finding stable employment, unemployment and poverty risks *etc.* (Arandarenko, 2011; Krstić *et al.*, 2010; Jovičić & Lazarević, 2014; European Commission, 2012). As a consequence of labor market flexibilization and latest international economic crisis, young people face the possibility of finding non-standard employment, long-term job search and labor market exclusion (European Commission, 2012; O'Reilly *et al.*, 2015). These are some of the reasons for the growing scientific and research interest in job search activities, its intensity and effectiveness.

On the other hand, the Internet has become a very important channel for job search activities (Kuhn & Skuterud, 2002; Van Roy, 2003; Kudlyak & Romero, 2013). Due to its rapid expansion, the intensity of Internet job activities among job seekers tripled in the period from 1998 to 2009 (Kuhn & Mansour, 2011). On the other hand, Internet job matching platforms have emerged over the past fifteen years, and have become an important element of modern labour markets (Levin, 2011). The Internet has led to reallocation of effort among various job search activities (Stevenson,

Correspondence:

Marina Savković

e-mail:

msavkovic@singidunum.ac.rs

2008), so the Internet resource has become the main source of information used by job seekers during the job search process (Van Roy, 2003; Stevenson, 2008; Beard, 2010; Kudlyak & Romero, 2013).

Internet use in job search process and its effect on employment outcomes have also changed over time. Although job search was first considered ineffective, recent findings suggest that it has become an effective tool for finding a job, so it reduces individual workers' unemployment duration (Kuhn & Mansour, 2011; Suvankulov & Chi Keung Lau, 2012). Also, job seekers who use Internet for search activities had positive employment or reemployment outcomes, compared to general job seekers population (Suvankulov & Chi Keung Lau, 2012). The Internet also has positive effects on general labour market activity. Some analyses have shown that the Internet use keeps job seekers active and reduces the possibility of job search discouragement by over 50 percent (Beard *et al.*, 2010).

2. INTERNET USE IN GENDER PERSPECTIVE

Bearing in mind gender based differences in labor market outcomes (Arandarenko, 2011; European Commission, 2012), gender perspective of Internet use in this case is important. Gender gap in the Internet use was evident in 1990s, but it decreased and almost disappeared in 2000s (Ono & Zavodny, 2002).

The main research question of this paper is: „Is there any gender-based gap in the Internet job search activities among the young job seekers in Serbia?" It was mainly related to Internet job search intensity and use of different Internet contents in job search process (online job boards, employers' websites visits, professional and other social networks, job search clubs, online job advertisements *etc.*). We were also interested in the devices job seekers use for Internet job search. Our hipothesis is defined in the following way: There are no statistically significant gender-based differences in Internet job search activities.

2. METHODOLOGY

Research method used in this case was the online survey. Respondents were participants of a career fair held at Singidunum University on March 4th, 2016. They were predominately graduates who uploaded their CV in the career fair database. They were asked to give answers to different questions related to several aspects of the job search process. Out of 173 respodents, 121 were women and 52 man, which aproximately represents gender struc-

ture of visitors attending this career fair. Also, over 98% of respondents were younger than 35.62. Furthermore, 8% of them were aged between 15-24, years old, since 35.7% were in the age group of 24-35.
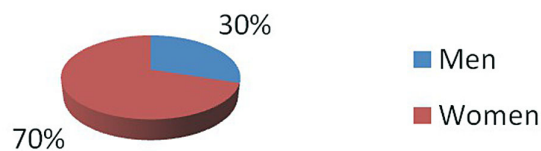
Figure 1. Sample structure

Job search activities could be generally analized through job search effort and intensity, job search strategies, preparatory and active job search behavior, formal and informal job sources, specific job search behavior job search quality, job search dynamics, and job search persistence *etc.* (Van Hoye, 2014, p. 2). We were predominantly interested in the intensity of job search activities. The areas of job search covered are:

- ◆ Internet job search activities,
- ◆ Devices used for Internet job search.

We used ANOVA to compare potential gender-based differences within the sample, related to job search activities. Independent variable was gender, since dependent variables were: "I use social networks (Linkedin, Twitter, Facebook *etc.*) in the job search process", "I use online job boards", "I visit employers websites", "I network with other job seekers using specialized websites". The respondents were asked to grade their specific Internet activity on 1-5 scale (where „1" stands for „never" and 5 stands for „very often").

We also wanted to find out something about the intensity and possible gender-based differences of devices used for Internet job search. ANOVA was also used in this case, where independent variable was gender, while dependent variables were: "I use laptop when search for job related information", "I use desktop computer when search for job related information", "I use mobile phone when search for job related information", "I use tablet computer when search for job related information" and "I use other devices when search for job related information". The questionnaire included other questions related to non-Internet job search activities (Use of HR agences services, Career fairs visits, use of university career center services, use of National Employment Office services *etc.*), job search strategy, salary and other relevant labor market preferences, but it will not be analyzed in detail, bearing in mind the specific research topic.

3. RESULTS AND DISCUSSION

According to the results in Table 1, there are no differences in general Internet use for job search activities. More than 95% of respondents actively use Internet in job search process, which is in accordance with the international trends of job seekers behaviour.

Gender of respondents	Answers			
	Yes	%	No	%
Man	50	96.15	2	3.85
Women	115	95.04	6	4.96

Table 1. Question: Do you use Internet services in the job search process?

The results show that there is no statistically significant gender-based difference in intensity of the Internet job search activities in any of the cases (Table 2). The use of online job boards (4.16) and employers websites visits (3.86) were the most intensive Internet job search activities for all the respondents. Networking with other job seekers was not recognized as an interesting job search activity by any group (2.29 in average).

Questions	Gender	Mean	SD	N
I use social networks (Linkedin, Twitter, Facebook *etc.*) in the job search process	Male	3.02	1.435	51
	Female	3.36	1.,448	120
	Total	3.26	1.448	171
I use online job boards	Male	4.25	1.214	51
	Female	4.12	1.204	120
	Total	**4.16**	1.205	171
I visit employers websites	Male	3.67	1.052	51
	Female	3.94	1.19	120
	Total	**3.86**	1.155	171
I network with other job seekers using specialized websites	Male	2.25	1.278	51
	Female	2.3	1.274	120
	Total	**2.29**	1.272	171

SD – standard deviation; N – Number of respondents

Table 2. Question: Intensity of different ways of Internet job search

It is interesting that online social networks are not used at all among 28.2% of the respondents. Linkedin was recognized as the best social network for job search activities (55.8%), Facebook was favored by 13,6% of the respondents, while Twitter was not recognized at all in this sense (no respondent recognized it as the best social network for job search).

Since we also surveyed intensity of non-internet job search activities, we can mention that the differences were recognized only for three job search activities: 1. Use of HR agencies services (F $(1,170)$= 3,944, p=0.05), 2. Career fairs visits (F $(1,170)$= 9,497, p<0.05), and 3. Use of university career center services (F $(1,170)$=5,092, p<0.05). Women are more engaged in all of the mentioned activities, which is consistent with the sample structure and gender structure of career fair visitors.

Questions	Gender	Mean	Std. Dev.	N
I use laptop when search for job related information	Male	3.55	1.646	49
	Female	4.17	1.354	118
	Total	**3.99**	1.468	167
I use desktop computer when search for job related information	Male	3.33	1.688	49
	Female	2.75	1.659	118
	Total	2.92	1.683	167
I use mobile phone when search for job related information	Male	3.18	1.523	49
	Female	3.43	1.38	118
	Total	**3.36**	1.424	167
I use tablet computer when search for job related information	Male	1.53	1.082	49
	Female	1.74	1.317	118
	Total	**1.68**	1.253	167
I use other devices when search for job related information	Male	1.51	0.845	49
	Female	1.89	1.407	118
	Total	1.78	1.277	167

SD – standard deviation; N – Number of respondents

Table 3. Devices used for Internet job search

Devices used for Internet job search activities were also an area of our research interest. Differences were found only in the cases of laptop (F $(1,170)$= 8,825, $p<0.05$) and desktop computer use (F $(1,170)$= 6,007, $p<0.05$). Female respondents use laptop more often than male respondents. On the other side, male respondents use desktop computers more intensively than female when looking for job related information. The most interesting devices for job search are laptops (3.99) and mobile phones (3.36). In most of the cases, the tablet computer was not recognized as an Internet job search device (1.68).

4. CONCLUSION

Our research results show that the Internet as a job search tool is used almost by all young job seekers in Serbia. They actively use different Internet platforms and contents in the job search process more often than non-Internet job search activities, which is similar to previous scientific findings in this field. We could observe significant differences in intensity of different Internet job search activities. Online job boards were most attractive to the respondents, while networking with other job seekers was not recognized as a regular job search activity. Internet use has became broadly accepted both among men and women, which is also relevant for job seekers behavior literature.

We could not find statistically significant difference in Internet use in the job search process among male and female respondents. Also, intensity of Internet job search activities is very similar. Some differences were recognized when we analyzed devices used for job search activities and non-Internet job search activities. Bearing in mind all of the mentioned, we can say that our research hypothesis is confirmed.

Some future analyses could be focused on gender based differences of older groups of job seekers. Also, job search strategies, general job search intensity could be correlated with Internet job search activities and possible gender based differences. Finally, effectiveness of every Internet job search activity should be evaluated in the perspective of employment outcomes, since some of the activities were widely accepted (Use of online job boards) and some were not recognized at all (Networking with other job seekers).

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METAMODEL OF A SERVICE-ORIENTED BUSINESS

Milosav Majstorović[1],
Dušan Regodić[2],
Gojko Grubor[3]

[1]Information Technology School,
Belgrade, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[3]University of Sinergija,
Bijeljina, The Republic of Srpska, B&H

Abstract:

In order to maintain their competitiveness or to achieve the desired position in the dynamic market environment, a vast majority of companies are turning to service-oriented business concepts. These changes require the design of a new business model that will take into account a new business approach. This task presents a great challenge for company managers, who are often burdened with the traditional view on business models. However, in order to facilitate this challenge, the appropriate approach and tools are required. The well-known approaches to development of service-oriented business provide informal and semi-formal tools that can produce ambiguities and which give limited possibilities for application of software tools in design. This paper presents service-oriented business as an ontological meta model aimed at solving the above mentioned problem. The developed meta model represents a unique conceptualization and it contributes to a more precise definition of service-oriented business concepts. The paper illustrates one possible application of the developed meta model for creating service-oriented business model of a certain organisation (company) through meta model instance. This application is implemented in an insurance company, life insurance sector.

Key words:
service-oriented business, ontology, meta model,
service-oriented business model, meta model instance.

1. INTRODUCTION

Service-oriented business provides services to its clients, *i.e.* customers. Generally, businesses and companies can be classified as those which provide goods (tangible items) and those which provide services. The companies that provide goods include mines, farms, factories, *etc.* Banks, retail facilities, communication media, health institutions, insurance companies, *etc.*, are the examples of organizations with service-oriented businesses (SOB). Information services, including software companies and Internet-based organisations are becoming a significant part of the service-providing industry. Therefore, this business forms so-called Service Industry, *i.e.* service sector which represents the main sector of the economy of developed countries. In these countries, service sector acquires more than 70% of gross national product and employment rate for years (Stauss, 2008).

Current and upcoming radical business transformation and innovative logic in the domain of high technology industry (*e.g.* ICT and

Correspondence:

Milosav Majstorović

e-mail:
milosav.majstorovic@its.edu.rs

pharmaceutics) demand that the companies reconsider the approach to their main activities. For example, in addition to the focus orientation towards the development of new software products, ICT companies must find new business opportunities in the service sector. In service business, service is the basis of value creation. If they want to become competitive or to maintain their competitiveness, they have to change their focus from goods towards services. When doing this they have to change the entire business logic from production of both goods and services for clients, towards creation of new values together with their clients (Wallin, 2012). These changes require the design of a new business model which will support a new approach to business.

Due to the growing popularity of the Internet, the attention focused on business models significantly increased in the middle of the 1990s not only in industrial, but also in academic circles (Zott *et al.*, 2010). This fact was a consequence of increased competition of similar products and services, which required their differentiation through different business models (Giesen *et al.*, 2007). At the system level, the concept of business model offers a comprehensive view of the business logic and activities required for successful business operations, and it is particularly focused on the presentation of value creation (Zott *et al.*, 2010).

Despite the application of business model concept in SOB, the existing approaches have their drawbacks in treating SOB characteristics (Zolnowski and Böhmann 2011). Also, the familiar approaches to the development of service-oriented business models (SOBM) provide informal and semi-formal tools that can produce ambiguities and offer limited possibilities for application of software tools in designing.

Aimed at solving the above mentioned problems, this paper presents SOB as an ontological meta model which takes into consideration the characteristics of Service Dominant Business Model (SDBM), and reflects the process of its creation (described in Luftenegger *et al.*, 2013). The developed meta model contributes to a more precise definition of business model elements for SOB, and creates an assumption for development of software tools which would provide easier creation of business models. The paper illustrates one of the possible applications of the developed meta model for creating SOBM of a specific organization (company), through meta model instance. This application has been carried out in the case of an insurance company (IC), life insurance sector.

Section 2 discusses the conceptual modelling, the concept of meta model and ontology from an academic perspective, and then elaborates on the concept of a busi-

ness model. Special attention is paid to SDBM. The new ontology meta model of SOB that shows logical structure and semantics of SOB elements and their relationship is given in Section 3. Section 4 presents the development of SOBM in the organization of a specific field (the insurance industry) through ontological meta model instancing. Section 5 considers the achieved results and ideas for further work.

2. RELATED PAPERS AND BASIC CONCEPTS

Conceptual Modelling, Meta models and Ontologies

There is a widespread use of conceptual models which facilitate the development, implementation and maintenance of information systems (IS). Conceptual modelling is described as "a formal description activity" of the aspects of natural and social phenomena for the purpose of understanding and communication among people. One of the advantages of conceptual modelling application is the possibility to include semantics of the desired concepts by using formal notation. The result of conceptual modelling is the description intended for people and not for machines. Therefore, the semantics contained in conceptual models is in most cases implicit, and cannot be processed automated (Fill, 2009). This paper uses UML language to express the conceptual model of SOB, with the emphasis being places on the simplicity of the model component structure view. The conceptual model created in such a manner can be extended for the purpose of explicit modelling of implied semantics, thus making it suitable for processing by using the techniques indicated in (Fill, 2009).

Models as the abstraction of specific phenomena play a significant role in modern software engineering, and they can be found at various levels of abstraction. At the higher level of abstraction "a model of the models" is called meta model, *i.e.* the model is an instance of meta model (OMG, 2011). Compared with other approaches for modelling language description, such as grammar graph or logic formalisms, meta models offer an intuitive approach to semantics specification; therefore, they are suitable for non-technical customers. Meta models are particularly suitable for definition of conceptual models (Fill, 2009). They also are used for this purpose herein.

In (Atkinson, 2003) two orthogonal dimensions of meta modelling are separated: a linguistic and an ontological one. The difference between these dimensions is reflected in the form of meta model instancing. The linguistic dimension deals with the definition of language and the relation between its elements. The ontological

dimension deals with identification and description of the elements within the observation domain. Therefore, ontological meta models are connected with classification of model elements, in accordance with their type, role and content. This paper uses ontological instancing in order to create a meta model of SOB and the derivation of business model of a service-oriented company by instancing the developed SOB meta model.

Business models

The interest in business models has become especially prominent since mid-90s, which resulted in more approaches for creating business model. The traditional concept of business model promotes dual focus: creation of value and assurance of value. Creation of value relates to the way that a company creates value for a customer. Value assurance is related to the way in which a company obtains benefit from the value creation process (Luftenegger *et al.,* 2013).

In (Zott *et al.,* 2011) the overview of literature related to business model is given, which covers many research fields and gives a comprehensive perspective. These research fields include: strategic approach to business models, e-commerce, innovations and technology management. Taking into consideration different development fields in business model research, Zott *et al.* (2011) identified the following aspects and catalysts for unique research of business models:

- First, business model itself is a concept focused on a particular company, but its scope extends beyond the boundaries of the specific organization.
- Second, at the system level business models refer to how the company realises its business.
- Third, management activities are crucial in the proposed conceptualization of a business model.
- Fourth, a business model aims to explain creation and assurance of value.

Business model concept has multiple definitions, which can lead to confusion and slower improvement in research and development of business models. One way to overcome this issue is development of ontology for business domains. Ontology can enable better definition and understanding of a particular business model and give a basis for the use of software tools as support to creating business models (Osterwalder, 2004). Some of the best established ontologies of business models are REA (Resource Events Agents), e³ value, Business Model Ontology – BMO (Hauksson, 2013). Osterwalder

& Pigneur (2010) gave a pattern for building a business model in the form of Business Model Canvas (BMC), which divides a business model into nine constitutional blocks. Each of these nine blocks can be grouped into four fields: offer, customer, infrastructure and finance.

Service dominant business model

Since the existing approaches to business model tools are limited by orientation towards tangible products as a dominant direction in business realization, in (Luftenegger *et al*., 2013) considerable effort was made towards conceptualization and development of tools for the design and analysis of business models for service dominant business. The context for this research was an interdisciplinary vision of Service Science.

Luftenegger *et al*. (2013) distinguish the concept of value in Service Science from a traditional view on the value in business models. Namely, value creation in the literature on business models is usually connected with production processes, where a company creates values (in commercial sense) when a product is sold to a customer. In this traditional view, when the value is created as a product (*e.g.* a car) it can be added through service (*e.g.* car maintenance). In this approach, the value is distributed as a product, and the service becomes a post-production process, where value can be added to the value based on product. However, Service Science treats final values through collaboration with the customer (joint creation of value). In this respect, the value is created through utilization, *i.e.* through benefits that are gained by using the product. Thus, Luftenegger *et al*. (2013) use the concept "value in use" in conceptualizing a business model within the Service Science.

Following the Service Dominant Strategy (SDS), Luftenegger *et al*. (2012a, 2012b) took into consideration the specific business aspects such as competences and collaboration values, relationships initiated from the inside, relationships initiated from the outside of an organization, as well as the role of participants and infrastructure resources. The Strategy is taken as a factor that has an impact on designing business models. Therefore, the specific business models with service oriented business are designed by using service dominant logic (Vargo and Lusch 2004) and (Vargo and Akaka 2009).

Luftenegger *et al*. (2013) use BMC derived from business model ontology (Osterwalder, 2004), in building the ontology of Service Dominant Business Model (SDBM). In doing so, they started from SDS as a basis (Luftenegger *et al*. 2012a). Starting from the statements related to

SDS, its elements were obtained through answers to the following questions:

1. How is the company connected with business environment in service dominant business?
2. How does the company realize business relations in service dominant business?
3. Which constitutional elements does the company require to realise service dominant business?

The answers to the above questions identify the elements which are grouped into the following categories: market relations, business competences and business resources. The elements of SDS are also presented in (Luftenegger *et al.*, 2012a) through so-called canvas of SDBM (similar to the business model (Osterwalder and Pigneur, 2010)). The elements of SDS obtained in this way are used as a baseline for gaining elements of SDBM. Luftenegger (2014) gives the procedure for obtaining these elements, which has been used for creating ontological meta model of SOB in this paper.

3. META MODEL OF SERVICE-ORIENTED BUSINESS

Figure 1 shows meta model of SOB. It is created on the basis of BMO (Osterwalder, 2004), BMC (Osterwalder and Pigneur, 2010), SDBM (Luftenegger, 2014) and the authors' experience. The meta model shows elements of SOB and their relationships. The following text briefly describes the elements of meta models and their relationships.

The concept of *value* often has multiple interpretations in literature. One of the meanings is usefulness, *i.e.* the significance of a business service or product. Vargo and Lusch (2004) suggest that the value is not an internal characteristic of a service, *i.e.* product, but it is established by the customer of the product, *i.e.* service as a utilization value, while the company only creates "value proposition". Having this in mind, in meta model these aspects of value concept are divided into three classes: *Mutual Value Proposition*, *Value in Use* and *Product/Service.*

Unlike the traditional concept of value proposition in BMC, Figure 1 emphasises that the value is created through the element of *Mutual value proposition* by interaction and participation of several participants, *i.e.* the suggested value should represent the solution to a certain issue of the customer. During the process of utilization, the value proposition becomes "utilization value" (the class *value in use*). Utilization value is reached through product or service usage (the class *Product/Service*)

The class *Participant* is an abstract class that designates all types of participants that appear in business. This superclass is suitable for modelling characteristics and relationships that all the participants in business have. Thus, all the participants in business realisation perform specific activities (the class *Activities*). The partnership, *i.e.* relations between participants, is enabled through the activities of the participants (the class *Partnership*). Partnership is a sort of agreement between participants (the class *Partnership* is a subclass of the class *Agreement*). Partnership itself can represent several agreements (the relation *Set of* between the classes *Partnership* and *Agreement).*

The intention to create value proposition in SOB through mutual activity of participants in the process has been illustrated by the relation *Based on* between the classes *Mutual Value proposition* and *Partnership*. Likewise, the product *i.e.* service is created through the partnership between the participants. The key role of partnership in SOB is also emphasized by the relation *Assures* towards the class *Benefit*. Therefore, the participants gain benefits through the partnership, which is also a motivation for their participation in the entire ecosystem.

Some specific resources are required in order to realise a business goal. The class *Resource* represents the concept which participates, *i.e.* which is used in the process of value creation. At the highest level of abstraction, the resources are instances of the class *Participant*, *i.e.* its subclasses *Customer*, *Partner* and *Organisation* (*i.e.* a company in the focus of a project). More specifically, the resources are composed of ICT infrastructure, employees, materials and other participants' capacities. The created value is delivered through a specific distribution channel (the instances of the class *Distribution channel*) which belongs to one of the participants. The distribution channel participates in the total business costs.

The *Capability* class designates the concept that is an abstraction of system elements which represent its behaviour. More specifically, capability is the ability of an entity (department, organisation, person, system, *etc.*) to perform activities which contribute to the accomplishment of its tasks especially within the mission of the whole system. In our approach, capability is also a type of resource (a subclass of the *Resource* class). A specific resource is provided by a respective participant, and capability enables the participant to contribute to value creation. Through their activities all the participants make specific costs (the appearance of the *Cost* class). The difference between gained benefits and operating costs is a realised profit. Therefore, profit is thus a derived element, so it is not specifically presented at the
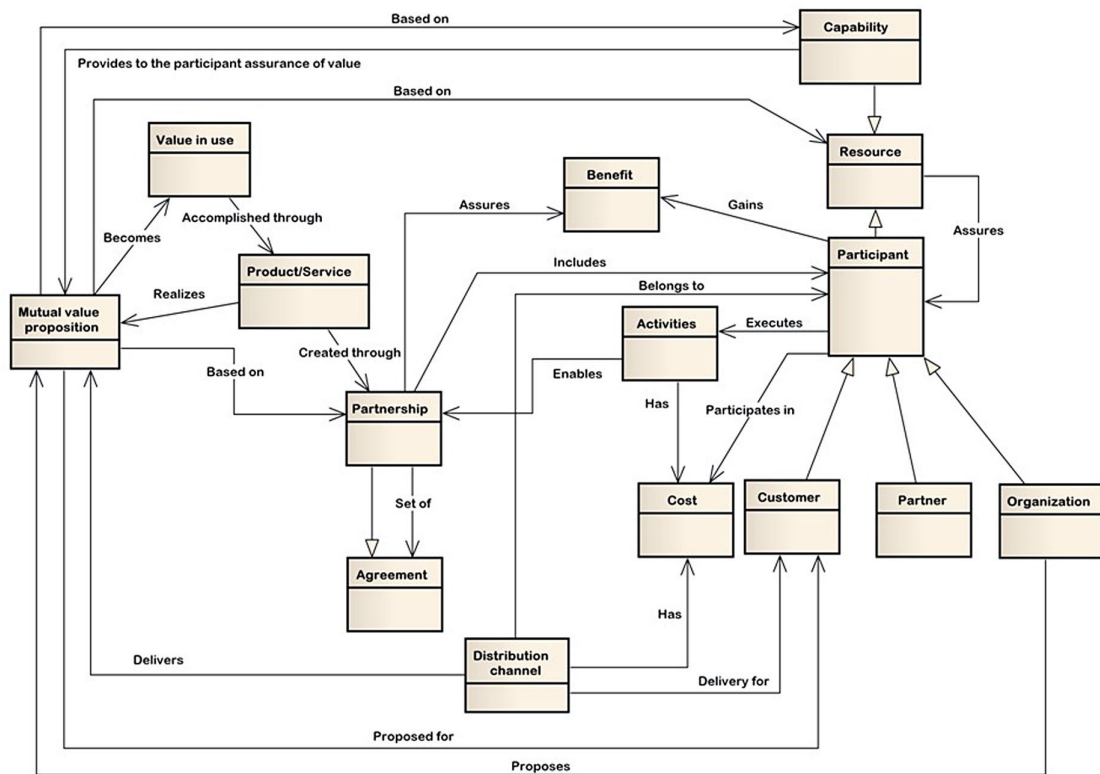
Figure 1. Ontological meta model of service-oriented business
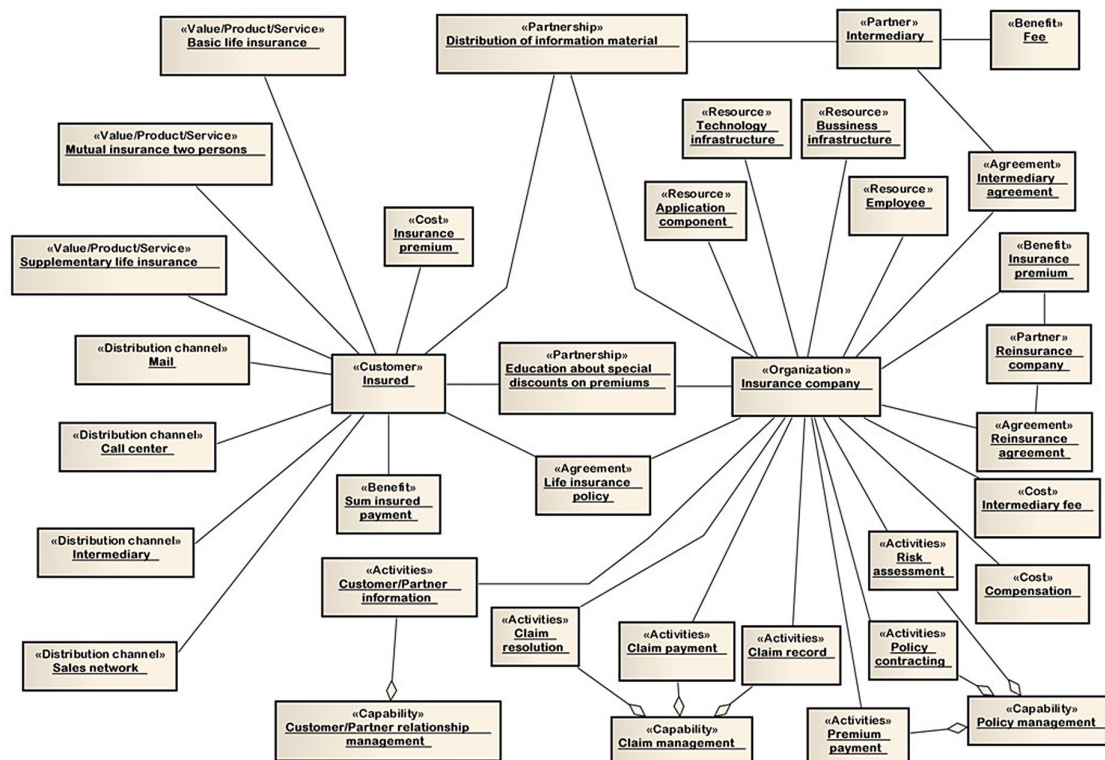
Figure 2. The example of SOBM of an organization

meta model although it is certainly one of the business objectives (except in non-profit organisations). Due to the aspiration towards simplicity and transparency of the meta model diagram, it does not show all the relations that exist between SOB concepts presented by the classes.

4. SOBM OF AN ORGANISATION

In our approach, the SOBM of a standardised organisation (company) from the specific domain, *i.e.* industry, is created by instancing the SOB meta model shown above, using SDBM (Luftenegger, 2014) and domain frameworks and standards. A business model from the domain of insurance industry will be presented here. Polaine *et al.* (2013) give theoretical and practical bases for service designing; they particularly deal with the insurance industry showing that insurance is a service, not a traditional product, which means that the insurance industry is characterized by SOB.

SOB meta model instancing

Figure 2 shows a SOBM for the insurance industry, life insurance sector. The model represents an instance of SOB meta model (Figure 1) shown with the UML object diagram. The objects presented in the diagram represent the instances of classes from the meta model. During the meta model instancing, the classes *Mutual Value Proposition*, *Value in Use* and *Product/Service* are presented by the object with stereotype <<Value/Product/Service>>. The relationships between objects are not labelled, and as a principle, they inherit their semantics from the relations between the classes from the meta model. Also, for transparency purposes, the diagram does not show all the relationships. The objects are standardised, and they mostly designate the roles typical for a specific domain (in this case the insurance industry).

In the diagram that illustrates SOBM for life insurance sector (Figure 2), each object is assigned a stereotype marking a class of meta model whose instance it represents. During the instancing of meta model, ontology (Osterwalder, 2004) and BMC (Osterwalder & Pigneur, 2010) are used, particularly a SDBM (Luftenegger, 2014). The domain frameworks and standards are used to include the semantics of a specific domain. In this case, ACORD Framework has been used – the framework which enables architectural basis for IC for faster and easier preparation and implementation of changes required for successful business in the dynamic market (Gregory, 2005).

Practically, SOB meta model instancing is realised by instantiation of its classes, starting from the basic premises of SOB (Wallin, 2012) and the answers to SDS questions, as well as BMC (Luftenegger *et al.*, 2013) adjusted to the specific business domain. The examples of the particular SOB meta model classes instancing for the field of life insurance are given below. Instancing is done by the specification of SDS and BMC elements, using the domain knowledge given through the domain framework and standards. Thereby, the instantiation of objects is performed by addressing (confronting) SOB meta model elements with the questions what, who, how and how much.

What is Value Proposition and Value in Use for an IC? How can the IC enable Value in Use? The IC should create such a product, *i.e.* life insurance service, which will enable clients to acquire the desired basic and supplementary insurance by paying insurance premiums. When answering these questions we get the examples of objects which are class instances: Mutual Value Proposition, Value in Use and Product/Service.

How can IC achieve mutual business risk with its clients and partners in the context of the proposed values, *i.e.* life insurance service? By the selection of a particular insurance service and an appropriate insurance risk assessment for the specific client. The examples of objects which present answers to these questions are: Policy Contracting and Risk Assessment. Both objects are instances of the meta model Activities class.

How can IC accomplish cooperation with its clients and partners for the purpose of mutual value creation? Arranging meetings where customers could present their desires and capabilities; organising educational meetings where the possible special discounts on premiums would be presented; distributing info materials; meeting partners (banks, statistics institutes, agents, *etc.*) to share experience and encourage business cooperation. The examples of objects which represent answers to this question are: Education about Special Discounts on Premiums and Distribution of Information Material. Both objects are instances of the meta model partnership class.

Who are IC clients? The examples of IC clients in the life insurance are physical entities interested in life insurance (the Insured), persons interested in contracting insurance for themselves or for others (Policy Holder), persons on whose behalf the insurance is negotiated (Insurance Beneficiary). Figure 2 shows only the Insured object which is an instance of the meta model customer class.

What benefit will participants in a business network gain? The insured person gains benefit through the payment of insured amount (object: Sum insured payment),

intermediary through the gained commission (object: Fee), IC and reinsurance company through received insurance premiums (object: Insurance premium). All objects are instances of meta model benefit class.

By answering all the SDS questions the elements of SOB model are obtained. The respective stereotype is granted to the model elements in accordance with the SOB meta model. By analysing BMC (Osterwalder & Pigneur, 2010), it is verified that if all the fields are filled in taking into consideration the domain knowledge of the specific industry (in our case it is the life insurance industry). Finally, it is checked if each class from a meta model has obtained the respective instance. For the classes which are not instanced in the described procedure, the additional analysis is performed to complete their instancing. The analysis assumes certain repetition of the previous procedure. After creating the instances, their connection is performed in accordance with semantics of the SOB meta model.

5. CONCLUSION AND FUTURE WORKS

The growing importance of SOB in modern economy requires changes of business models in the companies which that want to apply SOB concepts. This has led to the question of adequate presentation of SOB concept in business models and definition of new approaches for their development. This paper has used meta modelling as an approach for SOB conceptualization. The ontological meta model is developed which represents the concepts of SOB. The meta model can represent a basis for the development of new business models in various domains of service business. The paper presents the creation of SOBM in an insurance company for the sector of life insurance, via instancing an ontological meta model.

Comparing to other existing approaches, the key benefit of our approach is the presentation of SDBM concepts through the ontological meta model which contributes to their more precise definition. Meta model reflects the process of SDBM creation, which begins from SDS and leads systematically to the identification of SDBM elements and their relationships.

In the future work, the semantic extension of the defined conceptual model (meta model) is planned, which would be suitable for machine processing. It would be used for the development of application which would provide software support for designing SOBM. Also, the research on synthesis of methodological framework for the development of SOB enterprise architecture is in progress, which would use the meta model presented in this paper. Therefore, the development of enterprise architecture would be in compliance with the defined business model, and the analysis of business model would show how the architectural changes affect business operations.

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INFORMATION TECHNOLOGIES AND PERSPECTIVES FOR EDUCATION DEVELOPMENT: LIFELONG AND ONLINE LEARNING

Slavka Drašković,
Ninela Kordić,
Jelena Stanković

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

This paper analyses the perspectives of education in the context of globalization and digital technologies. The Internet and the new economy which supports the increasing need for innovation and diversity have mostly led to the demand for lifelong education in order to effectively follow and adapt to changes. Information technologies (IT) actively support the creation and development of the knowledge market, enabling access to different sources of knowledge and information. Digital technology represents one of the key factors of the new economy based on the constant need for accessing new knowledge, but it also creates a global platform for distance learning as the source of fulfilling such needs. It has also led to new approaches in education by moving the emphasis from education of young people to education of adults and developing new field in adult education: the heutagogy.

In addition, the authors analyze the relation between the innovation-success paradigm and lifelong learning, stating that the need for continuous education creates a setting in which personal development never stops. They introduce the success scheme showing that continuing education, innovation and personal development are the required conditions for success. The perspectives of online education are also implied.

Key words:

the Internet, digital technology, lifelong learning, distance learning, innovation, education, success.

1. INTRODUCTION

Information technologies (IT) have brought about crucial changes in all aspects of society, business and education. Years ago, IT was distinguished as one of the main drivers of knowledge sharing and lifelong learning process development (Harasim *et al.,* 1995). The trend of rapid changes which accompanies new technology development shapes all together the present and future education processes, as well as the processes of teaching and learning. The new technology development has enabled flourishing of e-learning systems as forms of education mainly created for the purposes of exceeding some important obstacles in learning and teaching, such as scarce and restrictive resources as time, space, and finances. Over the past twenty years, people have managed to improve the quality of higher education by introducing computer-based learning systems. Such systems have the ability to create three important humane conditions for the users: communication, interaction and collaboration (Harasim *et al.,* 1995), which proved to be crucial for achieving the effective education outcomes..

Correspondence:

Slavka Drašković

e-mail:

sdraskovic@singidunum.ac.rs

The absence of one of the mentioned humane actions may result in creating intellectual property inadequate to serve as a source of potential competitive advantage.

In contemporary high-tech environment, the development and competitiveness requests innovation and diversity, based on knowledge and possibilities for continuous learning (Draskovic, 2011e). In such an environment, information and knowledge become key sources for building diversity (Al-Shammari, 2011), while innovations become the new paradigm of business development (Powell and Snellman 2004), thus making the processes of learning and searching for new knowledge never ending.

2. INFORMATION TECHNOLOGIES AND LIFELONG LEARNING

Lifelong education is defined as the activity of learning during the lifetime with the purpose of improving knowledge, skills and competencies for personal, civil, social and/or social perspectives of employment (Commission of the European Communities, 2001). The lifelong learning concept has become particularly important over the last decade, supported by development of new technologies which have started to change the way of sending and receiving information, cooperating, socializing and communicating (Kolb, 1984).

New technologies, hypercompetition, demand for innovation and new knowledge, have led to moving an emphasis from education of young people to education of adults. Furthermore, it has contributed to flourishing of Lifelong learning (LLL) and academic programs for adults (Draskovic, 2011e). Professional education of adults has been fast-developing during the past thirty years but not in the traditional form. A lot of educational institutions have introduced distance learning systems (DLS) implementing technological innovations to this fastest growing market of higher education: adult education (Merriam and Caffarela, 1999).

The shift from the society with an emphasis on young people to the society oriented towards adults plays a significant role in higher education development, especially in cases of creating online teaching and learning programs. As the focus of higher education moved from education during young age to permanent lifelong education of adults, education itself is no longer an exclusive right of the 18-year-olds. It has become an opportunity of the middle-agers.

One of the results of such a trend in education is the development of new fields in adult education: the heutagogy. Heutagogy is a term created by Hase and Kenyon

(2001) to define a lifelong learning, approach also called self-determined learning. It is based on the idea that the student is in the center of self-learning process, not the teacher and/or the curriculum. The student creates the learning program which is personalized according to time and learning outcomes. Hase and Kenyon (2001) argue that education, especially higher education, needs to develop a system that is proactive for learners, rather than reactive. After the presentation in 2001, this concept has been treated as a practical suggestion in e-learning education environments (Chapnick and Meloy 2005).

3. LIFELONG EDUCATION AND PERSONAL DEVELOPMENT

Emerging of web 2.0 supported the development of lifelong learning process, enabling direct, personalized learning to be established on an everyday basis (Dunlap and Lowenthal, 2011). In this way, new technology supports development of self-determined learning putting individual needs at the center of their education. This is even more important because the need for lifelong education creates a setting in which personal-development never ceases.

Continuous personal development becomes a necessity in today's global world, which has always been for any individual striving for success. This is even more true because personal development is the result of any individual success and is part of the process of change. Personal development-personal change and success are inevitably linked as described by „The scheme of success" (Draskovic, 2011d).

The Ssheme shows that success implies changes, crises, action, pioneer undertaking-innovation of some kind, and is influenced by the circumstances, as well as by the person itself. One has to go through personal development in order to get to the next level of success, as only then the success will be accomplished (Draskovic, 2011d).

The American myth of success, on which the American nation has been built, affirms this process. It is still an inevitable part of American culture and still prevailing, but it has changed over time. In the contemporary version of the Myth, the success does not only mean „grow rich" but „develop full personal potential", and wealth and richness will come as a result of it, as shown in Figure 2.

Thus, personal development becomes part of today's paradigm of innovation and knowledge-based society in which individual development through continuous education is the basis for development of the society (local community, company, *etc.*).
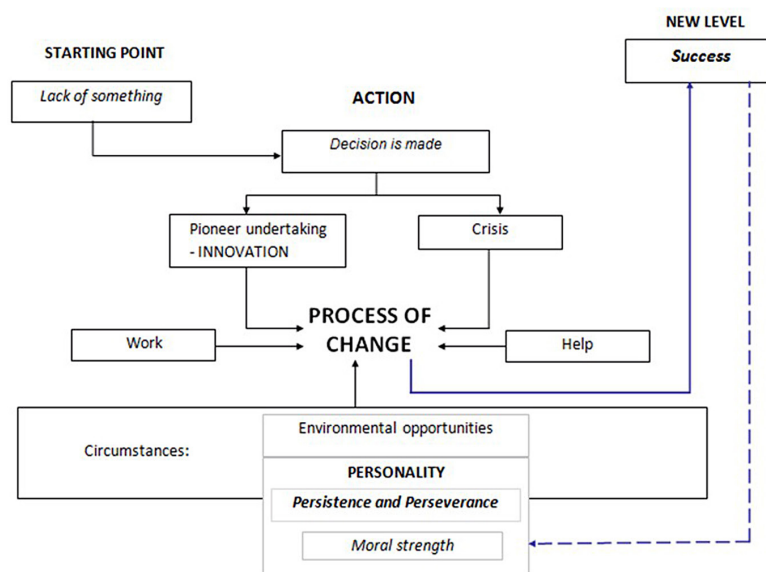
Fig. 1. The scheme of success (Draskovic, 2011.d)
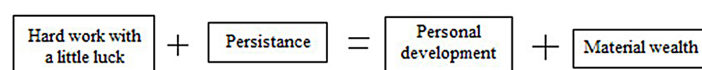
Fig. 2. American myth of success – contemporary version (Draskovic, 2011d)

Distance learning, as an innovative approach to education, teaching and learning, erases the boundaries for getting new knowledge on a continuous basis, as the source of competitiveness and development of a society.

4. PERSPECTIVES OF ONLINE AND LIFELONG EDUCATION

Online versus traditional education

In the beginning of distance education research and development, during last decade of the 20th century and the first decade of the 21st century, the prevalent issue was focused on comparing traditional versus distance education, and measuring the ratio of performance of online learning against traditional education (Schulte, 2010). A number of researches have been done in order to examine the efficiency of online and distance learning courses. The researches which compared distance learning and traditional courses have shown that the distance learning methods are as efficient as the traditional whenever there is interaction among students and feedback from the lecturers (Moore and Thompson, 1990; Verduin and Clark, 1991). Successful online learning practices are basically the same as successful traditional learning practices (Moore and Thompson, 1990; Wilson and Al-

len, 2010). The researches have also shown that online education requires extensive preparation and planning, and that the students are better off when their lecturers are skilled, when they adequately handle the technology, making an eye contact with the camera, repeating questions and having a sense of humor (Arsham, 2002; Wilson and Allen, 2010). It has become evident by now that the students who have taken online courses request support and instructions in order to study successfully. The support can be a combination of student-student and student-lecturer communication.

Although students performed better in an online education situation than in face-to-face situations on average, the traditional courses are more respectable (Arsham, 2002). It is considered that traditional lecturers use more obvious, clearer signals coming from their students during classes in order to make a better understanding of their teaching curricula (Ross, 2008). However, new technologies have supported the use of appropriate media and its combination during classes, with the use of auditive and visual effects which made possible to work in virtual classrooms, making the education process as vivid as in traditional, physical space. Virtual classrooms are proved to be motivating, enabling students and lecturers to actively communicate, providing

feedback, encouraging discussions, work in small teams during and after classes. Students keep interacting with each other, which leads them to group problem solving (Moore and Thompson, 1990; Wilson and Allen, 2010).

Future society based on knowledge

In July 2004, the European Union (EU) delivered the conclusions that the improvements of LLL are necessary for successful development of „the society based on knowledge". From 2007 to 2013 the EU bodies designed The Lifelong Learning Program (LLP) „to enable people, at any stage of their life, to take part in stimulating learning experiences, as well as developing education and training across Europe"with the budget of almost €7 billion. The EU continued with developing LLP under the new name Erasmus in the period from 2014 to 2020 (EU Life Long Learning Programme). The goal of the program is building the society based on knowledge and enhancing lifelong learning with the support of information technologies.

Serbia joined the EU Program for lifelong learning in December 2011 following the signing of a memorandum between Serbian government and the EU. Universities in Serbia took the leading role in developing lifelong learning (EU Life Long Learning Programme). The Center for Lifelong Learning was formed at the University of Belgrade, followed by the centers at University of Novi Sad and Nis, with the help of Tempus program.

The EU countries, and less developed countries in Europe like Serbia, focus their programs and funds on sustainable lifelong education (EU Life Long Learning Programme). In the USA, the number of lifelong programs, platforms and models are in progress, especially one of the options for development of online studies so called „mass open online courses"(MOOC) (Elaine and Seaman, 2013). Among the famous MOOC platforms there are EdX, Udacity and Coursera. Reports on the number of American universities which look upon online education as a key component of their 10-year long-term strategies (precisely from 2002 to 2012) have shown a small but steady increase over time. The percentage of all the students taking at least one online course is 32, and is the highest recorded (Elaine and Seaman, 2013).

Research and Predictions

Distance education is growing exponentially, and will continue to grow (Schulte, 2010). The researchers who have analyzed the literature on trends and issues facing distance education, like Howell, Laws, Williams and Lind-

say, have concluded that the technology will tend towards omnipresent and versatile Internet technology and that IT fluency will be needed and expected by all educational users (Eastmond, 2007). They also predict that the demand for online distance education will increase, and that the distinction between it and conventional education will blur. Winston agrees with that and underlines forces that will drive higher education with digitization, among which are digital publications, digital libraries, student proficiency in digital communication, publisher control of content and curriculum, increasing power of consumer-driven education delivery, increase in for-profit colleges and universities, *etc*. (Eastmond, 2007). He argues that these forces will create a number of possible scenarios by 2030, in which he describes the academe in a new age. The emerging generation will embrace and become natural users of the omnipresent Internet technologies. He believes that they will need to continuously learn, at any time or place. Winston further foresees that the publishing industry will own the knowledge base, transmitting it digitally, replacing the classroom professors as the source of knowledge. Professors, not higher education institutions, will be accredited and they will be free agents, working for several institutions simultaneously. He also foresees professional association accreditation and flourishing for-profit universities (Eastmond, 2007). Other researchers, like Beaudion (2006), have made similar conclusions but argue that despite the rapid development of online education over the past decade, the changes are being implemented at a slow pace. He predicts further globalization, the expansion of online LLL process, but also considers that the conventional higher education will not take advantage of digital media and telecommunication. The vacuum will be filled with further inclusion of commercial companies, foreign institutions and for-profit universities in the process. His speculations about further online education development are directed towards gaining interactive and collaborative advantages of DLS over traditional education in classrooms, followed by strong development of high technologies, which will enable people to connect with technology to create half-machines or cyborgs (Beaudoin, 2006).

Several prominent university higher education and new technologies experts (Parr, 2014) have given their predictions about the future of higher education. They have identified augmented reality, sensor technology and crowd sourcing as the technologies that could revolutionize higher education. They consider such trends as revolutionary for the higher education, and believe that they should be used in many different aspects of education over the next few years.

5. CONCLUSIONS

The introduction of new technologies has helped eliminating space barriers in teaching and learning. Furthermore, it has contributed to adult education development in the sense of learning from home, after work, from whatever source, wherever it comes from.

Online learning will continue to grow as distance learning has become: (1) an opportunity for collecting fresh knowledge, (2) a response to global trends and challenges such as hypercompetition, (3) a response to the need for better education approaches in time of constant change and innovation, (4) the part of new development paradigm based on knowledge without borders, (5) a solution for eliminating financial limits in education, and (6) an answer to the need for implementation of new technologies in all aspects of life and work (Draskovic, 2011e). Therefore, LLL and online education have become the vital part of a new paradigm of innovation, knowledge-based society and personal development.

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THE IMPORTANCE OF RESPONSIVE LOGO DESIGN ACROSS A WIDE RANGE OF DEVICES ON THE WEB

Aleksandar Mihajlović,

Jelena Gajić,

Jelena Stanković,

Milan Tair

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The aim of this paper is to clarify the significance of using responsive logos on web pages. It aims to bring a more flexible and contextual system of brand identification. This can be done by moving away from strict and inflexible design guidelines. The authors shall attempt to explain why logos in all its variations can be unambiguous memory hooks. Also, we emphasise that they can behave like many other elements in responsive web pages. Contemporary businesses demand adaptation of their content to many sophisticated communication platforms. Among these are the devices with different varying screen dimensions. A responsive logo can be used to build better user experiences across a wide range of devices, thus elevating brand freshness. Having in mind that logos are the key elements of corporate identity and brand positioning, it is mandatory to optimise it for every scenario. It is an element on par with colours or slogans. It can be simplified by applying responsive design principles to individual elements that make out the logo. By removing unnecessary parts in relation to the varying screen size, a clearer and much more readable logo can be arranged. We have built a model for applying responsive design to logos and performed experimental testing in the real environment.

Key words:

logo design, branding, responsive design, scalable vector graphics (SVG).

1. INTRODUCTION

Over the 25 year long history of the web, all images, including logos, have remained the most important pieces of information on the Internet. Unfortunately, they have not always been adaptable to varying screen sizes. Everything about them has been fixed, their size, format, *etc.* (Eric Portis, 2014). Over the years, various computer display resolution (specified as the width and height in pixels) have been used. With arrival of devices of different sizes (desktops, laptops, tablets, phablets and mobile phones), the need for change and adaptation has become constant. In 2001, the first responsive web design (RWD) site was introduced. RWD aims to provide methods for adapting the web page content for viewing and seamless user experience transition with minimum resizing, panning and scrolling, across a wide range of devices.

Also, RWD helps to create active content that adapts to the properties of the device used to render it to the user. Web pages are typically created using Hyper-Text Mark-Up Language (HTML) to mark-up their content which defines the structure of the very page. On the other hand, plain

Correspondence:

Aleksandar Mihajlović

e-mail:

amihajlovic@singidunum.ac.rs

content is not sufficient on the modern web. Instead, Cascading Style-Sheet (CSS) code is used to define custom styling of web page structures, such as images, content blocks, sections, links, buttons, *etc.* The CSS language has evolved over time to provide many new features for styling web content and to provide ever more flexible, dynamic and definitions for fully customize design of page elements. One of the most powerful CSS properties are media queries. Media queries allow programmers to provide custom style-sheet definitions for elements of the web page when a certain set of criteria are met. These media queries can consist of a single criterion or, more frequently, a set of criteria such as that the device is a screen (a device where the user can see the rendered graphical representation of the web page) and that the minimum device width needs to be of a certain length (*i.e.* in pixels) for the CSS styles defined in that media query definitions to be used.

From the beginning, images have been the number one obstacle in implementing truly adaptable and operational responsive pages. Their inability to effectively adapt to both the constraints and affordances of the browsing context at hand was the key issue. In most scenarios, logos are simply scaled down to fit the available space in the resized context. This causes the logo to become unreadable and blurred.

2. LOGO - VISUAL SIDE OF BRAND

In the business world, logos are communication "touch points" linking companies to the stakeholders. The logo, as a promotional tool, (Ashworth & Kavaratzis, 2009) is a part of intentional formal communication. Hildreth (2010) considers logos as identifiers, while Stock (2009) defines logos as straightforward applications of branding tools. The main identity component of functional brand (Kotler, 2003) - the logo, should be easily recognised and applied to various promotional platforms. This applies both to the physical and digital environment. It makes the brand visible (Kelly, 2016). Consumers and stakeholders come across visual stimuli (logo, colours, shapes, styles, taglines, typefaces, *etc.*) when interacting with brands. It indicates that the visual elements should be created correctly in order to make popular and needed brand association with customers (Philips *et al.*, 2014).

Milton Glaser states that logos are gateways to brands (Kelly, 2016, p.8-9). Also, their main functions are to trigger perceptions, to create first-hand associations, to play a major role in the place-branding process and to be a quick form of communication. Snyder pointed out (1993) that logos represent visual signatures for brands.

These logos are responsible for building and maintaining brand's personality (Zakia & Nadin, 1987). Logos are not only the means of capturing customers' awareness but are among the most important means of communication. This is due to the fact that customers are primarily exposed to them when establishing initial contact with companies (Cian *et al.*, 2014).

Using flexible identity of logo enables strengthening and enhancing brand position. This helps uniting communication strategies visually. In a highly developed digital surrounding of contemporary businesses, it is mandatory to consider using it for the purposes of creating responsive logo design. The flexible identity of logo supports maximising logo visibility. This is achieved through various design applications moving beyond the rules that govern the common use of the logo. The flexible identity means that each touch point, such as any piece of the signage, the artefact, wall colour, *etc.* offers visual symbolism and the connection to the brand. This does not necessarily include the use of the logo itself (Kelly, 2016).

The importance of visual aspects of logo is recognised in communicating brand strategy and marketing practice. It requires investments in its (re)designing. For instance, the costs of logo design for the 2012 Olympics in London reached $625.000. In 2008, Pepsi spent $1 million. Furthermore, British Petroleum invested $211 million for their logo redesign in the same year (Cian *et al.*, 2014).

A brand has to be amicable and comprehensive by everyone at all touch points. Also, the introduction of digital portable devices calls for complete and continuous processes of adaptation of a range of visual brand elements for different marketing purposes. Digital platforms such as smart phones and social media encourage logo adaptation. This is required in order to achieve better flexibility and remain visible. Thus, responsive logo design must be applied carefully in favour of enhancing brand image and identity (Kelly, 2016).

3. PROBLEM DEFINITION

The aim of this paper is to clarify the importance of visual punctuation, present the responsive logo design concept and demonstrate the potential solution to one of the problems that companies on the web face today. Due to the increasing use of different types of devices, companies need to adjust their web sites for different resolutions and orientation. This is done by creating responsive web sites. Responsive design is made possible by means of media queries. As mentioned before, each media query consists of criteria that need to be met in order for the set of defined CSS styles to be applied. The

first part of the query that makes a single criterion is the media type or the media device (Carey, 2013). After the media type is defined, a set of expressions follow. They can better define the circumstances when the media query definitions should take effect. These expressions can be used to recognize device properties and states, such as the width, orientation, colour depth, resolution, scanning output type for television screens and similar (Lewis & Moscovitz, 2009).

Google also announced that responsive design would become a notable ranking factor in the Search engine results page (SERPs). Because of this, all companies on the market that wish to gain and/or retain competitive advantage take responsive design as an extremely important development objective. As Ofcom's Eighth International Communications Market Report (2014) shows, smart phones and tablet devices are equally important as desktop and laptop. This means that having a consistent strategy across all user platforms can be extremely effective. This trend is so prevalent that Google has begun boosting ratings of sites that are mobile friendly. This ranking applies for searches made from mobile devices.
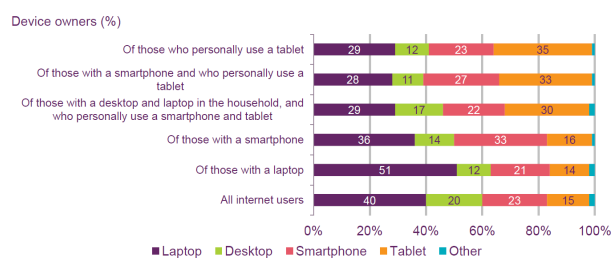
Graph 1. Most important devices for connecting to the Internet (Ofcom research, Q1, 2014)

In the research published by the Social media today, 83% of mobile users say that a seamless experience across all devices is very important (Miles, 2015). The assumption that a large number of companies have already responded to the market demands is wrong. The real situation is totally different. When it comes to the top 100 sites analysed, only 11.8% of these sites use responsive web design (Meunier, 2015). There is an issue of large number of these responsive websites. The problem is that the brand symbol or logo, simply often does not, or cannot, respond well to changes in a way that it is displayed. The importance of this problem is large, considering that this is the key element in corporate visual communication. Therefore, it must not be neglected. Nevertheless, many companies and their web designers do not consider this issue. In some cases, they were prohibited from dealing with it in case of more conservative corporate cultures.

The market demands for responsive web design are creating an ever growing pressure to adapt logos to smaller screen sizes. In most cases, the logo is just shrunk to fit the available space. This approach can work for rectangular logos with simple and minimalistic appearances. On the other hand, if the composition or proportion of a logo is different, simply reducing its size can make smaller details unrecognisable and small type unreadable. This can be overcome by adopting the concept of responsive logo design for RWD.

4. ADVANTAGES AND DISADVANTAGES OF RESPONSIVE WEB DESIGN

With the emergence of hand-held computers, such as PDAs and early tablet computers, developers have struggled to adapt the concurrent user interface philosophy to the new platform (Robertson, Wharton, & Ashwo, 1996). Unlike these scenarios, where one user interface is designed for the purpose of a specific device or screen type, responsive design aims to provide the same content for multiple devices without having to take the user to a different web page where different design definitions are used (Kuo-Ying, 2009). Responsive design concepts are employed mostly on the web. However, modern mobile applications employ their own design pattern for responsive user interfaces (Lehtimaki, 2012). These design patterns differ from the concept of responsive web page design, in the way that they are adapted for rendering on mobile devices. Nevertheless, the web page design that targets even mobile phones continues to gain popularity (Google Trends, 2016). Disadvantages of responsive design patterns are related to the fact that they are used to adapt the content to smaller screen sizes. When doing this, certain information may be lost and some features, such as navigation are made more complicated. Normally, on desktop sized devices, web pages feature a single click menu, where submenus can be uncovered upon hovered above their parent menu item. Finally, only one menu item is activated by clicking on it. With mobile phones, hovering is not yet practical. In such cases, web sites adapt the menu to be expandable upon click in order to uncover children items. This, in turn, requires more interaction from the user in order to properly navigate the web page. Another disadvantageous consequence of smaller screen size is the need to scroll through the content. Originally, web pages that have their content optimised for desktop screens have more content which, when condensed to mobile screens, tends to expand the virtual scrollable screen to greater lengths requiring even more user engagement in order to properly review the content. This can sometimes

have profoundly negative effects on the experience of mobile phone users viewing the responsive web page, as explained by (Lestari, Hardianto, & Ni, 2014) and (Hussain & Mkpojiogu, 2015). Regardless of this fact and based on the positive trends mentioned before, the advantages of responsive design outweigh its disadvantages. New web standards allow for new extensions of the responsive design. Among these is the concept of creating responsive modules. This, so called modular responsive design, allows for certain parts of the user interface to be adaptive to their own immediate surroundings. This happens to be unrelated to the context of the page and its surrounding device screen (Wiener, Ekholm, & Haller, 2015).

5. PROPOSED SOLUTION FOR RESPONSIVE LOGO

As we have discussed in the previous sections, logos are usually simply shrunk to fit the available space. Because of this, they are not responsive. The idea behind responsive web design is that its layout should be readjusted according to the screen on which it is being viewed. At the same time, it should be readable on a 4-inch smart phone, just as on a 27-inch monitor. Logos should act in the same way. They should change shape, simplify and lose words or other fragments. In other words, they should respond to the surrounding context.

To solve this problem it takes a different approach in understanding the boundaries of logos. Companies can revise their logos to become simple and scalable. Elsewise, they can change the way they implement their logos. Instead of using up valuable screen space with an unresponsive logo that becomes indistinct and unrecognisable, a better solution is to provide responsive logo that can adapt to varying sizes.

A few years back, a London-based designer, Joe Harrison, famously experimented with responsive logos. He launched a concept which took the iconic logos of big brands and put them through their responsive paces (Harrison, 2015). For example, the "Walt Disney Pictures" logo (Cass, 2015) changes are shown in Image 1, as the browser windows resizes. The logo first loses its castle and becomes a type, then it shortens to Disney, before finally shrinking into a whimsical cursive letter "D".
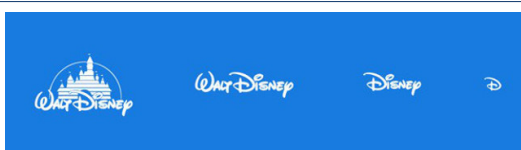
Image 1. Example of responsive logo - „Walt Disney Pictures" (Cass, 2015)

Branding guidelines

Well-designed identities often allow logos to be displayed in different variations depending on the context. Usually, they are presented and outlined in a branding guidelines document. These guidelines provide a rule on proper implementation of logo within certain size constraints. In cases of responsive logo, guidelines should specifically provide alternate logo formats that could be used in smaller areas.

Another example is shown in for Singidunum University's logo in Image 2. A well-defined branding guideline provides an alternate format of logo that could be used in smaller areas.

Image 2. An example of an alternate mode of Singidunum University's logo

The small version of the logo, displayed in Image 2, has the logotype removed and the mark expanded to match the height of the symbol. See Image 3 that compares the two modes of the logo in a condensed header on a 320px wide small screen. It is evident that the bottom logo is more readable and less untidy.

Image 3. Examples of logos displayed on a 320px wide small screen

Brand recognition and visual identification will not be lost, if adjustments are made because of physical limitations. Flexibility can support and enhance the identity as a whole.

Reduction of details

In rare cases, a detailed logo appears. By reducing the level of details at small sizes, logo is simplified and read-ability can be greatly enhanced. For that purpose, detailed shapes can be simplified and trimmed. Thin lines can be made thicker; outline elements could be inverted and filled in, *etc*. For each variety of logo, the level of detail is progressively reduced. This can be done by reducing its size, which greatly enhances the readability of logo at small sizes.

Implementation of RWD and usage of image sprites

Technical implementation of responsive design relies on modern Internet and web technologies. Among these, the most important is the web browsers' support for the advanced CSS version 3 language features. Besides original CSS features that allowed for limited responsive imple-mentations even before CSS version 3, the new standard has introduced a number of new devices or media types.

A code snippet, which includes a CSS code with the media query feature shown below, illustrates a method of creating a responsive logo for four different screen resolution widths.

```
<style>
  .logo {
    background-repeat: no-repeat;
    background-position: center;
    display: inline-block;
    background: url('../img/logo-lg.png');
    height: 60px;
    width: 290px;
  }
  @media only screen and (max-width: 800px) {
    .logo {
      background: url('../img/logo-md.png');
      height: 50px;
      width: 220px;
    }
  }
  @media only screen and (max-width: 480px) {
    .logo {
      background: url('../img/logo-sm.png');
      height: 40px;
      width: 140px;
    }
  }
  @media only screen and (max-width: 320px) {
    .logo {
      background: url('../img/logo-xs.png');
      height: 40px;
      width: 60px;
    }
  }
</style>

<a class="logo" href="#"></a>
```

Listing 1. A code snippet that includes a media query CSS rule set that adds support for a responsive logo for four different screen resolution widths

The techniques commonly used for displaying differ-ent images at different breakpoints are image sprites. A sprite is a collection of images stored within a single file. Web sites with many images require more time to load. At the same time, they generate multiple server requests. By using image sprites, loading time and the server request count is reduced. This results in saving bandwidth (Bow-ers, Synodinos, & Sumner, 2011). However, it yields the need to create sprite images with each variation of the logo, and potentially additional images for each targeted pixel density.

Another option is to use an adaptive, multi-layered image format with layers set to appear when overlaid over different backgrounds and sizes. We are currently experimenting with this concept. It will support the needs of new responsive image techniques. However, it is still in experimental phase. Currently, it only includes imple-mentations for adapting the logo to varying background colours and brightness intensities.

Use of Scalable Vector Graphics (SVG) images

With the growing need for resolution independent graphics that consumes the Internet, the necessity to use SVG has appeared. SVG is a file format that scales without losing definition. It gives us resolution independence and true single file implementations.

6. CONCLUSION

As described in this paper, the existing solutions that aim to solve the issue of logo adaptability are usually sufficient. However, we have identified that there are practical challenges for implementing a truly responsive logo within a responsive web page. In order to support multiple screen resolutions and screen densities, logos must be remade to comprise of modular units that, on their own, sufficiently represent and help identify with the brand they belong to. These units should be simple in terms of graphical design in order to be readable and recognisable even when displayed in very small sizes. We reproduce a responsive logo by means of CSS media queries implementation and prove the concept. Also, we propose the use of componential logos made in the vector format, preferably SVG. Finally, our conclusion is that there is still space for future work. This is mainly because the current responsive logo concepts depend on the web page dimensions. We suggest expanding the concept to include other properties of the surrounding context, such as the background of the logo. Currently,

designers and web developers need to take into account the underplaying background of the logo and need to display a light or dark logo variant based on that.

7. FUTURE WORK

In the future, the authors will develop a model that implements a responsive logo for vector and raster images in a multi-layer image file format that supports additional meta-data. That will ensure the proper use of the responsive logo according to the predefined rules, and it will be done automatically. That will result in a decreasing number of errors when applying the logo by third parties. Also, the authors shall devote particular attention in their future work to conducting experimental research that will expose business clients and consumers to responsive logos on the web and examine their experience and reactions to modified design logo solutions.

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A GUIDE FOR ASSOCIATION RULE MINING IN MOODLE COURSE MANAGEMENT SYSTEM

Goran Avlijaš,
Milenko Heleta,
Radoslav Avlijaš

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The main goal of educational data mining is development and evaluation of different methods of exploration of educational data. Different analytical tools offer opportunities to analyze data generated by different kinds of Learning Management Systems (LMS). The goal of this paper is to describe the process of association rule mining in Moodle LMS, in theory and praxis, step by step. For practical demonstration we have used the data from one of the Singidunum University Moodle courses. The data was analyzed using the open source data mining software Weka. Selected variables included students' login frequency, number of accessed resources and forum messages, as well as the average performance on quizzes. With minor adaption of the proposed method any educator can realize benefits of association rule mining, regardless of prior knowledge in data analysis, and without having to purchase expensive software tools.

Key words:

data mining, moodle, association rule mining.

1. INTRODUCTION

The utilization of distance education systems has increased in the last decade, and virtual learning platforms are increasingly installed by educational institutions in order to offer e-learning options to students and enhance the quality of traditional courses. These e-learning systems provide different types of channels and work environments which enable distribution of information and correspondence between learners and educators. Among other features, these systems enable distribution of information to students, preparation of assignments and tests, engagement in discussions, collaborative learning within forums and chats *etc.*

Modular Object-Oriented Dynamic Learning Environment (Moodle) is one of the most commonly used open-source e-learning systems. It is an open-source LMS which enables development of comprehensive and flexible online courses and experiences (Rice, 2011). This system accumulates a large amount of data which can be used for the analysis of students' behavior. It registers every activity of a student, such as reading, writing, taking tests, performing various tasks and communicating with peers (Mostow and Beck, 2006).

Correspondence:

Goran Avlijaš

e-mail:
gavlijas@singidunum.ac.rs

Most of the learning management systems include a database which contains different types of information: user data, academic performance, interaction data *etc.* Although some of the systems provide certain types of reporting, with large datasets it is difficult for a system itself to extract valuable information. Most of them do not provide built-in software which enables teachers to evaluate the course structure and content and its effectiveness. Therefore, a very promising ground for resolving this issue is the application of data mining tools (Zorrilla *et al.*, 2005).

2. EDUCATIONAL DATA MINING

Data mining (DM) represents automated recognition of implicit and interesting patterns from large amount of data (Klösgen, 2002). DM is an interdisciplinary scientific area which encompasses several computing paradigms: rule induction, decision tree, Bayesian learning, ANN, statistical algorithms, and so on. The most commonly used data mining techniques include classification, clustering, association rule mining, visualization, statistics, text mining *etc.*

In order to improve the learning process, researchers have investigated application of different data mining techniques in the educational context. Data mining tools allow teachers to analyze and visualize learning data in order to recognize useful patterns and evaluate the effectiveness of the course. The results obtained can be directed to students and certain activities or resources can be suggested that can improve the overall learning process.

According to Romero, Ventura, and García (2008), data mining in learning management systems represents an iterative process which should improve the overall learning and decision making process. Data mining process in educational context, as general data mining process, uses the following four steps:

- *Data collection*. While students use the system information is collected in the database. In case of Moodle, data is collected in a form of system logs.
- *Preprocessing*. After collection, the data needs to be transformed into the suitable format for analysis. A specific software can be used for preprocessing.
- *Data mining*. In order to develop a model and discover useful rules, the appropriate data mining algorithms should be applied at this stage.
- *Results evaluation*. Finally, educator interprets the obtained results and uses discovered knowl-

edge to improve the learning and decision making process.

3. MINING ASSOCIATION RULES IN MOODLE

Association rule mining (ARM) has been used in learning management systems for finding correlations between items in order to: diagnose learning problems and offer students advice (Hwang *et al.*, 2003), determine suitability of learning materials (Markellou *et al.*, 2005), and identify patterns of performance disparity between groups of students (Minaei-Bidgoli *et al.*, 2004). ARM can also be used to: provide feedback to the teacher based on discovered relationships from students' usage information (Romero *et al.*, 2004), find most common errors (Merceron and Yacef, 2004) and optimise course content based on student interests (Ramli, 2005).

The Moodle learning management system is an open source learning platform, it represents an alternative to other similar commercial solutions. It is used in more than 240 countries worldwide by a large number of educational institutions, with more than 70 million users and more than 80,000 web sites (Moodle). Singidunum University implemented Moodle in 2006 and since then several thousand students have enrolled in more than 100 courses.

Moodle allows course administrators to access detailed logs of student activities, which keep track of materials and resources accessed by students and record every click for navigational purposes. Logs can be filtered by course, participant, day or type of activity. For some activities such as tests, a detailed analysis of each response is available in addition to the final score. Teachers can use logs to analyze students' performance, what and when they did something, and as such, they can be suitable for data mining.

Depending on the needs, users can choose between general/specific and commercial/open-source data mining tools. Open source machine learning software Weka (Waikato Environment for Knowledge Analysis) is developed by University of Waikato, New Zealand. WEKA comes with a set of data mining algorithms for data preprocessing, classification, regression, clustering, association rules and visualization (Witten *et al.*, 2011). In this paper, we used Weka because it is free, developed in Java and uses ARFF dataset external representation format.

Weka software enables recognition of interesting relationships between attributes in a form of association rules, which represent close correlation of support and

confidence. The confidence is defined as ratio of number of observations that contains the consequence and number of observations that contain the antecedent. The support is the ratio of the number of observation that contain both antecedent and consequence and the total number of observations in the dataset (Agrawal *et al.*, 1993).

In order to use a particular data mining algorithm, the dataset needs to be transformed into the appropriate format. Therefore, in order to apply the mining algorithm, preprocessing activities such as cleaning, transformation, enrichment, integration and reduction should be performed. Data preprocessing in Moodle is not that demanding as in other systems. However, activities such as data selection, acquisition, discretization and transformation have to be carried out. The following section describes data preprocessing and application of the selected association rule algorithm.

Data Preprocessing

The first step of data preprocessing is *data selection*. Although information is available for several thousand students in more than 100 different Moodle courses at Singidunum University, we have selected the course in Project Management. In the chosen course, students used different kinds of Moodle activities and resources (different types of resources, forum messages, quizzes). Table 1 shows the selected attributes. The total number of students in this study was 197.

Attribute	Description
stud_id	Student personal number
cs_view	Number of course visits
rs_view	Number of resources accessed
fr_view	Number of forum messages read
quiz_avg	Average score on quizzes

Table 1. Attributes used for each student

The next step of data preprocessing is *data acquisition*. The main prerequisite for data acquisition is creation of a Moodle log file which contains all necessary information. For the purpose of demonstration, we have generated a log table, which contains data about students' activities in the selected course. In order to create the final data set, the obtained data was transformed into a single summarized spreadsheet with the structure illustrated in Table 2.

stud_id	cs_view	rs_view	fr_view	quiz_avg
stud_1	82	33	5	23
stud_2	28	2	3	21
stud_3	40	15	3	28
stud_4	26	3	3	17
stud_n	60	47	8	19

Table 2. Structure of summarized dataset

The third step of data preprocessing is *data discretization*. In order to increase comprehensibility, numerical data needs to be discretized. In this process numerical values are divided into categorical classes that can be more easily understood by the teacher. We have discretized all the numerical values except student ID. For transforming continuous attributes into discrete attributes unsupervised global methods such as equal-width method, equal-frequency method or the manual method can be used (Dougherty *et al.*, 1995). As shown in Table 3, the equal-width method with three intervals and labels (low, medium and high) have been used for the selected attributes. The Weka system also enables discretization of numerical attributes using the 'discretize' filter.

stud_id	cs_view	rs_view	fr_view	quiz_avg
stud_1	high	low	low	high
stud_2	med	low	low	med
stud_3	high	high	low	low
stud_4	low	low	low	med
stud_n	med	med	low	high

Table 3. Sample of discretized data

The last step of data preprocessing is *data transformation*. After discretization, data needs to be transformed into the format required by data mining algorithm. In our case, Moodle log was exported as CSV file, which can be imported in WEKA and exported as Attribute-Relation File Format. An ARFF file is an ASCII text file that describes a list of instances sharing a set of attributes (Witten *et al.*, 2011). It is also possible to directly export Moodle log file as ARFF using specific tools for preprocessing such as Open DB Preprocess.

Application of association rule mining

Association rule mining is one of the most explored mining methods (Ceglar and Roddick, 2006). As defined by Agrawal, Imieliński, and Swami (1993), the problem of association rule mining is defined as: let $U = \{u_1, u_2, ..., u_m\}$ be a discrete universe, a finite set of objects. Let $A = \{a_1, a_2, ..., a_n\}$ be a finite set of attributes with binary values. Each object of universe U is described by attributes a_i, i = 1, 2, ..., n thus generating a data set. An associative rule is defined as an implication of the form $X \Rightarrow Y$ where $X, Y \in A$ and $X \cap Y \neq \oslash$. The set of attributes X is called antecedent of the rule; the set of attributes Y is called consequent of the rule.

Although there are many $X \Rightarrow Y$ rules, in order to discover interesting ones, various measures of significance can be used; one of the most common are minimum thresholds on support and confidence. The support supp(X) is the proportion of objects in the data set which contain the attributes from X. The confidence of a rule is:

$$conf\,(X \Rightarrow Y) = \frac{supp\,(X \cup Y)}{supp\,(X)} \qquad (1)$$

These concepts are explained in the following example. For the data set given in Table 4 it is possible to infer some association rules, as well as the confidence and support parameters. For $X = \{A_1, A_2, A_3\}$ supp(X) = 1/4 = 0.25 because there is one object (number four) for which there is a 'yes' value for every attribute. For example, the confidence of the rule $X \Rightarrow Y$, where X = {A1, A2} and Y = {A3} is:

$$conf\,(X \Rightarrow Y) = \frac{supp\,(X \cup Y)}{supp\,(X)} = \frac{0.25}{0.5} = 0.5 \qquad (2)$$

Attributes	A1	A2	A3
Instances	Student passed quiz	Student accessed platform	Student passed final exam
1	yes	yes	no
2	no	yes	yes
3	no	no	no
4	yes	yes	yes

Table 4. Simple example of data set

The previous rule $X \Rightarrow Y$ is interpreted as follows: the student who has passed the quizz and accessed the learning platform frequently has a 50/50 chance of passing the final exam. Apriori algorithm was the first algorithm that was used for association rules mining, and it served as the basis for other algorithms that were developed later, such as Apriori-TID, Eclat, FP-Growth, and so on (Ceglar and Roddick, 2006).

Several association rules algorithms can be used in the Weka, and for finding association rules we decided to use the Predictive Apriori algorithm. The Predictive Apriori is an improved version of the Apriori algorithm, which maximizes the probability of making an accurate prediction and resolves the issue of balance between support and confidence (Garcia *et al.*, 2011). Garcia, Romero, Ventura, and de Castro (2006) performed experimental tests on a Moodle course and confirmed better performance of Predictive Apriori in comparison to Apriori-type algorithm.

In the Predictive Apriori algorithm, measures of support and confidence are combined into a single value called predictive accuracy. This value is used to generate the Apriori association rule (Scheffer, 2001). In Weka software, Predictive Apriori generates „n" rules based on n value selected by the user. In the data set described, attribute selection is further complicated by the fact that some attribute values were not binary, which is why this involves a more extensive search.

The association rule generation is often the most appropriate technique due to several reasons:

- This is an exact method which excludes any subjective influence while analyzing a data set.
- The result is presented in a readable and easy-to-understand format.
- The number of generated rules can be limited in order to extract only the most accurate.
- It is expected that association rules have a great value when inferred from data set in the education domain because association rules can be treated as a hypothesis.

Results evaluation

The analysis was conducted in Weka in order to generate association rules. The Weka system requires that the attributes with numerical values do not participate in the association rule mining, which is why the were excluded from the analysis. We have executed the Predictive Apriori algorithm and generated rules with highest

predictive accuracy. Table 5 shows a list of the top 10 rules with highest predictive accuracy of the rule.

The number of discovered rule can be considerable with larger datasets. There can be many uninteresting rules, such as redundant rules, similar rules and rules with random relation. Rules relevant to educational purposes usually show the expected or conforming relationships or unexpected relationships. These rules can be very useful for teachers when making decisions about activities and identification of students with learning problems.

Table 5 shows that the number of read messages does not have a significant impact on the final grade outcome, since some of the top 10 rules are contradictory (such as rules 1 and 7). When it comes to login frequency (course view), according to rules 1, 4, 5 and 10, high quiz score cannot be expected when e-learning platform attendance is low. A similar case occurs with the number of accessed course resources (rules 1, 3 and 5). Rules 2, 7 and 8 show that if the course attendance is high, it is expected that the average quiz score obtained will be high. Using this information as a basis, the educator can give careful consideration to students who invest less energy in the learning process, since they are prone to failure. This way the educator can provide motivation and influence those students on time to pass the course.

	Best rules found	Predictive accuracy
1	cs_view=low fr_view=med rs_view=low 30 ==> quiz_avg=low 30	0.99077
2	quiz_avg=high fr_view=high 15 ==> cs_view=high 15	0.98141
3	cs_view=low rs_view=low 78 ==> quiz_avg=low 76	0.97457
4	cs_view=low fr_view=med 35 ==> quiz_avg=low 34	0.96928
5	cs_view=low fr_view=high rs_view=med 6 ==> quiz_avg=low 6	0.95017
6	cs_view=high fr_view=med rs_view=high 6 ==> quiz_avg=high 6	0.95017
7	cs_view=high fr_view=med 24 ==> quiz_avg=high 23	0.94704
8	cs_view=high rs_view=high 23 ==> quiz_avg=high 22	0.94410
9	quiz_avg=high rs_view=high 23 ==> cs_view=high 22	0.94410
10	cs_view=low 99 ==> quiz_avg=low 94	0.94095

Table 5. Predictive Apriori algorithm results

4. CONCLUSION

In this paper, we have described the association rule mining of Moodle data and how it can be utilized to enhance the learning process. As more students take part in online learning environments, databases expect to grow and mining opportunities expect to increase. In this sense, association rule mining can be useful for predicting student performance outcomes and identifying students who require special attention from teachers to increase the overall success ratio.

Data mining tools such as Weka are still too complex for most of the teachers and their capabilities go far beyond the average educator needs. In order to simplify application, educational data mining tools should be more user-friendly, intuitive, accompanied with proper visualization of results. This can be accomplished with integration of data mining tools and learning management system. Integrated tools could enable data processing in the same environment, so the responses and results can be directly implemented in the learning management system.

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POSSIBILITIES OF PROTECTING PERSONAL DATA PUBLISHED ON SOCIAL NETWORK SITES IN THE LIGHT OF THE LAW ON PERSONAL DATA PROTECTION

Vida M. Vilić[1],
Ivan Radenković[2]

[1]Clinic of Dentistry Niš,
Niš, Serbia
[2]Law Office „Stanković"
Niš, Serbia

Abstract:

Aside from being a typical place for everyday activities and social communication, social networks are a unique place where various types of social behaviour and interactions can be observed. The majority of social network users leave a lot of their personal data on their social network accounts as they believe that they will be visible only to their friends and good-willed users, *i.e.* that they will not be misused or perverted. Unfortunately, misuses of personal data collected by social networking sites are far from being rare. Violation of the right to privacy most often occurs on the most popular social networking sites with the highest number of registered users. The Law on Personal Data Protection of the Republic of Serbia sets out the requirements for personal data collection and processing, as well as the limits for such data collection and database creation, the mechanisms aimed to maintain security of the collected data and the issue of data keeping surveillance. The authors shall attempt to determine whether this law applies to personal data collection on the Internet and whether it can ensure adequate and efficient legal protection of users.

Key words:

right to privacy, personal data, social networks,
law on personal data protection.

1. INTRODUCTION

The right to privacy is one of the basic human rights. It is both an international and constitutional right of public and civil law significance, affecting everyone (*erga omnes*) and providing people with protection against disturbances coming from the state authorities and other people. Unlike publicity, privacy entails confidentiality and non-disturbance. It applies to an individual's private life which should justifiably involve peace and tranquillity, as well as undisturbed intimacy. [1] The right to privacy gives an individual a chance to selectively present himself/herself to the world up to the desired level. [2]

The Law on Personal Data Protection (hereinafter referred to as: the Law) [3] sets out the requirements for personal data collection and processing, the rights and protection of the rights of persons whose data is being collected and processed, limitations to personal data protection, proceedings before the authority responsible for data protection, data

Correspondence:
Vida M. Vilić

e-mail:
vila979@gmail.com

security, data filing, data transfers outside the Republic of Serbia and enforcement of this Law (Art. 1). *Does this Law apply to the personal data collection on the Internet, especially on social networking sites, and can it ensure legal protection to the users?* Social networks very often share the personal data of their users with different companies, most often with the companies involved in marketing and advertising, supplying them with their users' personal data together with their interests, thus invading their personal rights and violating their privacy. [4]

2. PERSONAL DATA AND RIGHT TO PRIVACY

The use of information and communication technologies has infiltrated into all spheres of human life, work, entertainment and numerous other private and business activities, so that almost everything in the society has become available online, from signing contracts to committing crime. By the help of the Internet and other accompanying technologies our society undergoes transformation in three specific areas: privacy, freedom of expression and free flow of information. The social changes in the modern society arising from the information and communication technologies of the 1970's brought an entirely new phenomenon into limelight – the information society. Information has become an important element of the freedom and right to spread information which largely depends on the actual lawfulness and ability to manage data collections. In the modern information society, technological advancement enables processing, keeping, accessing and transferring information in any form regardless of the distance, time and quantity.

In the previous period, virtual space was full of interesting and useful information, but the instruments to make that space interactive and to actively participate in data creation were very limited. Nowadays, social networks serve as a means to connect people across the planet. Aside from the advantages of the Internet and social networking, there is a growing evidence of misuses of virtual space. One of the issues arising in connection with computer misuse is the issue of protection of each individual's personal right – the right to privacy. Certain groups of people are particularly exposed to computer misuse of privacy. These are the people who have already enabled collection of a considerable amount of their personal data through their frequent use of certain social services, or the people with deviant or criminal behaviour.

Personal assets such as life, freedom, name, honour and reputation used to be regarded as an inseparable part of one's personality. Personality rights also include the right to privacy which protects one's personal data and records connected with one's private life from public disclosure. In its original sense, privacy embodies one's wish not to be disturbed. [5] Privacy in electronic communications (involving collecting, processing and sharing the user's information with third persons) can be understood as the right not to be systematically observed and not to have one's activities or personal data recorded, *i.e.* as a right of individuals to personally decide on issues like when, how and to what degree the information on the accounts should and could be made available to others, while some authors [6] define privacy as a complex concept that encompasses personal autonomy, democratic participation, managing of one's own identity and social coordination. At the heart of this multidimensional entity there is a wish to keep one's personal data for oneself so that other people cannot access them.

In the context of social networking, privacy and personal information include all the data entered by a person in his/her profile, such as pictures, comments, data on their whereabouts, socializing and the like. [7] Some of the reasons for voluntary disclosure of personal data that some authors have recognized include one's need for attention, disinterest or a loose attitude regarding one's own or other people's privacy, incomplete presentation of information, trust in the safety of data on social networking sites, as well as trust in one's network friends. [8]

Speaking about the right to privacy, it should be emphasized that the rights observed as opposite from this right include the right to be informed and the right to access information that should not jeopardize the right to privacy. Legal regulation of these two rights should lead to their balanced and non-opposing quality. In certain cases, there is a legitimate interest of the public into gaining an insight into certain information, as well as the citizens' right to be „left alone", *i.e.* to make the data on themselves inaccessible to the public. In such cases, it is necessary to make an estimate as to which of the principles should be given priority, but in a way that would affirm the other principle to the highest possible degree.

The growing popularity of social networking sites has led to more extensive debates regarding privacy protection. Spokeo is not a classical social network, but rather a search engine for connecting people based on the data collected by aggregation. Namely, the website

contains information regarding the age, relationship status, income, data on close family members, as well as addresses of the registered users. Such information is collected from the data already existing on the Net, as entered by the social networks' users, but the site does not guarantee the data accuracy. [9]

The most frequent ways of disrespecting personal data on the Internet include unauthorised access, collecting and processing of users' data, abuse of collected data and interception of distributed data.

3. LAW ON PERSONAL DATA PROTECTION

In terms of Article 3 of the Law, personal data means any information relating to a natural person, regardless of the form of its presentation or the medium used (paper, tape, film, electronic media *etc.*), regardless of whose order, on whose behalf or for whose account such information is stored, regardless of the date of its creation or the place of its storage, regardless of the way in which such information is learned (directly, by listening, watching *etc.*, or indirectly, by accessing a document containing the information *etc.*) and regardless of any other characteristic of such information.

The purpose of the Law is to enable every natural person to exercise and have recourse to protection of their right to privacy and other rights and freedoms in the context of personal data protection (Art. 2). Under this Law, personal data protection is ensured to any natural person, regardless of their nationality and residence, race, age, gender, language, religion, political and other affiliations, ethnicity, social background and status, wealth, birth, education, social position or other personal characteristics.

It is interesting that the Law does not apply to the data available to everyone and published in mass media and publications (Art. 5, par. 1, item 1), as well as to the data published on oneself by a person capable of taking care of his/her interests (Art. 5, par. 1, item 4). The above provisions provide ground for a conclusion that this Law cannot be applied to the protection of the users of social networks in cases of abuse of the published personal data by a third person.

Nonetheless, Article 8 of the Law states that processing shall not be allowed if a physical person did not give his/her consent to processing, if processing is carried out without legal authorization, if the processing method is inadmissible or if the purpose of processing is not clearly defined. Data processing means any action taken in con-

nection with data, including: collection, recording, transcription, multiplication, copying, transmission, searching, classification, storage, separation, crossing, merging, adaptation, modification, provision, use, granting access, disclosure, publication, dissemination, recording, organizing, keeping, editing, disclosure through transmission or otherwise, withholding, dislocation or other actions aimed at rendering the data inaccessible, as well as other actions carried out in connection with such data, no matter is those actions are automated, semi-automated or otherwise performed. Thus, the Law still leaves a chance for protection of personal data that have been published without the user's explicit approval, which is fully in accordance with a ban set in Article 146 of the Criminal Code that sanctions unauthorized collection of personal data.

The Law allows data collection without the consent of the person concerned only if such processing is necessary for the protection of anyone's life, health and physical integrity, as well as in order to ensure compliance with legal regulations (Art. 13).

4. CONCLUSION

Although a great number of users of social networks is aware of the fact that privacy on social networking sites can be violated, or at least jeopardized, a huge corpus of personal data keeps being accumulated on such sites. The existing legal regulations are not sufficiently „up-to-the-point" when it comes to defining the mechanisms for protecting the Internet users in general, particularly the users of social networking sites who willingly leave their personal data, thus making them available to the millions of Internet users throughout the world.

Each user who has an active account on any of the popular social networking sites must be aware that a danger of misusing the entered data is always present, as well as that he/she must „dose" the quantity of published personal data and decide with whom they will share data in the virtual world. The best way to protect privacy of all Internet users is the principle of controlled disclosure of personal data. The users who want better protection of their privacy may try internet anonymity as an option that gives you a chance to use the Internet without giving third persons an opportunity to connect with the internet activities for users' personal identification. The feeling of closeness that virtual space offers to its users can be very dangerous because, on the one side, the users are not always those they claim to be and do not always have good intentions. On the other hand, social

networks live on account of advertising companies with whom they share their users' personal data in order to be offered their services in return.

The protective measures that reduce the risk of misuse of the entered personal data are available on several social networks, thus reassuring the users that their data and personal information will not become available to everyone without their will and approval. Adjustment of one's privacy settings is a necessary step in using any social network, and each user has privileges to use such adjustments when leaving his/her own personal information on the Internet.

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CRIMINAL LAW PROTECTION OF PERSONALITY: IMPLEMENTATION OF COUNCIL OF EUROPE'S CONVENTION ON CYBERCRIME NO. 185 OF 2001 INTO SERBIAN LEGISLATIVE

Vida M. Vilić

Clinic of Dentistry Niš,
Niš, Serbia

Abstract:

Along with the development of information technologies, the issue of legal regulations that can prevent and sanction cybercrime has gained worldwide significance. EU's regulatory framework for electronic communications, networks and services is a basis for the national laws of all EU member states. The Council of Europe was one of the first international organisations to put forward an initiative for building up legal presumptions to restrain cybercrime with joint efforts of several countries. The Criminal Code of the Republic of Serbia regulated criminal offences regarding violation of computer data security, thus clearly contributing to a more efficient fight against cybercrime. Still, this regulatory framework did not fully embrace the deviant forms of behaviour manifested as misuse of computer technologies and computer systems (*e.g.* Internet harassment, unauthorised alteration of the contents published on the Internet, *etc.*). Also, the issue of jurisdiction regarding the criminal prosecution of the perpetrators of these crimes still remains unresolved being that most of such offences have an international character. As Serbia signed and ratified the Convention on Cybercrime CETS No. 185 in 2009, the Criminal Code of the Republic of Serbia should recognise as criminal offences numerous deviant forms of behaviour (Internet harassment, unlawful interception, Internet frauds, *etc.*) and determine sanctions for the offenders.

Key words:

cybercrime; Convention on Cybercrime CETS No. 185,
Criminal Code of the Republic of Serbia, regulated offences.

1. INTRODUCTION

With the development of information technologies, the issue of legal regulations aimed to prevent and sanction cybercrime has gained worldwide significance. The EU's regulatory framework for electronic communications, networks and services is a basis for the national laws of all EU member states. The Council of Europe was one of the first international organisations to put forward an initiative for building up legal presumptions to restrain cybercrime with joint efforts of several countries. Relying on the provisions of the Council of Europe's Convention on Cybercrime of 2001 [1], many international organisations have passed numerous recommendations regarding the desirable changes of national criminal justice systems in the field of cybercrime prevention.

The Council of Europe's Convention on Cybercrime no. 185 of 2001 with its additional protocol is undoubtedly the most significant and the

Correspondence:

Vida M. Vilić

e-mail:

vila979@gmail.com

most comprehensive international document and its provisions have been incorporated into the national criminal justice systems of the signatory countries and the countries that have ratified this document.

2. CONVENTION ON CYBERCRIME CETS NO. 185

The Council of Europe's Convention on Cybercrime no. 185 of 2001 adopted in Budapest (hereafter called: the Convention), along with its additional protocol still remains the most comprehensive attempt to build a legal framework for the fight against cybercrime at the international level. The Convention entered into force in 2004, setting the grounds to develop national legislatures to combat cybercrime. Up to now, 47 countries, members of the Council of Europe, have signed the Convention, out of which only Andorra, Greece, Liechtenstein, Monaco and Sweden have not ratified it yet. [2]

The Convention was conceived in order to deter action directed against confidentiality, integrity and availability of computer systems, networks and computer data as well as the misuse of such systems, networks and data. The ultimate goal was to introduce a system of punishment, sufficient for effectively combating such criminal offences by facilitating their detection, investigation and prosecution at both domestic and international levels and by providing arrangements for fast and reliable international cooperation.

The Convention contains provisions dealing with substantive and procedural criminal law issues. The provisions of the Convention are grouped into four chapters. The language of the Convention is technically neutral so that all the provisions can be applied to both existing and future technology. According to the Convention, all criminal offences must be committed intentionally and in a premeditated way, but the interpretation of the terms "intention" and "premeditation" is left to each party's domestic laws. Also, the access to a computer or computer system must be done without right.

In the part of the Convention addressing the issues of substantive criminal law, the member states are advised to establish as criminal offences under their domestic law: (a) the offences against confidentiality, integrity and availability of computer data and systems (Art. 2-6): illegal access, interception, data interference – alteration of computer data, deletion or damaging, hindering without the right of functioning of a computer or computer system, misuse of devices - production, sale, distribution

or use of any device designed to be used for the purpose of committing any of the above-mentioned offences; (b) Computer-related offences (Art. 7-8): computer-related forgery, computer-related fraud; (c) Content-related offences (Art. 9) and (d) Offences related to infringements of copyright and related rights (Art. 10).

3. LEGAL REGULATIONS OF THE REPUBLIC OF SERBIA RELATED TO CYBERCRIME AND THEIR HARMONISATION WITH THE PROVISIONS OF THE CONVENTION

The Republic of Serbia signed both the Convention and the Protocol in Helsinki on 7 April 2005, at the time of the State Union of Serbia and Montenegro, and the National Parliament of the Republic of Serbia ratified both documents in 2009 [3]. The compulsory application of the Convention commenced in August 2009. The mentioned documents served as a legal basis for domestic laws and standards, as well as for establishing specialised state bodies to combat cybercrime in general. The most important regulations adopted and adjusted to the provisions of the Convention include: the Criminal Code [4], the Law on the Liability of Legal Entities for Criminal Offences [5], Criminal Procedure Code [6], the Law on Special Measures for the Prevention of Crimes against Sexual Freedom Involving Minors [7], the Law on Seizure and Confiscation of the Proceeds from Crime [8], and the Law on Special Authorizations for Efficient Protection of Intellectual Property [9]. However, some issues remain legally unregulated and unsanctioned.

I) The first regulatory document within the positive legislation of the Republic of Serbia to be considered in the light of the issue of cybercrime is the Criminal Code of the Republic of Serbia [10]. The Criminal Code addresses criminal offences connected with the use of computers, implementing the provisions of the Convention in the domestic legislation.

In Article 112, item 9, "a juvenile" is defined as "a person over 14 years of age but who has not attained 18 years of age", while item 10 of the same Article defines "a minor" as "a person who has not attained eighteen years of age". Thus, the domestic legislation embraces the provisions of Article 9 of the Convention, according to which the term "minor" includes all persons less than 18 years of age, partially renouncing a discretionary power given to each and every country ratifying the Convention to establish a lower age limit, provided that it cannot go lower

than 16 years of age. This is particularly important when it comes to defining a criminal offence referred to in Articles 185-185b of the Criminal Code of the Republic of Serbia, *i.e.* in Article 9 of the Convention regarding child pornography.

In Article 112, items 16-20 and 33-34, the Code defines the terms such as "computer data", "computer network", "computer programme", "computer virus", "computer" and "computer system". By recognising a computer data as movable, the Code set a basis to adjust and "modernise" many other established criminal offences by recognising the offences done by a computer or by abusing computer programmes or systems as forms of the existing criminal offences.

The national legislation has made a significant progress regarding the issue of criminal law protection against cybercrime by establishing and sanctioning the following criminal offences within Chapter XXVII concerning criminal offences against computer data security. Subsidiary nature of criminal legal protection of individuals' right to privacy means that in most cases criminal law provisions could be applied when privacy protection can not be achieved by other means. On the other hand, criminal protection is fragmented, which means that it is only used in severe cases of violation of the right to privacy [11]. The Criminal Code specifies the protection of privacy rights by providing only a few criminal offences.

a) The offence of "Damaging Computer Data and Programs" (Art. 298 of the Criminal Code of the Republic of Serbia) states that illegal deletion, alteration, damaging, concealing or any other deterioration resulting in the uselessness of computer data or programmes shall be punishable. The mentioned offence is in complete conformity with the offence of "Data Interference" established in Article 4 of the Convention which refers to alteration, deletion or damaging of computer data. In line with the discretionary power given to the countries to introduce tougher punishments for more serious forms of this offence resulting in a significant material damage, the Code has additionally introduced some more severe punishments for this offence if the damages caused exceed four hundred and fifty thousand dinars (RSD), *i.e.* one million five hundred thousand dinars.

b) The offence of computer sabotage, as regulated by Art. 299 of the Criminal Code, involves entering, destruction, deletion, alteration, concealing or any other deterioration resulting in uselessness of computer data or programmes or destruction or damaging of a computer or any other device for electronic processing and data transfer intended to prevent or significantly disrupt electronic processing and transfer of the data important for the state authorities, public services, institutions, companies or other entities. The Convention does not recognise an offence that would fully correspond to this offence, as established and punishable in the Serbian national legislature in the above-specified way. Instead, the Convention only recognizes acts intended to disrupt normal functioning of a computer or a computer system, as well as misuse of devices with intent to be used to commit any of the previously mentioned offences (Art. 5 and 6), but it does not specify that such acts must target the data of importance for state authorities, public services, institutions, companies or other entities.

c) The offence of creating and introducing computer viruses (Art. 300 of the Code) involves the creation of a computer virus with intent to introduce it into another computer or computer network as well as the act of introducing such virus into another computer or computer network resulting in damage. Art. 5 of the Convention refers to the hindering of the functioning of a computer or a computer system as an offence that involves inputting, transmitting, damaging, deleting, deteriorating, altering or suppressing computer data, resulting in serious hindering of the functioning of a computer or computer system. The Convention makes no mention of a computer virus being created or introduced into a computer or computer system, but the consequence of this offence largely corresponds to the consequence of the offence established by the Serbian Criminal Code.

d) Computer fraud (Art. 301 of the Code) is an offence committed by a person who enters incorrect data, fails to enter correct data or otherwise conceals or falsely represents data and thereby affects the results of electronic processing and transfer of data, with the intention to acquire unlawful material gain for himself or for another person, thus causing material damage to another person. This offence is fully compliant with the computer-related offences referred to as "Computer-related fraud" in Art. 8 of the Convention involving any premeditated input, alteration,

deletion or suppression of computer data or any interference with the functioning of a computer system causing a loss of property to other persons with the aim of procuring a significant economic benefit for oneself or for another person.

e) The offence of unauthorised access to a computer, computer network or electronic data processing (Art. 302 of the Code) involves infringing security measures by unauthorised breaking into a computer or computer network, or illegal accessing electronic data processing, as well as use of data obtained in such a way. The Convention does not explicitly recognise this particular offence, but the act is in it essence identical to the one established by Articles 2 and 3 of the Convention, referring to illegal access and illegal interception.

f) The offence of preventing or restricting access to a public computer network (Art. 303 of the Code) occurs if a person prevents or hinders access to a public computer network while a more serious form of this offence involves a person in an official capacity committing this act in the discharge of duty. In this case, too, the Convention does not explicitly recognise this offence, but the act is in it essence identical to the one established by Articles 2 and 3 of the Convention, referring to illegal access and illegal interception.

g) The offence of unauthorised use of a computer or computer network (Art. 304 of the Code) is committed by anyone who illegally uses computer services or a computer network with the intent to acquire unlawful material gain for oneself or for another person. Differently from the previous ones, this offence can only form the basis of a civil action. The provisions referring to the mentioned offence in the Criminal Code is in conformity with Articles 2 (illegal access) and 6 of the Convention (misuse of the devices designed for the purpose of committing criminal offences).

h) The offence of designing, acquiring and giving to somebody else the means for the purpose of committing criminal offences against security of computer data (Art. 304a of the Code) occurs when a person owns, acquires, makes or gives to somebody else computers, computer systems, computer data and programmes for the purpose of committing any of the offences from Chapter XXVII of the Criminal Code. This offence is also recognized by the Convention on Article 6 which

defines misuse of the devices designed to commit offences and suggests to the countries, signatories of the Convention, to sanction the following forms of behaviour as offences: production, sale, procurement for use, import, distribution or any other way of making available the devices, computer programmes, computer passwords, access codes and similar data which may be used to commit any of the previously mentioned offences or to access a computer system as a whole or part of it with the intent to use it for the purpose of committing any of the mentioned offences, as well as owing of computer programmes, computer passwords, access codes and similar data in order to use them to commit any of the mentioned offences.

Aside from the criminal offences established in Chapter XVII of the Criminal Code of the Republic of Serbia regarding the security of computer data, the mentioned Code in Chapter XVIII deals with sexual offences and establishes the following offences that directly rely on Art. 9 of the Convention: showing, procuring and possessing pornographic material and exploiting of minors for pornography (Art. 185) as well as using a computer network or other technical devices for the purpose of committing sexual offences against minors (Art. 185b). In Art 9, the Convention establishes a group of offences related to the content of the published data specifying all punishable offences regarding the content of the published data. The Article establishes as a sexual offence every premeditated act of child pornography that includes producing child pornography for the purpose of its distribution through a computer system, offering or making available child pornography through a computer system, distributing or transmitting child pornography through a computer system, procuring child pornography through a computer system for oneself or for another person, as well as possessing child pornography in a computer system or on a computer-data storage medium. In the spirit of the Convention, the term "child pornography" includes pornographic material that visually depicts a minor engaged in sexually explicit conduct, a person appearing to be a minor engaged in sexually explicit conduct, as well as realistic images representing a minor engaged in sexually explicit conduct. The criminal law solutions in our Code are in full compliance with the above-given provisions of the Convention.

Article 10 of the Convention on Cybercrime specifies the offences related to infringements of copyright and related rights including reproduction and distribution of unauthorised copies of any work through computer systems. The Criminal Code of the Republic of Serbia also establishes the offences which are directly in compliance with Article 10 of the Convention.

The Convention on Cybercrime in Art. 7, par. 1 suggests to the national legislatures to establish as a criminal offence the act against computer-related forgery. The Criminal Code of the Republic of Serbia does not recognize offences of computer-related forgery in the same strict sense as the Convention, but incriminates the following acts which do contain certain elements from the Convention: in Chapter XXII as criminal offences against the economy - counterfeiting money (Art. 223), forging securities (Art. 224), forgery and misuse of credit cards (Art. 225), forging value tokens (Art. 226), forging symbols for marking of goods, measures and weights (Art. 245), and in Chapter XXXII, as criminal offences against legal instruments - forging a document (Art. 355) and special cases of document forging (Art. 356), as well as forging of official documents.

On top of the offence of computer fraud established in Article 301, the Criminal Code of the Republic of Serbia also recognizes the following offences containing certain elements from the Convention: in Chapter XXI, as criminal offences against property – fraud (Art. 208), frauds in insurance (Art. 208a), petty theft, embezzlement and fraud (Art. 210), and in Chapter XXXIII, as criminal offences against official duty - fraud in service (Art. 363) and embezzlement (Art. 364).

In the Criminal Code of the Republic of Serbia, there are numerous criminal offences that need to be adjusted to the provisions of the Convention. This primarily refers to criminal offences against the freedoms and rights of man and the citizen, honour and reputation, humanity and other values protected by the international law (racial and other discriminations, human trafficking), criminal offences against life and body (suicide incitement and help) which can be committed in the virtual space, in which a computer may serve as a means of committing a crime while using certain social networks may be the very act of crime.

In Chapter XIV – Criminal Offences against Freedoms and Rights of Man and Citizen, the Criminal Code of the Republic of Serbia recognises the criminal offence of violation of privacy of letter and other mail (Art. 142), which also sanctions e-mail violation. In pretty much the same way, the positive legislation regulates the issues of eavesdropping and recording of chat rooms which is very frequent on social networks. The same chapter establishes the offence of unauthorised wiretapping and recording (Art. 143), but without any concrete reference to cyberspace communication. With regard to frequent surveillance of the communications carried out through social networks and in chat rooms, it is necessary to widen the scope of this offence to embrace electronic communications, without limitation to conversations, statements or declarations. The offences of unauthorised photographing (Art. 144) and unauthorised publication and presentation of other person's texts, portraits and recordings (Art. 145) do not include unauthorised photographing or publication of the data published on the Internet or on social networks.

Being that violation of privacy in cyberspace can be done in manifold ways, the criminal offence of unauthorised collection of personal data (Art. 146) should include sanctioning of such behaviour if done with the data published by social networks' users for the purpose of informal communication with other users. The Convention does not regulate the issue of the right to privacy and personal data protection in cyberspace or in computer-based communications in an explicit way. Indirectly, the Convention does so by sanctioning illegal access to computer data, their forging and fraud practices, as well as through the offences regarding child pornography which can be interpreted as violations of the right to privacy. Still, the entire regulation deals with technical issues, leaving aside the essential issues related to protection against such criminal forms of behaviour. For instance, it does not provide for a specific protection of the persons whose photographs have been made in public because the standpoint taken regarding this issue does not recognize the very act of taking someone's picture as privacy jeopardising. Also, the positive legislation does not contain any provisions to protect the users of social networks from disturbance, sexual harassment, cyber mobbing, bullying, false representation, internet frauds and the like. With regard to the existing practices, it is also necessary to recognise using social networks for the purpose of human trafficking as a separate offence.

Aside from substantive provisions of the Convention, our national legislation also incorporated the provisions regarding the scope of criminal legislation and competences for the prosecution of offenders: the criminal legislation of the Republic of Serbia applies

to everyone committing a criminal offence on its territory or on a domestic vessel, regardless of where the vessel is at the time of committing the act, in a domestic aircraft while in flight or in a domestic military aircraft. Thus, Articles 6-10 of the Criminal Code of the Republic of Serbia are fully harmonised with Article 22 of the Convention, on reciprocity condition. In accordance with Article 6, par. 5 and Articles 10 and 24 of the Convention, the Code also establishes extradition and criminal prosecution of foreigners on condition of reciprocity and provided that such criminal offence is punishable pursuant to laws of the country of the commission, or based on a special approval given by the republican public prosecutor.

II) As for the liability of legal entities for criminal offences in the field of cybercrime, the legal solutions contained in the Law on the Liability of Legal Entities for Criminal Offences [12] rely to a certain degree on Art. 12 of the Convention which establishes liability of legal entities for the offences recognised by the Convention if such offences are committed by a natural person who has a leading position within such legal entity acting either individually or as part of an organ of the legal person. The Law on the Liability of Legal Entities for Criminal Offences defines in Art. 7 that the liability of a legal entity rests on the culpability of the responsible persons, *i.e.* natural persons who have been entrusted, either legally or actually, a certain scope of duties in the legal entity, authorised persons and persons authorized to act on behalf of the legal entity.

Depending on the seriousness and form of the criminal offence, as well as on the type and seriousness of the resulting consequences, the Convention establishes that the liability of a legal entity may be criminal, civil, or administrative without prejudice to the criminal liability of the natural persons who have committed the offence. The national legislation establishes the following penal sanctions that may be imposed against a legal entity for the commission of criminal offences: sentence (fine and termination of the status of a legal entity which may be imposed solely as principal sentences), suspended sentence (with or without protective supervision) and security measures (prohibition to practice certain registered activities or operations, confiscation of instruments, and the publicizing of the judgment). The criminal proceedings are instituted and conducted jointly by a legal entity and the responsible person, and a single sentence is passed (Art. 35).

III) As for the procedural provisions which are directly connected with detection of cybercrime offences, the Criminal Procedure Code [13] establishes specific evidentiary actions for cybercrime offence detection. Namely, Article 162, par. 3 states that a special evidentiary action may be ordered for unauthorised exploitation of copyrighted work or other works protected by similar rights (Article 199 of the Criminal Code), damaging computer data and programmes (Article 298 paragraph 3 of the Criminal Code), computer sabotage (Article 299 of the Criminal Code), computer fraud (Article 301 paragraph 3 of the Criminal Code) and unauthorised access to protected computers, computer networks and electronic data processing (Article 302 of the Criminal Code) in which case the court may, upon a substantiated proposal of the public prosecutor, order surveillance and recording of the communication carried out via phone or other technical devices or surveillance of the e-mail or other address of the suspected party as well as confiscation of the letters and other mailings. Such a special evidentiary action can be ordered against a person for whom there are grounds for suspicion that he has committed a criminal offence, and evidence for criminal prosecution cannot be acquired in any other manner, or their gathering would be significantly hampered (Art. 161, par. 1), *i.e.* against a person for whom there are grounds for suspicion that he is preparing one of the criminal offences and the circumstances of the case indicate that the criminal offence could not be detected, prevented or proved in another way, or that it would cause disproportionate difficulties or substantial danger (Art. 161, par. 2).

In spite of the attempts to get harmonised with the Convention, the Code does not establish a definition of electronic evidence in cases of cybercrime offences.

IV) Aside from the criminal law provisions of substantive character contained in the Criminal Code of the Republic of Serbia, the field of legal protection of intellectual property rights within the fight against cybercrime is also regulated by the Law on Special Authorizations for Efficient Protection of Intellectual Property [14]. The mentioned Law is fully harmonized with Art. 10 of the Convention, because it bans production, possession and placing into circulation of goods and supply of services that infringe upon the intellectual property rights established by the applicable law or an international agreement (Art. 4), as well as broadcasting and re-broadcasting of a

radio or television program that contains authors' works or any subject-matter of related rights, if the obligation to pay a remuneration for the use of such rights is not regulated in conformity with the law that regulates collective protection of copyright and related rights (Art. 5, par.1).

V) The Law on Special Measures for the Prevention of Crimes against Sexual Freedom Involving Minors [15], reconfirms sanctioning of criminal offences referred to in Art. 9 of the Convention on Cybercrime as well as in Articles 185 and 185b of the Criminal Code of the Republic of Serbia regarding the criminal offences of child pornography and exploitation of minors for pornography. As stated in Article 3, the Law applies to the offenders of age who have committed, among other things, the acts of showing, procuring, and possessing pornographic material and exploiting a minor for pornography, as well as the act of exploiting a computer network or any other means of communication for committing criminal offences against sexual freedom involving minors. This Law is an important step forward because it states that the criminal offences targeted by this Law are not subject to a statute of limitations.

VI) In accordance with the provisions of the Convention and the Criminal Code of the Republic of Serbia which prescribe security measures of confiscation or confiscation and destruction of instruments, the Law on Seizure and Confiscation of the Proceeds from Crime [16] specifies in Article 2, par. 1, item 3 that the provisions of that Law must be applied to the criminal offences of showing, procuring and possessing pornographic material and child pornography (Articles 185-185b of the Criminal Code of the Republic of Serbia).

4. CONCLUSION

Cybercrime belongs to recent forms of crime and its emergence is a result of a huge advancement of technology in the field of telecommunications. A growing use of the Internet and social networks, as well as an increasingly wider use of computer technology in everyday life, embodies a tremendous progress from the standpoint of social development. On the other hand, the use of computer technology, particularly of the Internet and social networks exposes a huge number of users to daily victimisation if the data transmitted by the Internet and social networks happen to be misused.

The protection of personal information in a virtual environment as a basic level of human rights' protection mostly refers to the protection of information systems, information itself and information networks, as a private property of individuals or public and private organisations [17]. Significant misuse of computers at the time of their construction and gradual upgrading was practically impossible because their usage required special education undertaken only by a relatively limited number of IT experts since computers were not used on a large scale. Everyday use of computers by a wide stratum of people, accompanied by a liberal approach to communication and information networks, led to a point when cybercrime that once belonged to the futuristic spheres became a dangerous and hard-and-fast form of present-day crimes.

In order to reduce misuse of computer systems and threats to the right to privacy of their users, it is necessary to come up with appropriate legal mechanisms and legal regulations for tracing and sanctioning such socially unacceptable forms of criminal behaviour. Also, it is very important to report cybercrime offences to the competent authorities in order to decrease „the gloomy number of crimes" and accomplish better preventive actions, recognition and monitoring of such offences, as well as to overcome the problems connected with a failure to report such offences. However, as cybercrime has become a transnational problem with consequences far beyond the borders of any single country, it is clear that the mechanisms for fighting against such offences must not remain focused only on the change of national criminal law legislatures, but should foster undertaking of appropriate technical, structural and educational measures, passing of appropriate international technical and legal instruments and creating awareness of the importance of the information bearing potential risk for the occurrence of cybercrime.

Successful prevention of misuses of computers, computer systems, the Internet and social networks is extremely important because this form of criminal behaviour creates tough and often incurable consequences. A detailed legal regulation, tracing and sanctioning of all forms of misuse of computers and computer systems followed by heightened attention, constant monitoring and control by both administrators and users are only some of the most important forms of preventive activities. Daily development of the Internet requires a lot of attention and skills for tracking cybercrime. For this reason, users' substantial computer education is necessary so that they would be able to detect Internet misuses in a timely manner, recognise and report any form of on line attacks

against privacy and thus contribute to reducing „the gloomy number" of cybercrime cases.

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TWITTER DATA ANALYTICS IN EDUCATION USING IBM INFOSPHERE BIGINSIGHTS

Miloš Popović,
Milan Milosavljević,
Pavle Dakić

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

This paper explains the usage of Twitter data in a number of subjects on higher education institutions. It examines procedures for defining the interactions between students and professors through social networks, in order to develop more effective teaching. Describing in detail the way in which Big data technology such as "IBM InfoSphere BigInsights" allows processing of the data, which are primarily downloaded from social networks and later organized in Hadoop environment. To that end, we have designed an application for creating data file based on the search query. Evaluation through analysis of exam results confirms that the proposed solution produces better results in terms of student's academic achievements. Students are encouraged to achieve better results, which ensures better cooperation in communication of all participants in the educational process.

Key words:

Twitter, data analytics, education, big data, IBM InfoSphere BigInsights.

1. INTRODUCTION

In the last three years, human society has created and saved more information than at any time in history [1]. Twitter on daily occurrences has more than 200 million tweets. Students are widely using social networks in education, indicating that Twitter has a large amount of information that can be further analyzed and used in the existing educational systems. It is possible to find out who and what term they are talking about, and what they made the search query for.

The most important result of this research is the implementation of techniques for the analysis of Twitter social network and the application in terms of higher education in Serbia. Originality is reflected in defining the methodological procedures for analyzing Twitter data using the application "TDAedu" that with help of the Big data technology - IBM BigInsights, can be used for statistical analysis in creating better educational system.

The overall objective of this work is to help teachers on certain subjects in higher education institutions to modernize their teaching content, using data that has been collected from social networks. Current trend in the world is in using the links to the latest blogs, or comments of the most influential Twitter users, in connection with the most frequently searched term.

Correspondence:

Miloš Popović

e-mail:

popmilos7@yahoo.com

2. RELATED WORK

Social networks such as Twitter and Facebook provide an opportunity for researchers in different fields to understand human behavior and social phenomena [2]. Three researchers jointly analyzed 3,000 tweets that were randomly selected from the tweets containing hashtag **#engineeringProblems**, and through analysis we can get interesting information that can be later used in various ways. This paper examines sentimental analysis which has recently become the focus of many researchers, since the analysis of online texts is useful and required in a variety of applications, aiming to inform users about the pros and cons in using various products [3]. It has been shown that, sentimental analysis of tweets, by using different algorithms, detecting sarcasm and summary of sentiment, is possible to obtain significant results. In addition, the paper [4] presents the methods of using Twitter data and sentimental analysis for prediction, such as the election predictions in Pakistan in 2013 and India in 2014. The analysis results were successful, since the studies have shown the exact result, even two months before the official results of the elections had been revealed.

The paper suggests a method for interaction between students and professors during the lecture, by using Twitter. The professor would ask surprise questions in the form of a quiz, after which students would submit their answers via smartphone [5]. Only a limited number of students who first answer correctly, for a certain amount of time, would be awarded with points.

This method would enable solving the problem of reduced concentration, resulting from frequent usage of smartphones for non-educational purposes. It forces students to concentrate on the lectures if they want to achieve a good result. The analysis of exam results and post-course surveys confirms that the suggested solution provides better results in terms of academic achievement of students, and their concentration during the lectures. This approach can be implemented without additional costs of purchase, instructions, or maintenance for each student.

Considering all the benefits Twitter can provide, as well as the earlier research regarding this matter, we can see that Twitter can help teachers to expand their lectures, depending on what currently the world's hottest topic is, when it comes to the research field. In addition, the teacher can analyze the student groups, and based on their discussions, comments, pictures, the teacher can obtain results about the potential problems, suggestions, hot topics and students wishes; which can be useful in preparation of teaching material.

3. CHARACTERISTICS OF SOCIAL NETWORKS

Social networks imply the formation of virtual communities, where users can exchange their opinions, collaborate and discuss topics related to their common interests, *etc*. The use of social networks has changed the way we spend our free time, do business and communicate, as well as the ways of learning and organizing teaching process. The tendency of people to exploit the possibilities offered by social networks are increasingly being used in education, in order to adapt to the needs of the learning process of students and making it interesting and appealing. We have noticed that the students started creating groups on social networks in order to connect and share information about the contents and academic obligations.

This has led the teachers to start creating and actively using social networks, so they can give students more accessible contents, encourage discussion among them and provide them access to variety of helpful examples and videos, which can help them review the content in a new way, taking a proactive approach in studying and critical understanding of the content.

Twitter as a source of information

Twitter represents a social network that allows users to send and read short messages of up to 140 characters. Twitter was created in March 2006 and was officially launched in July 2006. Twitter is being developed at an incredible rate, reaching over 200 million users with more than 200 million tweets a day. Users create their own Twitter account, and from the moment they receive the account information they can start "tweeting", a term for sending messages on Twitter. Users can follow the other users' tweets, a process known as "following". These users are also called "followers". Tweets that the user is sending are visible to all. However, users can choose the option of sending tweets to their "followers" in particular so they will not be visible to the public.

The goal of Twitter is very simple. It is designed for short information and communication and the users are usually between 18-34 years old [6]. About 300 participants participated in a poll conducted on the Internet, of which 70% from Europe and the rest from North

America and Asian countries. All respondents answered the set of questions on how they were using Facebook and Twitter, and which of the these two social networks they preferred.

In order to connect the questionnaire results with the subject's character, each subject was given a personality test - standard measuring instrument that assesses personality traits based on openness (for new experiences), conscientiousness, extroversion and neuroticism (emotional (in) stability). In addition, intellectual curiosity, need for cognitive stimulation and acquiring new skills were also measured among the respondents. Social use of Twitter is associated with high scores on tests of sociability and openness as a dominant trait (but not with neuroticism), while negatively correlated with conscientiousness. This finding suggests that Twitter is not used to deal with loneliness, but a source of information. Limited with short statuses, Twitter users use the social network for cognitive stimulation, without socializing. Taking all of this into consideration, Twitter was selected as the main source of updated information which can improve the quality of education.

Social analytics is a term that has become very popular in recent years, mostly because by using these sites on a daily basis, a large amount of data is being created, and the information is publicly available via API (Application Programming Interface). Therefore, using the techniques of analysis with social networks, we have come up with some interesting new information that may be of important use in various areas such as: computer science, economics, marketing, politics, sociology, *etc*.

In Belgrade Business School, there are 7 professional studies departments of all the above mentioned areas, so in addition to the realization in the computer science department, the idea can also be implemented to other departments, where the professors would able to enrich their lectures with the latest trends using Twitter analysis.

4. BIG DATA

Big data represents the ability to manage a large amount of different data at reasonable speed and within an appropriate time frame, in order to allow data analysis in real time. The data is supplied from many different sources and can be found in various forms. With fast of development of sensors, smart devices and social networks, generated data has become complex, primarily because it includes not only traditional structured data, but unstructured or semi-structured data as well.

Big data analytics allows you to work through massive amount of information in real time and previously collected information as to find the unseen patterns and nonsense to the eye, that can lead to new findings, and point out to opportunities for new services and products. Moreover, it allows the development of more effective ways of functioning, improving the transparency and accountability of institutions. Big data has a huge impact on society. Everyday people are offered a variety of opportunities, as digital users, in order to enhance the value of information. Data is already a source of power in the modern world and a very valuable product for those who can analyze it. All people are the users of digital data. It allows us to have the access to all the knowledge that was once considered out of reach or was the privilege of the few.

Big data technology - IBM InfoSphere BigInsights

It is estimated that one third of the global information is stored in the form of alphanumeric text and "Still image" data format, which is extremely useful for most Big data technologies. Big data technology and the benefits it brings have been recognized by the leading software companies that deliver commercial software. IBM BigInsights is a software platform that can help in analyzing large amount of a broad spectrum data - the data that is often ignored or rejected because they are too impractical or difficult to process using traditional methods.

In order to effectively carry out the value of such data, BigInsights included several "open source" projects, including Apache Hadoop and several technologies developed by IBM, including BigSheets tool. Hadoop and its related projects provide efficient software framework for "data-intensive" applications that exploit distributed computing environment to achieve a high level of scalability. IBM technologies enrich this "open source" frame with analytical software, integrated software, platforms and tools with the extension.

IBM InfoSphere BigInsights Quick Start Edition is a free technology that allows new solutions on how to efficiently convert large and complex amount of data, [7] by combining the Apache Hadoop (including MapReduce and Hadoop Distributed File Systems) with a unique IBM technologies such as Big SQL, text analysis and BigSheets. To install the IBM InfoSphere BigInsights Quick Start Edition, it is necessary to fulfill several conditions. As for the hardware prerequisites for starting and installation, a minimum of 4GB of RAM, 40GB of

hard disk space, and two processors are required. The operating system by which BigInsights works is Linux. IBM BigInsights technology is suitable for the analysis of data from the Twitter social network.

The aim is to create an application that will, using this technology, successfully analyze Twitter data and thus help modernize the educational system in high schools. With this in mind, several studies have been made on how to implement this improvement. Studies have shown that most students use social networks on a daily basis, and regarding the fact that social networks offer a large amount of updated information that can be used for educational purposes, it was concluded that the best solution was to create an application that could analyze data obtained from social networks, in order to facilitate the search and therefore help teachers to improve the topicality of their content.

5. PROCESS OF CREATING A FILE FOR ANALYSIS

Twitter maintains an open platform that supports millions of people around the world who share the discovery of what is happening in real time. Twitter wants to empower its partners and customers to build a valuable information network, by allowing a free creation of various applications for different purposes.

Twitter social network for free creation and development of various Twitter applications requires the creation of a Developer's account. This makes it possible to successfully analyse the data and that what the Twitter API v1.1 is for. In its first version, Twitter API v1.0 used to bring back data to JSON format by using Ajax calls. However, now a new version of Twitter API v1.1 supports a variety of methods and data search, retrieving data in the following formats: XML, JSON, RSS and Atom. The new version also requires user authentication with built-in time limit for each code used when accessing the API, so now OAuth authentication and verification are being used.

The next step is to create the application, put personal data and location where the files for analysis will be stored. After that, you should write a request that will allow Twitter to know what needs to be searched. Requests may be different, depending on what information the user wants to receive. They can be simple, consisting of a few phrases or a hashtag. It is possible to search for tweet queries from certain locations, using a certain language. In addition, it is possible to search for tweets that are most popular or have multiple queries. In this case,

the search is related to a word "android" and the query looks like this: **q=android&count=1000**

By this query, Twitter will generate last 1000 tweets containing the word "android" to the code which is necessary for the following step in order to create a file from which the data will be further analyzed.

Figure 1. Creating request for analysis inside TwitterAPI

After that, we receive the command called "cURL command" that needs to be used within a few minutes. This is the information which is obtained after the query generates code that is required in the first step.

The biadmin documents will then locate a file called "and.json". "JavaScript Object Notation" (JSON) is a simple, text-based open standard designed for human-readable data exchange which is derived from the JavaScript language to represent simple data structures and associative arrays, *i.e.* objects. Despite its close ties with JavaScript, JSON is an independent language. It is often used for serialization and transfer of structured data over the network connections, especially between the server and web application, serving as an alternative to XML.

Loading data into IBM BigInsights is performed by typing an address http://BIVM:8080 in Web console. We need to find a file that has been created and upload it to the tab "Files" where they will be recognized as a text CSV file. In the following procedure we need to save the file as a Master workbook called "analysis of android," which is then automatically opened in BigSheet tool. BigSheets the analysis tool based on the browser which was originally developed by a group of new technologies of IBM (Emerging Technologies group).

Today, BigSheets is included in BigInsights in order to enable users to explore and analyze data. BigSheets represents tabular interface so that users can create, filter, combine, explore, and schematically show the data collected from various sources. BigInsights Web console

includes a tab at the top to access BigSheets. BigSheets is a tool for the analysts provided by the IBM InfoSphere® BigInsights, and it is a platform based on open source Apache Hadoop project. BigSheets is the spreadsheet tool that is mainly used for analysis of social media and structured data collected through the application of samples obtained from a BigInsights.

When BigInsights collects and enters the data from different sources, BigSheets tool allows interactive exploration and managing the data from distributed data system. It is easy to form and manage data in BigSheets tool by using the built-in macro functions. It is also possible to create charts for a visual presentation of work and export analysis results into one of several popular output formats.

6. USE OF APPLICATION – TDAEDU IN EDUCATION

Figure 2. TDAedu application example

Data access allowed to Twitter users is displayed by the application in 17 columns. This is the meaning of these data:

header1 = (created_at) - Date and time the tweet was created; header2 = (id_str) - ID number; header3 = (geo) - Geographic location; header4 = (coordinates) - Coordinates; header5 = (location) - Location; header6 = (user.id_str) - ID of the user; header7 = (user.name) - Username; Header8 = (user.screen_name) - Twitter Username; header9 = (user.location) - The location of the user;

Header10 = (user.description) - A brief description of the user; header11 = (user.url) - Link to the user; header12 = (user.followers_count) - The number of followers; header13 = (user.friends_count) - The number of "friends" that a user follows; header14 = (retweet_count) – The number of tweets; header15 = (FAVORITE_COUNT) - The number of favorites; header16 = (lang) - Language used by a user; header17 = (text) - Complete tweet in a form of text.

According to all these data, it is possible to perform several types of virtualizations:

The most commonly used language in tweets

The first example shows the total percentage of language coverage - the language mostly used in writing the tweets that are being analyzed. The application displays the column header 16 which is the column showing in which language the tweet is written, and the Total column that uses the COUNT function to calculate the number of the same languages from the column header16. Moreover, it is possible to make a virtual display using the chart where you can see that among the last 1000 tweets almost two-thirds were written in the Japanese language, followed by English, and German, *etc.* By using this analysis, the teacher can see which languages are mostly used to talk about the word from our query. In this case, we made a search for the word "android". After the analysis, a lecturer can tell students to create an android application in the Japanese language, in order to have better results on the market. On the other hand, they can visit most popular Japanese websites for android programming, since this analysis shows that this topic is very popular in Japan.

Influential people

Social media have gained great popularity among marketing teams, and Twitter represents an effective tool for a company and helps draw attention to their products. Twitter facilitates the involvement of users and direct communication with them, and in return users can provide the "word of mouth" marketing to the company by talking about their products.

This type of analysis could be of interest for students studying marketing and trading. A teacher instructs students to find influential users, and show them the potential utilization of users for marketing purposes.

In addition to the analysis of certain concepts in marketing to perceive the reaction of users to the specific product, it is possible to detect a new advertising idea. Marketing departments can be more efficient by selecting who they want to reach to, and it can done by discovering the most influential person on Twitter, because by retweeting the messages can go much further than the followers of the person who originally sent the tweet. Bearing this in mind, it is necessary to try to engage users whose posts tend to generate a lot of retweets. Since Twitter keeps track of all retweets, it is possible to reach the target group through the analysis of Twitter data.

Showing links

 In order to use Twitter analysis for school subjects related to information technologies, the example of request about android applications has been made. Right before the lecture, a professor who teaches android programming analyses Twitter data with students and obtains information that are trending and are connected to that area, and therefore adapt the lecture to the trending information.

In order to obtain good insight into the most popular android applications, the application sorts out the tweets by the most influential users, those who have the largest number of followers, meaning these users are always the first to publish information on current events in the world. After sorting the users, the application will use the URL function from tweets in the column 17 (column showing the entire tweet) to show only the links to most updated blogs or go directly to updated applications. There is also a display of the column 17, which contains a complete tweet to have a better insight into the link that is displayed. The application then inserts the column with the number of followers to sort the links by most influential users, and at the end, there is the column 15, which shows the number of users who liked the tweet content. With this display it is possible to see the links that are most preferred by the users.

The application provides the ability to quickly open a link, so that users do not have to wait for the link to open in a new window. Specifically in this case, after the first 5 links open, we could already get the information about currently most popular android applications. The most popular tweet included a link to the application released on that day, which is called Hacking Gmail App and which was posted on the "The hacker news" blog.

Figure 3. Sorted links from the most popular tweets

Tweets analysis from student groups

One of the ways Twitter data can be used is for the analysis of student tweets that use a certain hashtag, in a conversation related to this subject. To successfully apply this analysis, it is required to make an agreement with a group of students (in this case the subject "information technologies in business") so that students can frequently discuss the subject on Twitter, during the preparation for the test or exam. The agreement is that after each set of questions related to the subject, or after each statement, assistance or answer to someone's question, they post a twe*et al*ong with a hashtag #bpsitb (Belgrade Business School - information technology in business), as to be easily accessible. If you search for #bpsitb entry, the application will display a window with the most commonly used words in those tweets.

In order to have the best analysis of the tweets with hashtag #bpsitb, it is necessary to count the number of words that were commonly used, and based on those results we could see what was mostly written about and what could be a potential problem for students. The applications WordCount, which is located within the IBM BigInsights, manages the collection of text files and gives back the total number of words located in that file. After tweets analysis, the application will show a picture with the number of words, most commonly used, being increased and vice versa. The results obtained from the analysis can be used to focus on what caused the most problems to students while preparing for the exam, and to make it clear for future generations, in order to avoid the same problem, that they need to pay more attention to that part of studying material.

7. CONCLUSION AND FUTURE WORK

Based on previous experiences of scientific research in this area, as well as the research in this paper, it can be concluded that the implemented methods and techniques for the analysis of social networks contribute to the improvement of learning outcomes and interaction between students and professors. Electronic education and Distance learning in the future will be an integral part of any education system. Efficiency, effectiveness and competitiveness of educational institutions will depend on the ability to adapt to the demands of students, and implement actions that will improve the learning performance. The results of this research offer the possibility for further work in this area, primarily in the area of upgrading and expanding the proposed solutions for the application of analysis of data from social networks; in creating and developing e-learning courses where content would be created according to data on student behavior and activities, both at the university and on the social networks. This collected data would be processed in the system and applied in real time. The main goal of future research would be to develop applications for creating adaptive courses which would not require additional skills from a teacher. Creating modern applications for analysis could execute queries offering more options which would also provide possibilities for advanced visualization.

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THE INTERNET AND DEVELOPMENT PERSPECTIVES

SOCIO-EDUCATIONAL E-LEARNING PLATFORM - PROPOSITION

Emir Pećanin[1*],

Siniša Ilić[2],

Bojana Milosavljević[3],

Bratislav Mirić[1],

Edin Dolićanin[1]

[1]State University Novi Pazar,
Novi Pazar, Serbia

[2]Faculty of Technical Science Kosovska Mitrovica,
Kosovska Mitrovica, Serbia

[3]Singidunum University,
Belgrade, Serbia

Abstract:

Universities rely on some kind of learning management system (LMS) for distribution of lecture recourses, books, video tutorials *etc*. Such systems are usually incorporated and work along with the traditional teaching methods to create a cohesive learning environment for students. Unfortunately, we are not always successful in creating such environments. Being unable to completely integrate IS (information system), e-learning system and LMS systems, and the lack of adequate communication components in those systems, results in diminishment of social interactions between teachers and students. That means that students have to rely on some other form of communication medium, usually social networks, to be able to interconnect, create social groups and interact. Social networks enable proper group organization and real-time communication between students. The proposed platform will try to create a correlation between the IS, the e-learning system giving it social network aspect and enabling direct, two-sided and transparent communication between students, teachers and university administration.

Key words:

CMS, LMS, educational system, social network.

1. INTRODUCTION

Modern web technologies, web-blogs, and wiki pages have allowed easy and efficient integration of e-learning into traditional teaching methods. As a result, universities rely on online repository, contend management system (CMS) or LMS for distribution of lecture materials.

Al-Qahtani and Higgist (2013) showed that mixed teaching methods that incorporate traditional and e-learning methods, yielded much better results than its individual components. Traditional and e-learning methods gave almost the same results when compared individually, but worse results when compared to mixed teaching methods.

Interactivity, simplicity, and social aspect – being able to exchange opinions with one's peers, allowed very fast growth of social networks. Today, usability of social networks goes far beyond a simple chat service.

Correspondence:

Emir Pećanin

e-mail:

epecanin@np.ac.rs

EdX, Udacity, Udemy and other e-learning platforms, use a similar approach by fully utilizing the social aspect of the platform to increase interactivity, attract new users and increase interest in learning.

In this paper, we will give a proposition for creation of an e-learning platform that places special emphasis on students, teachers, interactivity and social interaction. The platform is expanded with administrative tools and database management tools. We will present a structured plan, role, and page organization and propose technologies that can be used in its creation.

2. PROPOSED TECHNOLOGIES

CMS & LMS

E-learning platforms can be described as modular content management systems (CMS). Modularity of such systems allows expansion of its features by installing or writing various plugins. The degree of modularity is defined by its creator, platform capabilities, and plugin complexity. If such systems are incorporated in an educational system, they are usually called LMS (learning management systems). A popular example of such a system is Moodle which is currently used by more than 30000 institutions across the world (Cole and Foster, 2009).

Unfortunately, certain features are simply impossible to implement in such platforms. Functionalities are either too expensive to implement or the LMS system cannot support such features. On the other hand, even the well-rounded systems are not used to their maximum potential. In the worst case scenario, such systems become web-pages additions where students can find and download latest lecture notes, practice examples and nothing else. Such systems even include rudimentary chat system that enables its users to send and receive messages but aren't used that much. Students and teachers tend to use e-mail clients.

Modern CMS systems, even if not originally intended for educational purposes, are flexible enough and can be excellent starting point for the creation of educational platforms.

No CMS can claim to be the best CMS system. We propose two reliable and stable CMS systems.

- ◆ **Drupal** – very flexible and adaptable CMS system. Very popular with frontend and backend engineers. Drupal has certain characteristics of PHP framework and is usually referred to as CMF – Content Management Framework.

The only flaw of this system is its complexity. Drupal is not very user friendly towards new users.

- ◆ **Wordpress** – started as blogging CMS. Today, Wordpress evolved into powerful CMS system. Simplicity, large user base and numerous plugins, allowed Wordpress to be used for development of complex web applications. Wordpress based applications and web pages tend to look all the same.

The usefulness of CMS systems becomes evident in situations where applications require web page structure. The fundamental flaw of CMS system is their plugin dependency. Each feature requires one more plugin to be installed. This tends to become a problem if number of installed plugins becomes too large. Instead of features, the CMS becomes overloaded with excessive plugins which contain unnecessary code degrading its performance *e.g.* for basic webpage functionalities Wordpress requires at least five plugins installed.

PHP Framework

PHP based Framework for application development is a popular approach that gives engineers absolute freedom when choosing what features to include in their system. This approach requires trained app designers and programmers, whereas CMS systems are not so demanding. In general, the consensus is that PHP framework is good as long as it has a dedicated team that keeps up with modern trends. According to last year's survey (Skvorc, 2015), Laravel PHP platform took first place (Figure 1). Laravel is one of the youngest PHP libraries. Customizability and flexibility made it top choice for app development (Rees, 2015).
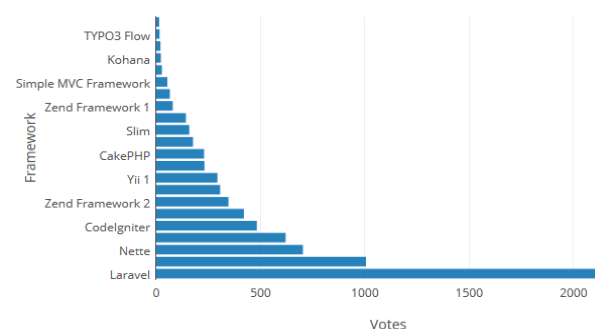
Figure 1. Popularity diagram based on survey from 2015.

PHP framework will take care of any computational tasks (back end) of our platform. We have several choices regarding the front end of our platform, HTML and CSS combination, Bootstrap or AngularJS.

For One page applications and web pages, the best choice is AngularJS. One page design is practical in a sense that it reduces number of HTML calls towards the server (Pitt, 2014).

Database

Since the proposed e-learning platform is a client-server, web orientated application, it will use a MySQL database. The structure of the database can be organized from scratch or, if university IS already uses one, can be adapted to existing database.

3. DESCRIPTION OF THE APPLICATION

The proposed application expands exiting features of a high-end LMS system in which teachers can organize the teaching curriculum, organize lecture material, test organization and creation, expanding it with a social network aspect. The application will have a built-in chat system and user profile pages with wall panels where teachers and students can pin messages and class notifications. For administrative staff a special panel would be created where they can control the flow of information and manage user roles.

There are five types of user profiles:

- **Administrator** – has complete control over the system.
- **Clerk** – can organize students and exam applications, has access to exam schedule and student report cards.
- **Teacher** – can create course pages, upload and edit lecture material on their own pages, create and organize test pages for his courses, can access subscribed student lists and edit them. Teachers can create chat rooms for Q&A sessions, but this profile type requires registration. This profile type requires registration.
- **Student** – can be a subscriber to a course, can download and comment on a course. Profile has access to chat seasons for subscribed courses. Can chat with other users and post messages on wall panels, his own and other user's walls. Profile type that requires registration.
- **Guest** – profile type that doesn't require registration, can see the overview of the course but cannot access its contents.

In terms of profile privileges, Teacher has all privileges of the Student profile, and Student has all privileges of Guest profile. Vice versa does not apply. Users with profile type Clerk are added by administrator directly so registration is not required. Administrator type profile is created with the creation of the platform database.

User pages

The base page of application is administrative panel, accessible only by the Administrator profile. The Clerk user profile can access certain categories of this panel. These user profiles don't require registration to allow use of the platform. For profiles Teacher and Student registration is mandatory. Teachers and students that are already in IS of the university will receive accounts generated by the system. Useranemes of the existing accounts are generated by the first letter of the name and a complete string of the surname *e.g.* Emir Pecanin would be epecanin. Passwords are randomly generated and emailed to the users. Once logged in, these users can change the password using their profile pages. Since the platform is open for registration, all new users can create new accounts by filling in registration form. Not all the users have their profile pages.

Administrator & Clerk profiles – Category organization of the Administrative panel can change depending on the needs of the institution. Design and organization of the panel should prioritize modularity and clean presentation of the information. We based our design on the dashboard of the popular CMS system. The overview page is shown in Figure 2. Basic information, navigation menu are common page components, we have included statistics, activities and date – task organization panel. The Clerk profile can access student category where they can organize and change student information, print reports and student related documents. This profile can access the sub-category Exam halls where they can organize exams by course or by available classrooms.

Teacher profile – Can create, edit and organize courses. Can organize student lists, edit marks and define course regulations. Both Teacher and Student profiles have wall panels where they can pin messages. Both Teacher and Student have Subjects link that leads them to the course list. For the Teacher profile it will show the list of courses user teaches and for students it will show the list of courses they subscribed to. Teacher and Student profiles have access to chat panels where they can communicate with other users and search panel they can use to find courses and other users that are in

the database. Both profiles have organization panels on their profile page where they can create *To do lists* and see what events are scheduled during the week currently shown in Figure 2.
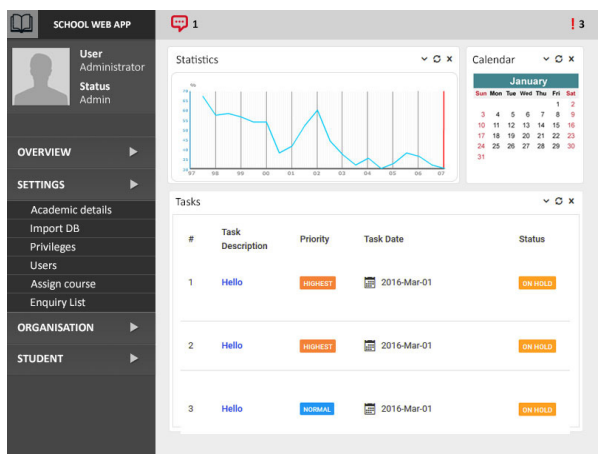
Figure 2. Overview page
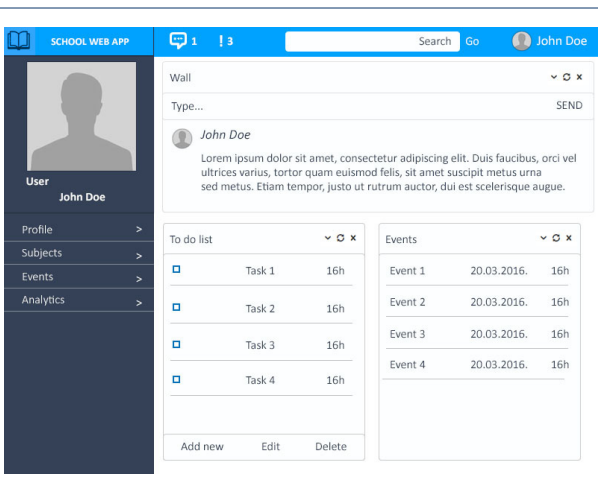
Figure 3. Profile page

4. LOGIC DESIGN

Access form

Users can gain access to the application using the access (log in) form. Input of username and password is required. Depending of what user profile they are assigned to, the application will show different pages. Administrator and Clerk profiles will see the page shown on Figure 2. Teacher and Student profiles will be shown Figure 3.

The form has a Guest button for the Guest profile users that will be shown as a generalized Figure 3 page excluding personal info, *To do list* and the ability to write on the wall panel.

Registration form

The registration form contains the following fields:

- E-mail address,
- Name,
- Surname,
- Username,
- Password,
- Repeat password,
- Year of birth.

All newly created user accounts are assigned to the Student user profile until the administrator reassigns them. The password needs to be at least 8 characters long combining lowercase and uppercase letters, and number. The application will notify the user if any error occurs. In case users leave part of the form empty, form will halt the creation of the account until the user enters all required information.

Once registration is complete, the user will receive an email message containing the validation link that will ensure that their email was input correctly.

Profile page

Requires input of additional information:

- Home town
    - In case of Student profile
    - Department
    - Study program
    - Index number
    - Year of enrollment
- In case of Teacher profile
    - Department

Information isn't mandatory but it is needed for the profile completion. In case the user does not fill in additional information, a message will appear in the header of the profile page requesting him to do so.

The Administrator profile page controls all functions of the application. The category list of administrative panel is given in Table 1.

Profile pages Teacher and Student contain the following links:

- Profile page – user profile page that contains basic user information. Users can write on the wall panel and share messages and notifications with other users. The page contains an event list panel and user account settings. The settings also include options where users can delete their own account.

Category	I level	II level	Description
Overview	-	-	Basic information and stastistics regarding students, student grades, number of active courses, diagram containing information about student presence
Settings	Academic details	-	Setting begin and end date of the semster
	Import DB	-	Used for importing and exporting data from external database
	Privileges	-	Used for defining user group privileges
	Users	-	Tabelar representation of user information, can be displayed and organised by certain condition
	Assign course	-	Used for asigning courses to users
	Enquiry List	-	Displays registered user list, used for accepting or declining user registration (usually for bot detection and removal)
Organisation	Course and allocation	Course	Defining student program regulations
		Teacher al-location	Used for reogranisation of teachers
	Subjects	Subjects	Creating new courses, defining course regulations
		Assign sub-jects	Used for subject assignment
		Sub. allocation	Used for allocation of teachers on existing courses
	Lession Plan-ning	Plan	Used for creating, editing and organising course curriculum
	Exams	Create exam	Used for creating course exams
		Set Grade scale	Used for setting grade scales
		Set Credit point	Used for defining credit points for each activity
		Set exam	Setting date for exams
		Broad sheet	Generates table containing exam results based on subject
		Report card	Generates course list and result achieved during the semester
	Exam hall	Exam hall	Used for organization of the exam halls
		Hall arrange-ments	Exam hall organization
		Invigilators	Used for assignement of invigilators to the exams or exam halls
	Circular	-	Used for circular messaging and sending global notifications (usually for system updates)
Students	Category	-	Student category organization
	Admission	-	Used for adding new students to database
	Student List	-	Tabelar representation of students according to year, student program or department
	Attendance	-	Tabelar representation and statistics of student attendance according to course, year, student program and department
	Print list	-	Used for generating student info reports, grade reports or course reports

Table 1. Navigation categories for Administrator user profile

- Subjects page – shows the course page. The Teacher and Student user profiles will have different composition of this page. For the Teacher profile it will show the list of courses the user is teaching. For the Student profile it will show a list of subscribed subjects.

- Event page – shows a tabular schedule of events during the current week and includes extra information for each event.

- Analytics page – shows student statistics, course attendance, students grade statistics etc. This page includes graphical representation based on these values.

Profile pages also include a chat system similar to the one popular social platforms use. Wordpress based applications can use plugin called ChatPirate.

The best solution is to develop the chat system ourselves. This way we can add all the features we need and

ensure that security of our webpage isn't compromised by installing the third party software.

The lectures have term based organization where every term contains fields where the Teacher profile can upload his lecture materials. The Teacher profile can edit, delete or hide uploaded lectures. Initially only the first term will be available. As soon as Teacher profile uploads some material, second term is shown with empty fields. Student profiles cannot see empty term fields on their pages. The application supports most of the popular video and audio formats as well as textual file format. Since the number of courses and lecture material will continue to grow, we must ensure that our server's hard drive capacity can store all of the uploaded data.

Term fields have comment panels where students can discuss lectures, give suggestions or remarks.

The Teacher profile can organize tests for the subscribed students. Generating a test is an automatized process defined by the application. Teachers need to fill in the question, one or more correct answers and one or more incorrect answers. Students can apply for tests. The application randomly generates tests using questions that the Teacher profile provided and grade students based on correct and incorrect answers. Tests are time restricted.

The Clerk profile manages student information, exams and student statistics. This profile can also manage Exam halls and generate and print report and grade cards for students.

The Guest profile can only access the course list. They can also see what terms are already uploaded on the application but cannot download or read files until they create an account.

CONCLUSION

Combining traditional teaching methods and e-learning methods has improved reception of knowledge and the quality of knowledge transferred to students. Yet, these systems are far from perfect. With great effort we try to perfect, invent and re-invent methods to increase the quality of lectures and transmission of knowledge.

This paper proposes the plan of elegant, robust and modular e-learning platform. The platform will upgrade outdated solutions where IS of the university, traditional teaching methods and communication systems are individualized and physically separated. We gave guidelines for its realization in hope that the platform will become a connecting bridge between teachers and students and improve communication between them.

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AN ARTIFICIAL NEURAL NETWORK MODEL FOR EFFICIENT ESTIMATION OF THE NUMBER OF MOBILE STOCHASTIC EM SOURCES IN THE SPACE SECTOR

Zoran Stanković[1],
Ivan Milovanović[2],
Nebojša Dončov[1],
Bratislav Milovanović[2]

[1]University of Niš,
Faculty of Electronic Engineering,
Niš, Serbia

[2]Singidunum University,
Belgrade, Serbia

Abstract:

Information on the total number of radiation sources that are currently observed in the physical sector may be of use in procedures dealing with efficient DoA (Direction of Arrival) estimation of stochastic radiation source. This paper introduces an artificial neural model based on MLP (Multi-Layer Perceptron) network, that is based on a value of the spatial correlation matrix signal sampled in the far zone ofradiation, and can determine in real time, the number of mobile stochastic sources (up to five sources) with mutually uncorrelated radiation that are currently present in the given sector in the azimuthal plane. This model is an upgrade MLP model that previously had implementation for a maximum of three sources in the sector. Training neural model was carried out on the samples of the spatial correlation matrix obtained by using Green's functions. The authors observe the case when the number of sources in the sector variable in time and when the sources during the movement in the given sector may be located in another arbitrary distance.

Key words:

multilayer perceptron (MLP), antenna system,
artificial neural network, wireless communication system.

1. INTRODUCTION

One of important activities that open the possibility of further increasing the number of users of modern wireless communication and quality of service which is offered to customers of such systems are, researching methods to effectively minimize the negative impact of interference on the site of received signals. In this sense, the procedures based on spatial filtering, signal antenna arrays and design characteristics of radiation using adaptive antenna arrays now receive special attention [1,2]. The above-mentioned processes show some of the key techniques that implement such procedures based on DoA estimation techniques [1.2], and the spatial localization of various sources of interference as deterministic and stochastic nature of radiation [3,4].

MUSIC (*Multiple Signal User Classification*) algorithm [2], and its modifications are so far the best known and most commonly used super-resolution algorithms for DOA estimation. These algorithms are characterized by a high degree of accuracy in determining the direction where EM signals come from. However, because of its complex matrix calculation requires powerful hardware resources, they are not suitable for

Correspondence:

Ivan Milovanović

e-mail:

imilovanovic@singidunum.ac.rs

real-time operations. A good alternative to the super-resolution algorithms, the application of artificial neural networks [5-7] to solve problems DoA where neural models that avoid complex matrix calculations can have an approximate accuracy of the MUSIC algorithm without having to be significantly faster than the MUSIC algorithm which makes them more suitable choice for deployment in real time [8-17].

In the process of DoA estimation, using either super-resolution algorithm or neural model, the knowledge of the number of sources of EM signals (radiation) represents important information that helps in the implementation of an efficient and accurate process. In the works [16,17] developed a neural model based on PNN (*Probabilistic Neural Network*) [18-20] that on the basis of the value of spatial correlation matrix signal which is sampled in the far zone of radiation, can determine in real time the number of mobile stochastic sources with mutually uncorrelated radiation that are currently present in the given sector in the azimuthal plane. The performance of our PNN model is shown in the examples were satisfactory, but it was concluded that increasing the maximum number of sources that can be found in the observed sector significantly complicates the structure of PNN model, which can lead to significant performance degradation neuronal models in terms of training and achieve satisfactory accuracy in the process of exploitation of models. This is primarily because the increase in the maximum number of sources that can be found in the observed sector dramatically increases the number of samples for training the neural model, and therefore, the complexity of used PNN where the number of neurons in the hidden layer in direct proportion to the number of samples for training models.

Bearing in mind the above mentioned limitations, the PNN model began with examining the possibilities of applying MLP network [5,6] as one of the alternative PNN in the process of determining the number of mobile stochastic sources with mutually uncorrelated radiation that are currently present in the given sector in the azimuthal plane. When selecting alternatives, it is necessary to take into account the fact that with an increasing number of samples, for training an MLP network, complexity grows to a much lower degree, compared to the growth of complexity of a PNN, because the number of neurons in the hidden layer of an MLP network is not in direct proportion to the number of samples, and in a number of samples an MLP network can have manifold smaller number of neurons in hidden layer in relation to a PNN. The first results were

achieved in [21], where the MLP neural model to determine the number of the source under the condition that a maximum of three sources can be found at the same time in the sector. This paper presents a MLP model trained to determine the number of sources in the sector under the condition that a maximum of five sources can simultaneously occur in the given sector and which was created to further the development and training of the MLP model, which was introduced in [21].

2. MODEL RADIATION SOURCES IN STOCHASTIC FAR ZONE

To generate a set for training a neural model, and a set of samples to test it, the same model of stochastic radiation source in the remote zone is applied, as in the papers [10-17]. The model of stochastic radiation sources in the distant zone represents radiation of a uniform linear antenna array of N elements located at the distance d (Figure 1). The degree of correlation between the current supply element antenna array that is described by the vector I=[I_1, I_2, ..., I_N]), is defined by the correlation matrix $c^I(\omega)$[3,4]:

$$\mathbf{c}^I(\omega) = \lim_{T \to \infty} \frac{1}{2T} \left[I(\omega)I(\omega)^H \right] \qquad (1)$$

In the zone of far-field electric field, the strength at the selected point is calculated in the following way:

$$E(\theta, \varphi) = \mathbf{M}(\theta, \varphi)\mathbf{I} \qquad (2)$$

where **M** represents the mapping Green's function:

$$\mathbf{M}(\theta, \varphi) = jz_0 \frac{F(\theta, \varphi)}{2\pi r_c} \left[e^{jkr_1} \quad e^{jkr_2} \quad \mathrm{K} \quad e^{jkr_N} \right] \qquad (3)$$

In the previous equations, θ & φ represent the corners of the selected point in the azimuthal and elevational plane compared to the first antenna element, $F(\theta,\varphi)$ is the radiation characteristics of the antenna element, rc is the distance between the selected points of the array center, z_0 is the impedance of free space, k is the phase constant ($k=2\pi/\lambda$), while r_1, r_2, ... , r_N represent the distance to the selected point from the first to the N-th antenna element respectively.

In the case that in the distant zone we sample values of the electric field intensity at more points, we use even more complex notation to indicate the distance. For example, in Figure 1. $r_{i,m}$ the distance between the i-th array element ($1 \leq i \leq N$) and m-th sampling points in a distant zone ($1 \leq m \leq M$), where M is the number of sampling points.
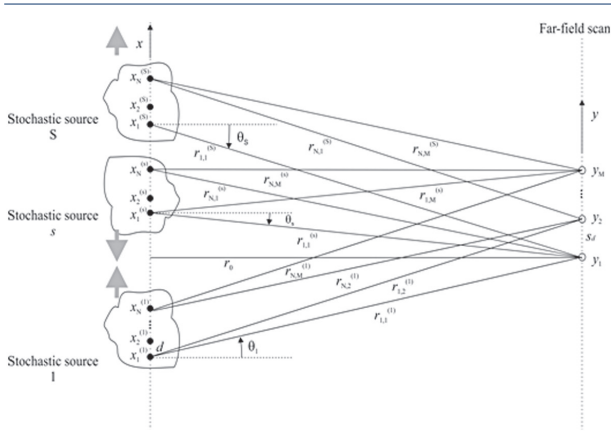
Figure 1. Model of stochastic radiation source in a distant zone showing the appropriate distance between sampling points and elements of antenna arrays that represent sources of radiation [10-17]

If the corresponding angles in the azimuthal and elevation level of M sampling points (y_1, y_2, ..., y_M) in far zone represent with (θ_1, φ_1), (θ_1, φ_1), ... , (θ_M, φ_M) respectively, then the correlation matrix of signals at these points can be determined in the following manner: [8]

$$\tilde{\mathbf{C}}_E[i, j] = \mathbf{M}(\theta_i, \varphi_i)\mathbf{c}^I \mathbf{M}(\theta_j, \varphi_j)^H, \ i = 1,...,M \ \ j = 1,...,M \quad (4)$$

In the case of multiple sources where S is the number of sources, matrix $\mathbf{M}$ has the following layout:

$$\mathbf{M}(\theta, \varphi) = jz_0 \frac{F(\theta, \varphi)}{2\pi r_c} \cdot \left[e^{jk_1^{(1)}} \mathrm{K} \ e^{jk_N^{(1)}} e^{jk_1^{(2)}} \ \mathrm{K} \ e^{jk_N^{(2)}} \mathrm{K} \ e^{jk_1^{(S)}} \mathrm{K} \ e^{jk_N^{(S)}} \right] \quad (5)$$

where $r_i^{(j)}$ is the distance between the i-th element antenna array that represents the j-th generation source and the observed point sampling in a distant zone so that the vector power supply is as follows:

$$\mathbf{I} = \left[I_1^{(1)} \mathrm{K} \ I_N^{(1)} \ I_1^{(2)} \ \mathrm{K} \ I_N^{(2)} \mathrm{K} \ I_1^{(S)} \mathrm{K} \ I_N^{(S)} \right] \quad (6)$$

where $I_i^{(j)}$ represents the power supply of the i-th element antenna array that represents the j-th generation source. The elements of the correlation matrix that is related to the sampling points $\tilde{\mathbf{C}}_E$ can be calculated when the equations (1) and (5) used for calculating the correlation matrix using equation (4).

If two sources of radiation have the same angles (θ, φ) but are located at different distances from the observed point in the distant zone r_{c1} and r_{c2} respectively, and if the sources are represented as antenna arrays with N_1 and N_2 elements respectively, then it can be shown that their correlation matrix is valid

$$\tilde{\mathbf{C}}_{E2} \approx \frac{N_2 r_{c1}}{N_1 r_{c2}} \cdot \tilde{\mathbf{C}}_{E1}$$

for the fulfillment of the conditions r_{c1}, $r_{c2} >> d$. Normalization of the matrix $\tilde{\mathbf{C}}_E$, with respect to the first element of the matrix $\tilde{C}_{E11}$, the matrix is obtained where its elements do not depend on the value of the r_c and N [16,17]. For training the neural network which the model contains, it is enough to take only the first level of matrix C_E ($[C_{E11}, C_{E12}, ... , CE_{1M}]$) because it turned out that the first type contains sufficient information to determine the angular position of the radiation source [9,10].

3. ARCHITECTURE OF MLP NEURAL MODEL TO DETERMINE THE NUMBER OF SOURCES OF RADIATION

According to the theory presented in the previous section, the problem of the modeled neural model will be presented in the following functional form:

$$s = f(\mathbf{C}_E) \quad (7)$$

Accordingly, the artificial neural network has a task to perform mapping from space signal which describes the correlation signal matrix CE, the discrete space containing the numbers of radiation sources that can be found in the observed sector in the azimuthal level where variable indicates the number of sources that are currently in the sector and where $s \in \{1, 2, ..., S\}$ and S represents the maximum number of sources of radiation, which at one point can be found in the given sector.
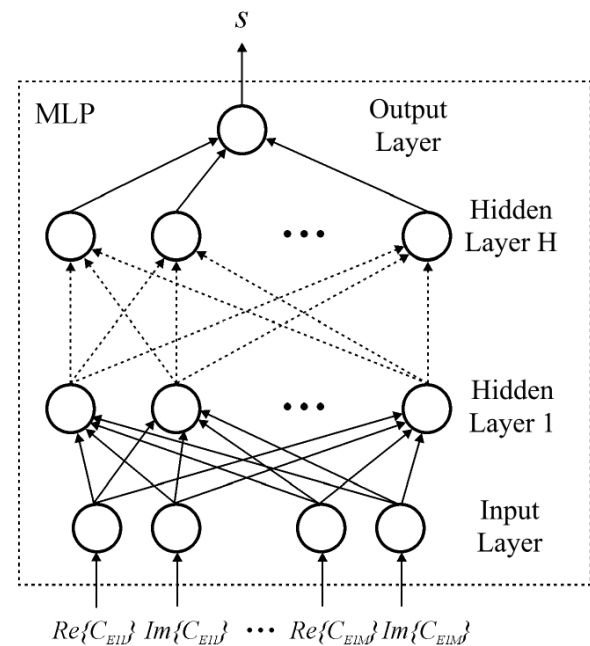
Figure 2. Architecture MLP neural model for determining the number of stochastic radiation sources in the reporting sector in the azimuthal level [21]

As already stated in the introductory sector, it is not necessary to use the value of all elements of the correlation matrix signal for satisfactory approximation of the mappings, but is possible to use only the first type $C_E[1,i]$, $i=1...M$ [8]. Consequently, the number of inputs to the neural network will be *2M*, because entries in the neural network cannot be complex numbers, but only real. Furthermore, the neural model that is functionally described as **y**=y(**x**,**w**), where y is it proper function of neural networks and the weight matrix w neural networks [5,6], will have a vector of inputs $x=[R_e\{c_{E11}\}$, $I_m\{cE11\}$, $R_e\{c_{E12}\}$, $I_m\{c_{E12}\}...R_e\{c_{E1M}\}$, $Im\{c_{E1M}\}]^T$, while the output value vector is **y**=s. Since the implementation models used MLP network that has a continuous output of real value, the corresponding MLP neural model will be defined in the following way:

$$s = round(y([\text{Re}\{c_{E11}\}, \text{Im}\{c_{E11}\}, K , \text{Re}\{c_{E1M}\}, \text{Im}\{c_{E1M}\}]^T, \mathbf{w}) \quad (8)$$
$$= f_{MLP}(\text{Re}\{c_{E11}\}, \text{Im}\{c_{E11}\}, K , \text{Re}\{c_{E1M}\}, \text{Im}\{c_{E1M}\}, W))$$

where fMLP transfer function or function processing MLP network while round function rounds out the real value of output MLP network to discrete integer value representing the number of radiation sources with *s*.

The architecture of the MLP neural model to determine the number of stochastic radiation sources in the monitored sector in the azimuthal plane is shown in Figure 2. Exit of the *h*-th hidden layer MLP network by which this model is realized, can be represented by vector $\mathbf{y}_h$ with dimmensions $N_h \times 1$ where is N_h the number of neurons in *h*-th hidden layer, and where the *i*-th element in that vector - $\mathbf{y}_h[i]$ represents the exit of *i*-th neuron *l*-th layer of the network (*l=h+1* and counting the input layer) $v_i^{(l)}=v_i^{(h+1)}$, also valid $\mathbf{y}_l = [v_1^{(h+1)}, v_2^{(h+1)}, K , v_{N_l}^{(h+1)}]^T$. It can be shown that the vector is

$$\mathbf{y}_h = F(\mathbf{w}_h \mathbf{y}_{h-1} + \mathbf{b}_h) \quad (9)$$

where y_{l-1} is the vector of dimension $N_{l-1} \times 1$ and represents the exit of the *(h-1)*-th hidden layer, wh the weight matrix of connections between neurons *(h-1)*-th and *h*-th hidden layer dimensions $N_h \times N_{h-1}$, where as $\mathbf{b}_h$, is the vector of the bias *h*-th hidden layer. According to this notation, $\mathbf{y}_0$ represents the output of the input buffer layer so that $\mathbf{y}_0 = x$. Element $\mathbf{w}_h[i,j]$ of the weight matrix $\mathbf{w}_l$ marks the weight of the link between the *h*-th neuron in the hidden layer *(h-1)* and *h*-th neuron in the hidden layer *h*, *i.e.* between *h*-th neuron in the network layer *s=h* and *j*-th neuron in the network layer *l=h+1*, while element $b_i^{(h)}=\mathbf{b}[i]$ represents the value of the bias of the *i*-th neuron in the hidden layer *h*. The function *F* represents the activation function of neurons in the hidden layers. In this case, tangent hyperbolic sigmoid function is used.

$$F(u) = \frac{e^u - e^{-u}}{e^u + e^{-u}} \quad (10)$$

All neurons in the last hidden layer are connected to the *H* output layer neuron. The activation function of the neurons in the last layer is linear and the output MLP network is:

$$y = \mathbf{w}_o \mathbf{y}_H \quad (11)$$

where wo weight matrix connects between neurons of the *H*-th hidden layer, and neurons from the exit layer, measuring $1 \times N_H$ (Figure 2). The final output of the neural model produced by rounding output MLP neural network to the nearest whole number:

$$s = round(y) \quad (12)$$

Indication of such defined MLP neural model that will continue to be used in the text is *MLPH-N_1-...-Ni-...-N_H* where *H* is the total number of hidden layers used in the MLP network, while Ni is the total number of neurons in the i-th hidden layer. Thus, tag MLP2-14-12 marks a MLP model indicates which neural network has four neural layers (input, output and two hidden layers) and which has 14 neurons in the first hidden layer and 12 neurons in the second hidden layer.

4. MODELING RESULTS

MLP neural model whose architecture was shown in the previous section has been applied to determine the number of stochastic radiation sources in the azimuthal sector [-30⁰ 30⁰]. The case was studied where, up to five radiation sources can be found in the given sector, at one point of time. One stochastic source is modeled as an antenna array of four elements, but in order to determine the correlation matrix signal in the far zone, radiation is carried out in the six-point sampling at a distance sd = l/2 = 0.02 m at f = 7.5 GHz (Table 1).

Frequency	f = 7.5 GHz
Max sources	S = 5
Number of elements in the antenna array of one source	N = 4
The distance between the elements of the antenna array	$d = \lambda/2$ (0.02 m)
The distance from the source to the stochastic sampling in the far zone	r_0 = 1000 m
Number of sampling sites in the distant zone	M = 8
The distance between sampling points	$s_d = \lambda/2$ (0.02 m)

Table 1. Parameter values of antenna array which represent stochastic sources and methods of sampling in the far zone of radiation sources

For the realization of the training model, MatLab 7.0 software development environment was used. The sets of samples for training and testing MLP models were generated using the inverse mapping from the one who does the MLP model

$$\mathbf{C}_E^t = f_{DoA}^{-1}(\boldsymbol{\theta}^t) \tag{13}$$

and which is realized by the equations (4) and (5). In the above mentioned mapping, $\boldsymbol{\theta}^t$ represents the vector of angular position of the radiation source $[\theta_1^t, \theta_2^t,..., \theta_S^t]$. Since the input of the neural network results in only the first type correlation matrix, training and test samples will take the form of $(\mathbf{x}^t(\boldsymbol{\theta}^t), s)$ where the vector inputs training and test sets applies

$$\mathbf{x}^t(\boldsymbol{\theta}^t) = [\operatorname{Re}\{C_{E11}^t\}\operatorname{Im}\{C_{E11}^t\}\operatorname{Re}\{C_{E12}^t\}\operatorname{Im}\{C_{E12}^t\}\mathrm{K}\operatorname{Re}\{C_{E1M}^t\}\operatorname{Im}\{C_{E1M}^t\}\}] \tag{14}$$

A uniform distribution of samples for training and testing MLP model in the sector $[-30^0\ 30^0]$ was applied in a manner: $[-30^0:d:30^0]$ where d is a step of sampling, meetings for training and testing MLP model are described as follows[17]:

$$\tag{15}$$

$$\{(\mathbf{x}^t(\theta_1^t),1) \mid \theta_1^t \in [-30:d_1:30]\} \cup$$
$$\{(\mathbf{x}^t(\theta_1^t,\theta_2^t),2) \mid \theta_1^t \in [-30:d_2:30], \theta_2^t \in [-30:d_2:30], \theta_1^t > \theta_2^t\} \cup$$
$$\begin{cases}(\mathbf{x}^t(\theta_1^t,\theta_2^t,\theta_3^t),3) \mid \theta_1^t \in [-30:d_3:30], \theta_2^t \in [-30:d_3:30],\\ \theta_3^t \in [-30:d_3:30], \theta_1^t > \theta_2^t > \theta_3^t\end{cases} \cup$$
$$\begin{cases}(\mathbf{x}^t(\theta_1^t,\theta_2^t,\theta_3^t,\theta_4^t),4) \mid \theta_1^t \in [-30:d_4:30], \theta_2^t \in [-30:d_4:30],\\ \theta_3^t \in [-30:d_4:30], \theta_4^t \in [-30:d_4:30], \theta_1^t > \theta_2^t > \theta_3^t > \theta_4^t\end{cases} \cup$$
$$\begin{cases}(\mathbf{x}^t(\theta_1^t,\theta_2^t,\theta_3^t,\theta_4^t,\theta_5^t),5) \mid \theta_1^t \in [-30:d_5:30], \theta_2^t \in [-30:d_5:30],\\ \theta_3^t \in [-30:d_5:30], \theta_4^t \in [-30:d_5:30], \theta_5^t \in [-30:d_5:30],\\ \theta_1^t > \theta_2^t > \theta_3^t > \theta_4^t > \theta_5^t\end{cases}$$

where generating the set for training takes, $d_1=0.1$, $d_2=0.5$, $d_3=2$, $d_4=4$, $d_5=6$, whereas, for generating the set for testing takes, $d_1=0.13$, $d_2=0.7$, $d_3=3$, $d_4=7$, $d_5=11$. With this distribution, the set for training is generated with, 14638 samples, and a test set of 5579 sample.

For the training model, Quazi-Newton method of training was used. In order to obtain the best possible MLP model, a training was conducted for a number of MLP neural networks, with two hidden layers and different numbers of neurons in them. In the process of testing the main criterion for evaluating the success of training, is the percentage value of samples for which determined a wrong number of present sources of radiation in the sector, or shorter, percentage value of samples that war misclassified (UPK [%]) [16,17]. In order to compare the test results of the model, Table 2 presents the testing results of six MLP models, that are on the same set of tests, and had the lowest percentage of samples that are misclassified. In this table, the UTK in-

dicates the number of samples for which the MLP model gave the exact number of present sources of radiation in the sector and with UPK indicating the number of samples for which the MLP model gave the wrong number of present sources of radiation in the sector.

MLP model	UTK	UPK	UPK [%]
MLP2-22-20	5445	134	2.46
MLP4-22-20	5438	141	2.59
MLP4-23-23	5443	136	2.50
MLP4-23-23	5434	145	2.67
MLP4-22-20	5445	134	2.46
MLP4-22-20	5444	135	2.48

Table 2. Testing resaults of six MLP models with the best resaults when it comes to determining the correct number of sources in the sector
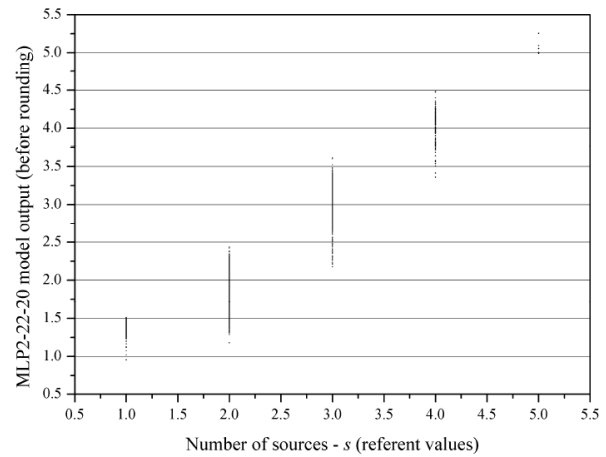
Figure 4. Diagram of dissipation MLP2-22-22 models on the test set when determining the number of present sources of radiation in $[-30^0\ 30^0]$ sector

As a representative model for determining the number of stochastic radiation sources in the given sector, in the azimuthal plane, the model of MLP2-22-22, was chosen. The model had the lowest percentage of misclassified samples, and that has shown the highest success rate in determining the number of radiation sources in the given sector. This model is shown in Figure 4.

It can be observed that the accuracy of the MLP model for the case of $S=5$, is as approximately accurate as the MLP models that have been developed for the case of $S=3$ [21]. This shows that the MLP model maintained good performances in modeling problems in spite of increasing complexity of the problem, and consequently, a significant increase in the number of samples for training.

5. CONCLUSION

In this paper, the examination of the possibility of MLP neural networks was continued to determine the number of radiation sources in the given sector in the azimuthal level that began in [21], with an increase of the maximum number of sources that can be found in the sector, simultaniously, from three to five sources. Due to the avoidance of complex numerical calculation, it is also shown that MLP model can quickly and with high accuracy determine the number of radiation sources in the observed sector. An increase in the maximum number of radiation sources that are simultaneously found in the observed sector, inevitably leads to a significant increase in the number of samples which are necessary for training the neural model, that will be able to process such a number of sources (8921 samples for 3 sources 14638 samples of 5 sources), and the fact that, with an increasing number of samples complexity of the PNN is growing much faster, than the complexity of the MLP network which can lead to limitations in the application of the PNN for the large number of radiation sources. MLP networks are emerging as more suitable variant to the PNN with a tendency to further increase the maximum number of sources of radiation that can be simultaneously found in the given sector.

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DATA-DRIVEN HUMAN ACTIVITY RECOGNITION IN SMART ENVIRONMENTS

Marina Marjanović-Jakovljević,
Angelina Njeguš

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Many applications of human activity recognition like healthcare, security *etc.* show how human activity recognition is important in everyday life. In this paper, we compare different machine learning algorithms like Naïve Bayes (NB), One R (1R) rule, Zero R (0R) rule, J 48 trees, Random Forest (RF) and Random Tree (RT) applied on sensor-based human activity recognition in a home environment. We show that Random Forest achieves better performance in terms of correctly classified instances comparing to other algorithms, while application of 0R rules algorithm achieves significantly the worst performance. Additionally, in order to reduce the dimensionality of the algorithm, we applied wrapper method using the same classifier in the attribute selection. It is shown that using the wrapper method the performance of the classification in terms of correctly classified instances is not significantly changed, while it shows much better performance in terms of algorithm complexity. After calculating accuracy of each algorithm, we calculate accuracy for each activity classified by each classifier.

Key words:

activity recognition, machine learning, sensors, classification, wrapper.

1. INTRODUCTION AND THEORETICAL BACKGROUND

The Internet evolved into Internet of Things (IoT), from processors embedded into the computers to processors and sensors embedded almost in every "thing" *i.e.* in any device. IoT, by market segment, can be classified into three broader categories, such as health self-tracking and personal environment monitoring, smart homes/buildings, and transportation/automotive applications (Swan, 2012). Activity recognition is the foundation of these areas as it enables a wide range of computing applications (*e.g.* elder care and health applications). In some papers it is shown that it is possible to detect a large range of activities (Bao *et al*, 2004) (Huynh *et al*, 2007; Lester *et al*, 2006). Since human activities are complex and highly diverse, the goal of activity recognition is to recognize common activities in daily life (Kim *et al*, 2010). However, recognizing complex human activities is still challenging area, especially when dealing with concurrent or interleaved activities.

Activity recognition can be defined as the process that includes (a) adequate sensors to monitor and capture a user's behavior according to environment state change, and (b) system for collecting, storing, processing, and analyzing perceived information, in order to create activity models for

Correspondence:

Angelina Njeguš

e-mail:

anjegus@singidunum.ac.rs

developing algorithms that will infer activities from sensor data (Chen *et al*, 2012). Activity recognition can be vision-based, sensor-based, data-driven or knowledge-driven.

Vision-based activity recognition uses visual sensing devices (*e.g.* video cameras) that generate video sequences or video digitized data. On the other hand, sensor based activity recognition uses wearable sensors or smart phones (attached to an actor), or dense sensing (attached to objects) that generate time series of state changes or various parameter values that are processed through some probabilistic or statistical analysis methods (Chen *et al*, 2012). With the expansion of mobile computing, wearable sensors receive more attention. Sensor-based are more convenient for smart environments, such as smart homes, smart hospitals, smart buildings, *etc.* In Anguita *et al.* (2012), a system for activity recognition is presented using Smartphone inertial sensors. Since mobile phones are limited in terms of energy and computing power, a novel hardware-friendly approach for multiclass classification is proposed. This method is based on Support Vector Machine and exploits fixed-point arithmetic for computational cost reduction.

Data-driven activity recognition creates user activity models from existing large datasets of user behaviors using data mining and machine learning techniques, and then uses the learnt activity models to infer activities (Gu *et al*, 2011; Okeyo *et al*, 2012). However, it is difficult to apply learnt activity models generally to all people. In Ordonez *et al.* (2012), the use of two machine learning algorithms, Artificial Neural Network and Support Vector Machines, within the framework of Hidden Markov Model, in order to perform activity recognition in a home environment, is described. A knowledge-driven activity recognition construct activity models based on rich prior knowledge. Hybrid approaches combine knowledge-driven and machine learning to formulate activity models (Okeyo *et al*, 2012).

In this paper different classification models applied on sensor-based dataset in home environment are compared. The aim is to identify the algorithm that achieves better performance for sensor-based activity recognition. Since all algorithms analyzed in numerous papers are extremely complex, this paper proposes wrapper methods to reduce the dimensionality of each method.

This paper is organized in three parts. The first part describes seven machine learning methods and their comparative advantages for the activity recognition problem. The second part describes datasets with selected activities and type of sensors. The third part presents the results of experiment and compares the performance between selected methods.

2. CLASSIFICATION MODELS DESCRIPTION

To represent and recognize the activities based on the optimal features, six different machine learning algorithms like NB, 1R, 0R, J 48 trees, RF and RT were applied to sensor-based data in terms of CCI and number of attributes were selected by a wrapper method.

Naive Bayes Model

Since all of the attributes contribute equally and independently to the decision, we can apply Naive Bayes (NB) method explained by John *et al.* (1995). Probability of event *H* with given evidence *E* is presented as

$$P_r(H|E) = \frac{P_r(E|H)P_r(H)}{P_r(E)} \qquad (1)$$

Where $P_r(H)$ presents Prior probability and $P_r(H|E)$ presents Posterior probability of event *H*. In our model, *H* presents a user activity that we want to identify, and evidence *E* presents an instance in our dataset. Evidence splits into independent parts

$$P_r(E|H) = P_r(E_1|H)P_r(E_2|H)...P_r(E_n|H) \qquad (2)$$

Where particular evidences, or attributes E_1, E_2...E_n, are statistically independent.

One R rule Model

This method is explained by Holt (1993). This method, the same as NB Model, relies on Frequency Table (Kohavi, 1995). It is based on using the minimum-error attribute for prediction, discretizing numeric attributes.

Zero R rule Model

The same as NB Model, 0R model is based on Frequency Table. This is the simplest classification method which relies on the target and ignores the predictors. It predicts the mean (for a numeric class) or the mode (for a nominal class) constructing a frequency table and selecting its most frequent value.

J 48 Trees Model

J48 model is one of the Decision Trees models, a hierarchical data structure based on conquer strategy. This classification model is explained by Quinlan (1993). The idea is to select which attribute to divide on at the root node, and then create a branch for each possible attribute value. Then, in order to make the selection, the procedure is recursively repeated for each branch, selecting an attribute at each node, using only instances

that reach that node. The objective is to get the smallest tree, and top-down tree induction methods use different approaches. The most used approach to produce pure nodes is an information theory-based approach founded by Claude Shannon (1948).

Random Forest

Since the combination of classification models increases the classification accuracy, Random Forest (RF) model is proposed (Breiman, 2001). It works as a large collection of forest of the correlated random decision trees.

Random Tree Model

This model is based on constructing a tree that considers K randomly chosen attributes at each node. A Random Tree (RT) model is explained by Aldous in 1991. RT model associated with random graphs is also explained by Aldous in 1990.

Wrapper-based Approach

In order to decrease data dimensionality, it will be interesting to select the most effective features from our feature vector. In Kohavi *et al.* (1997), Wrapper method for feature selection is described. The flowchart of wrapper-based approach in this paper is presented in Figure 1.

This method is based on the evaluation of the attribute sets by using a learning scheme. Cross validation is used in order to estimate the accuracy of the learning scheme for a set of attributes. In order to compare performance with and without subset extraction and find a subset, the evaluator will use the same classifier as in training set.
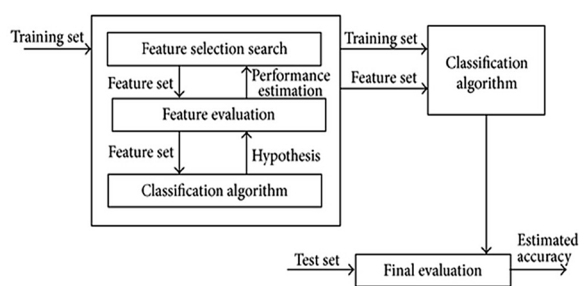
Figure 1. Flowchart of wrapper-based approach to feature subset selection (Kohavi et at, 1997)

3. DATA SETS DESCRIPTION

In order to validate this testing, we use 407 instances from Ordonez A dataset generated by Kasteren (2013). This dataset comprises activities of daily living (ADL) performed by a user in home environment. Datasets were generated by a set of simple state-change sensors. The wireless sensor network (WSN) was measuring passive infrared sensors to detect motion, reed switches for opening or closing of doors or cupboards, and float sensors for measuring the toilet being flushed.

Instances were described by description, sensor event (feature) and ADL (label). Features were recorded using a WAN and data were labelled manually (UCI, 2013). Nine different ADLs, included as labels, were considered: "Leaving", "Toileting", "Showering", "Grooming", "Sleeping", "Breakfast", "Lunch", "Snack", and "Spare time".

Table I shows the number of separate instances per activity in the dataset. Table II, Table III and Table IV show attributes that are considered for this test as location, place and sensor type, respectively.

N_0	Label	Count
1	Sleeping	15
2	Toileting	19
3	Grooming	111
4	Showering	14
5	Breakfast	70
6	Spare_Time/TV	80
7	Leaving	31
8	Lunch	49
9	Snack	18

Table I. Activities count

N_0	Label	Count
1	Bed	15
2	Cabinet	15
3	Basin	70
4	Toilet	45
5	Shower	14
6	Fridge	56
7	Cupboard	34
8	Toaster	14
9	Cooktop	13
10	Microwave	20
11	Seat	80
12	Maindoor	31

Table II. Location of sensors count

N₀	Label	Count
1	Bedroom	15
2	Bathroom	144
3	Kitchen	137
4	Living	80
5	Entrance	31

Table III. Place count

N₀	Label	Count
1	Pressure	95
2	Magnetic	136
3	PIR	97
4	Flush	45
5	Electric	34

Table IV. Type of sensors count

4. EXPERIMENTS AND RESULTS

This experiment was performed using WEKA (Waikato Environment for Knowledge Analysis) tool, developed at the University of Waikato in New Zealand. This software contains large spectrum of tools such as: data pre-processing, classification, regression, clustering, association rules, and visualization. The purpose of this paper is to compare six different machine learning algorithms like NB, 1R, 0R, J 48 trees, RF and RT applied on sensor-based human activity recognition in a home environment in terms of correctly classified instances (CCI) and number of attributes (NA) selected by a wrapper method. After calculating accuracy of each algorithm, it is important to calculate accuracy for each activity classified by each classifier.

In the first part of experiment, we compare classifiers in terms of CCI applied on the entire data set, that has 4 attributes. In the second part of the experiment, we used wrapper method in order to reduce the dimensionality of data. The results are provided with a 10-fold cross-validation.

	Classifier					
	NB	1R	0R	J48	RF	RT
CCI in original data set (%)	78,1	77,8	27,3	76,6	79,6	77,9
CCI with wrapper (%)	77,1	77,9	27,3	76,9	76,6	77,9
NA with wrapper	3	1	0	3	1	1

Table V. Clasiffiers comparison

	Metric		
	P	R	ROC
Sleeping	1	1	1
Toileting	0	0	0,854
Grooming	0,854	1	0,968
Showering	1	1	1
Breakfast	0,681	0,457	0,926
Spare_Time/TV	1	1	1
Leaving	1	1	1
Lunch	0,389	0,714	0,885
Snack	0	0	0,915

Table VI. Deatailed accuracy by class- NB

	Metric		
	P	R	ROC
Sleeping	1	1	1
Toileting	0	0	0,5
Grooming	0,854	1	0,968
Showering	1	1	1
Breakfast	0,597	0,614	0,764
Spare_Time/TV	1	1	1
Leaving	1	1	1
Lunch	0,354	0,469	0,676
Snack	0	0	0,5

Table VII. Deatailed accuracy by class -1R

	Metric		
	P	R	ROC
Sleeping	0	0	0,415
Toileting	0	0	0,474
Grooming	0,273	1	0,492
Showering	0	0	0,41
Breakfast	0	0	0,497
Spare_Time/TV	0	0	0,497
Leaving	0	0	0,482
Lunch	0	0	0,489
Snack	0	0	0,451

Table VIII. Deatailed accuracy by class- 0R

	Metric		
	P	R	ROC
Sleeping	1	1	1
Toileting	0	0	0,849
Grooming	0,854	1	0,966
Showering	1	1	1
Breakfast	0,51	0,714	0,9
Spare_Time/TV	1	1	1
Leaving	1	1	1
Lunch	0,282	0,224	0,874
Snack	0	0	0,894

Table IX. Deatiled accuracy by class -J48

	Metric		
	P	R	ROC
Sleeping	1	1	1
Toileting	0	0	0,85
Grooming	0,854	1	0,966
Showering	1	1	1
Breakfast	0,662	0,614	0,927
Spare_Time/TV	1	1	1
Leaving	1	1	1
Lunch	0,417	0,612	0,886
Snack	0	0	0,916

Table X. Deatiled accuracy by class -RF

	Metric		
	P	R	ROC
Sleeping	1	1	1
Toileting	0	0	0,849
Grooming	0,854	1	0,966
Showering	1	1	1
Breakfast	0,597	0,614	0,925
Spare_Time/TV	1	1	1
Leaving	1	1	1
Lunch	0,354	0,404	0,883
Snack	0	0	0,915

Table XI. Deatiled accuracy by class -RT

According to Table V, we can conclude that in the case when we use the entire data set, RF algorithm achieves better performance in terms of CCI comparing to other algorithms, while application of Zero R rules algorithm achieves significantly the worst performance. On the other hand, when wrapper approach is applied, RT has better performance in terms of CCI comparing to RT, while 1R achieves higher CCI comparing to NB. Observing data dimensionality, NB and J48 show higher complexity than other algorithms.

In Table V-Table XI, detailed accuracy for each activity, for each classifier used in this paper is presented. Precision (P) is calculated as proportion of instances that are correctly classified divided by the total instances classified as that class. While Recall (R) is calculated as a ratio of the proportion of instances classified as a given class and the actual total in that class.

Receiver operating characteristics (ROC) graphs are very useful for classifiers comparison in machine learning and data mining research (Fawcett, 2005).

According to table VI, activities such as: "Leaving", "Sleeping", and "Spare time" have the best performance, while "Breakfast", and "Lunch" show the worst performance when NB classifier is applied.

In table VII is demonstrated that activities such as: "Sleeping", "Leaving", "Showering", and "Spare time" have best performance in terms of P, R and ROC when 1 R classifier is applied, while activities such as "Toileting" and "Snack" result in significantly worst performance.

Table VIII shows that when 0R classifier is applied, the best performance shows activity "Grooming". However, it still has very low precision of 0,273.

According to table IX, activities such as: "Leaving", "Sleeping", "Spare time" and "Showering" have the best performance, while activities such as "Breakfast", "Lunch" and "Snack", whose recognition requires magnetic sensors activation, show the worst performance when J48 classifier is applied.

In tables X and XI accuracy by class when RF and RT classifier is applied is shown respectively. They show similar result where "Sleeping", "Showering", "Spare time" and "Leaving" result in best performance, while "Snack" and "Lunch" activities have very low P and R.

5. CONCLUSION AND FUTURE WORK

According to the results obtained, we can see that order in performance of applied classifiers in terms of CCI is different when wrapper method is applied. In

case when we use the entire data set for the purpose of human activity recognition, RF classifier shows the best performance, while in case when wrapper approach is applied, RT shows the best performance compared to other classifiers used in this paper.

Additionally, it is shown that is possible to improve the system performance in the human activity recognition problems, using the wrapper method for reducing the dimensionality of the data. In further research, it would be interesting to compare those classifiers on all five data sets described by Kasteren (2013) as: "KasterenA", "KasterenB", "KasterenC", "OrdonezA" and "OrdonezB".

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INFORMATION FUSION IN INTELLIGENT SYSTEMS

Endre Pap

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Information fusion in intelligent systems is one of the basic problems. This issue is rapidly increasing since more complex systems are being developed, *e.g.*, robotics, vision, knowledge-based systems and data mining. The process of combining several values into a single representative one is called aggregation, and we present two applications of aggregation functions in multisensor data fusion and network aggregation in sensor networks. Special attention is devoted to the situation of pairs of aggregation functions under the semiring structure (pseudo-analysis). The author shall present two applications of it in image processing.

1. INTRODUCTION

Information fusion is a fundamental problem in intelligent systems and its importance is rapidly increasing since many complex systems are being developed. There are many areas where there is a need to develop theoretical background for information fusion, *e.g.*, fields such as robotics (fusion of data provided by sensors), vision (fusion of images), knowledge based systems (decision making in a multicriteria framework, integration of different kinds of knowledge, and verification of knowledge-based systems correctness) and data mining (ensemble methods) are well known. The aims of information fusion include the following: to improve the available knowledge, to update the current information, to lay bare a consensual opinion, to derive or improve generic knowledge by means of data.

The process of combining several (numerical) values into a single representative one is called *aggregation*, and the function performing this process is called *aggregation function* [8]. In this paper, we consider aggregation functions as mappings that assign a single output in the closed unit interval [0; 1] to several inputs from the same interval.

In order to deal with the problems involving interaction between

Correspondence:

Endre Pap

e-mail:
epap@singidunum.ac.rs

criteria various classes of nonadditive set functions have been introduced. Based on them Choquet and Sugeno (see [14]), idempotent [9], universal, pseudo-integral [14] and other integrals [14], [15], [23] were introduced. The pseudo-integral is part of the pseudo-analysis, where a real interval $[a, b] \subset [-\infty, \infty]$ equipped insted of the usual addition and product, with two operations: the pseudo-addition $\oplus$ and the pseudo-multiplication $\odot$. Based on $\oplus$-measure (pseudo-additive measure), pseudo-integral is defined. Then properties of the pseudo-integral including inequalities for this type integral have been investigated, see [14], [19]. The pseudo-analysis is used in many applications, modeling uncertainty, nonlinearity and optimization, see [9], [12], [13], [16], [17].

This paper is organized as follows. Section II presents some basic facts on aggregation functions. Applications of aggregation functions in multisensor data fusion and sensor networks are presented in Section III. Some elements of pseudo-analysis are presented in Section IV. Two applications of pseudo-analysis are given in Section V.

2. AGGREGATION FUNCTIONS

One of the mainly used aggregation function is the arithmetical mean AM: $[0,1]^n \to [0,1]$. of n numbers $x1$, $x2,..., xn \in [0,1]$, given by

$$AM(x_1, a_2, \ldots, x_n) = \frac{x_1 + x_2 + \cdots + x_n}{n} = \frac{1}{n}\sum_{i=1}^{n} x_i.$$

Important property of the arithmetical mean is monotonicity, i.e., if in the arithmetical mean $(x+y+z)/3$ we take instead of the number z a greater number z', then obviously that the new arithmetical mean $(x+y+z)/3$ will be greater than the previous one. This would be true if we did the same on any coordinate, and also true for general case of n-dimension. The second important property of the arithmetical mean we obtain if we take the border numbers 0 and 1; i.e., the arithmetical mean of n zeros is again zero and the arithmetical mean of n ones is again one.

The inputs that aggregation functions combine are interpreted as degrees of membership in fuzzy sets, degrees of preference, strength of evidence, etc. For example, a rule-based system contains rules of the following form:

IF 't_1 is A_1' AND . . . AND 't_n is An' THEN 'v is B'.

If $x_1,..., x_n$ denote the degrees of satisfaction of the rule predicates 't_1 is A_1',..., 't_n is A_n' then the overall degree of satisfaction of the combined predicate of the rule anteced-

ent can be calculated as $A(x_1,..., x_n)$. If all input values are 0, it implies lack of satisfaction, and if all inputs are 1 then this is interpreted as full satisfaction. As a consequence, aggregation functions should preserve the bounds 0 and 1.

The general definition of aggregation functions, see [8] is the following.

Definition 1:
A function A : $[0,1]^n \to [0,1]$ is called an *aggregation function* in $[0,1]^n$ if

(i) A is nondecreasing: for $x_1 \le x_1', \ldots, x_n \le x_n'$ we have
$$A(x_1, x_2,..., x_n) \le A(x_1', x_2',..., x_n');$$

(ii) A fulfills the boundary conditions
$$A(0, 0,... ,0) = 0 \text{ and } A(1,1,..., 1) = 1.$$

We list only few aggregation functions in $[0,1]^n$, for pleanty of them see [8]:

(i) Geometric mean: $\quad GM(\mathbf{x}) = \left(\prod_{i=1}^{n} x_i\right)^{1/n}.$

(ii) Harmonic mean: $\quad HM(\mathbf{x}) = \dfrac{1}{\frac{1}{n}\sum_{i=1}^{n}\frac{1}{x_i}}.$

(iii) Minimum: $\quad Min(\mathbf{x}) = \min\{x_1, \ldots, x_n\}.$
(iv) Maximum: $\quad Max(\mathbf{x}) = \max\{x_1, \ldots, x_n\}.$

We frequently use the arithmetical mean, but the question is when it is meaningfull to use it. In some practical situations, the appropriate mean is uniquely determined by the situation itself.

Example 2:
(i) Connecting n resistors with resistances $x_1,..., x_n$ in series, then the average resistance is the arithmetic mean of $x_1,..., x_n$. On the other hand, if the resistors are connected in parallel then the effect is the same as if one had used n resistors with the same resistance, all equal to the harmonic mean of $x_1,..., x_n$.
(ii) In information retrieval, where precision and recall are two widely used metrics for evaluating the correctness of a pattern recognition algorithm. The harmonic mean of the precision and the recall is often used as an aggregated performance score.
(iii) In hydrology, the arithmetic mean is used to average hydraulic conductivity values for flow that is parallel to layers, while flow perpendicular to layers uses the harmonic mean.

Clasification of aggregation functions, see [8]:

(i)   Conjunctive $0 \leq A \leq \text{Min}$;

(ii) Internal (means) $\text{Min} \leq A \leq \text{Max}$;

(iii) Disjunctive $\text{Max} \leq A \leq 1$;

(iv) Mixed.

3. APPLICATION OF AGGREGATION FUNCTIONS

A. Multisensor data fusion

Multisensor data fusion refers to the synergistic combination of sensory data from multiple sensors and related information to provide more reliable and accurate information than could be achieved using a single, independent sensor. The important advantages of multisensor fusion are redundancy, complementarity, timeliness and cost of the information. The fusion of redundant information can reduce the overall uncertainty and thus serve to increase the accuracy with which the features are perceived by the system. Complementary information from multiple sensors allows features in the environment to be perceived that are impossible to perceive using just the information from each individual sensor operating separately [11]. Multisensor data fusion strategies are developed for advanced driver assistance systems (ADAS), see [22], where there are given data fusion concepts, an applicable model, paradigm of multisensor fusion algorithms, current sensor technologies and some applications such as object tracking, identification and classification and a providence view on next-generation car safety and driver assistance systems. The fuzzy logic approach is used in the model as sensor fusion. To follow a vehicle by an adaptive cruise control (ACC) system one must keep safe distance by measuring the front vehicle distance to the host vehicle. The host vehicle is equipped with four types and five sensors among total 16 sensors that should be considered, each of which with different coverage area and may be infected by some environments noise, consequently with deferent measurements regarding the position of front vehicle. All sensor data are fuzzified in order to determine a near real distance. After several modifications and improvements of membership functions with Min-Max aggregation operator of FuzzyTECH Simulator, a satisfactory following by the host vehicle is extracted.

Sensor fusion is also used for classification of objects and for pattern recognition. Let X be a set of objects under consideration (such as airplanes, cars, animals, flowers, *etc.*), and $\{C_1,..., C_p\}$ are predefined classes. Assume that each object in X is measured by a set of sensors $S_1,..., S_n$. Each sensor provides a partial description of objects. For example, a plane can be detected by several radars and observed by other equipment. In a military situation, only two classes of planes count: friend or foe, see [8]. We remark that the aggregation function may depend on the particular class considered. Some sensors may be more discriminative for certain classes, but unable to distinguish some others. This means that the weight assigned to sensors may depend on the classes. In such a situation, internal weighted aggregation functions can be a good choice.

B. In-network aggregation in sensor networks

A sensor network consists of a large number of individual devices called sensor motes. Each device produces a data stream through sensing modalities. Because in many cases there is no need to report the total data stream, and because individual observations may be noisy or missing, it is necessary to aggregate information collected by sensors. A spanning tree is used, where each sensor combines its own observations with those received from its children. This is an effective procedure for aggregation functions such as Min, Max, AM when there is no failure. In general, one can use so-called decomposable aggregation functions, where the value of the aggregation function can be computed for disjoint subsets of variables, and then in the second step, these value can be aggregated to obtain the aggregate of the whole set of variables. Node or link failures, or packet losses may cause significant change in the aggregated value. For instance, some aggregation functions such as AM are duplicate-sensitive: incorrect aggregated value is resulted when the same value is counted multiple times. In [6] an approximate method is proposed to overcome these difficulties of duplicate-sensitive aggregation functions in faulty sensor networks. In a similar way, a flexible on-board stream processing method of sensor data of a vehicle is introduced in [21].

4. PSEUDO-ANALYSIS

Let $\preceq$ be full order on $[a, b] \subseteq [-\infty, \infty]$.

The pseudo-addition $\oplus : [a, b]^2 \to [a, b]$ is a function that is commutative, non-decreasing with respect to $\preceq$, associative and with a zero (neutral) element denoted by 0: Let $[a, b]_+ = \{x \mid x \in [a, b], 0 \preceq x\}$. The pseudo-multiplication $\odot : [a, b]^2 \to [a, b]$ is a function that is commutative, positively non-decreasing, *i.e.*, $x \preceq y$ implies $x \odot z \preceq y \odot z$ for

all $z \in [a, b]_+$, associative and with a unit element $1 \in [a, b]$, i.e., for each $x \in [a, b]$, $1 \odot x = x$. The pseudo-multiplication $\odot$ is distributive over the pseudo-addition $\oplus$, i.e., $x \odot (y \oplus z) = (x \odot y) \oplus (x \odot z)$, and $0 \odot x = 0$. The interval $[a, b]$ equipped with pseudo-multiplication $\odot$ and pseudo-addition $\oplus$ is a semiring, denoted by $([a, b], \oplus, \odot)$ (see [10], [14]).

We list three characteristic cases:

Case I: (Idempotent $\oplus$ and non-idempotent $\odot$)

$x \oplus y = sup(x, y)$, is an arbitrary not idempotent pseudo-multiplication on the interval $[a, b]$. A full order is induced by the idempotent operation sup as follows: $x \preceq y$ if and only if $sup(x, y) = y$. The pseudo-multiplication $\odot$ is generated by an increasing bijection $g : [a, b] \rightarrow [0, 1]$, $x \odot y = g^{-1}(g(x) \cdot g(y))$. It holds $0 = a$ and $1 = g^{-1}(1)$.

Case II: (g-semiring) The pseudo-operations are defined by $x \oplus y = g^{-1}(g(x) + g(y))$ and $x \odot y = g^{-1}(g(x) \cdot g(y))$, where $g : [a, b] \rightarrow [0, 1]$ is continuous and monotone.

Case III: (Idempotent $\oplus$ and idempotent $\odot$)

$x \oplus y = sup(x, y)$, $x \odot y = inf(x, y)$, on the interval $[a, b]$. Here is $0 = a$, $1 = b$ and the pseudo-addition induces the usual order. Let X be a non-empty set and A be a σ-algebra of subsets of X, i.e., (X, A) be a measurable space.

Definition 3:

A σ-$\oplus$-measure is a set function $m : A \rightarrow [a, b]_+$ such that the following conditions are fulfilled:

(i) $m(\varnothing) = 0$ (for non-idempotent $\oplus$)

(ii) for any sequence $(A_i)_{i \in N}$ of mutually disjoint sets from A, we have: $m(\bigcup_{i=1}^{\infty} A_i) = \bigoplus_{i=1}^{\infty} m(A_i)$

The pseudo-characteristic function of a set A is defined by

$$\chi_A(x) = \begin{cases} \mathbf{0} & , & x \notin A, \\ \mathbf{1} & , & x \in A. \end{cases}$$

A step (measurable) function is a mapping $e : X \rightarrow [a, b]$ that has the following representation $e = \bigoplus_{i=1}^{n} a_i \odot \chi_{A_i}$ for $\alpha_i \in [a, b]$ and sets $A_i \in A$ are pairwise disjoint if $\oplus$ is nonidempotent.

Definition 4:

Let $m : A \rightarrow [a, b]$ be a σ-$\oplus$-measure.

(i) The pseudo-integral of a step function $e : X \rightarrow [a, b]$ is defined by

$$\int_X^{\oplus} e \odot dm = \bigoplus_{i=1}^{n} a_i \odot m(A_i).$$

(ii) The pseudo-integral of a measurable function $f : X \rightarrow [a, b]$, (if $\oplus$ is not idempotent we suppose that for each $\varepsilon > 0$ there exists a monotone ε-net in f (Z) is defined by

$$\int_X^{\oplus} f \odot dm = \lim_{n \to \infty} \int_X^{\oplus} e_n(x) \odot dm,$$

where $(e_n)_{n \in N}$ is a sequence of step functions such that $d(e_n(x), f(x)) \rightarrow 0$ uniformly as $n \rightarrow \infty$.

For more details see [9], [14].

We shall consider the semiring $([a, b], \oplus, \odot)$ for three cases, namely I, II and III. If the pseudo-operations are generated by a monotone and continuous function $g : [a, b] \rightarrow [0, \infty]$, then the pseudo-integral for a measurable function $f : X \rightarrow [a, b]$ is given by,

$$\int_X^{\oplus} f \odot dm = g^{-1} \left(\int_X (g \circ f) d(g \circ m) \right), \qquad (1)$$

where the integral on the right side is the Lebesgue integral. When $X = [c, d]$, $A = B(X)$ and $m = g^{-1} \circ \lambda$, λ the Lebesgue measure on $[c, d]$, then we use notation

$$\int_{[c,d]}^{\oplus} f(x) dx = \int_X^{\oplus} f \odot dm. \qquad (2)$$

This form of pseudo-integral is known as the g-integral, see [14]. When the semiring is of the form $([a, b], sup, \odot)$, cases I and III and function $\psi : X \rightarrow [a, b]$ defines σ-sup-measure m by $m(A) = \sup_{x \in A} \psi(x)$, then the pseudo-integral for a function $f : X \rightarrow [a, b]$ is given by

$$\int_X^{\oplus} f \odot dm = \sup_{x \in X} (f(x) \odot \psi(x)). \qquad (3)$$

5. APPLICATION OF PSEUDO-ANALYSIS

Many applications can be found in [2], [9], [12], [13], [14], [16]. We shall give here only two applications.

A. Image approximation

If one replaces the sum with the maximum $\bigvee$, the general form of a max-product approximation operator is obtained:

$$P_n(f, x) = \bigvee_{i=0}^{n} K_n(x, x_i) \cdot f(x_i), \qquad (4)$$

where $K_n(\cdot, x_i) : X \rightarrow [0, \infty[$, $i = 0, ..., n$, are a given continuous functions. Here $f : X \rightarrow [0, \infty[$ is a continuous

function on a compact metric space (X, d). Let also, $x_i \in X$, $i \in \{0,..., n\}$, $n \geq 1$ be fixed sampled data. Such an operator was used in image approximation can be found in [7] where max-product Shepard operator was defined and studied. In several cases, max-product approximation outperforms classical linear approximation in the sense that they lead to essentially better error estimates, if for example Bernstein basis is used in the construction of max-product operators.

As second case we consider a pair of operators $\oplus$ and $\odot$ from case II. We use these pairs of operations instead of the standard addition and multiplication of the reals as follows:

$$P_n(f, x) = \bigoplus_{i=0}^{n} K_{n,i}(x) \odot f_i, \qquad (5)$$

where $K_{n,i}(x) : X^2 \rightarrow [0,1]$ are given continuous functions, $i=1,..., n$. The operator P_n is continuous and pseudo-linear. In the formula (5) f_i denotes the classical discrete cosine transform of the target function f, and K where g^{-1} is the inverse of the generator function g, and $A_{n,i}$ is a function defined through the cosine function for all $i=1,..., n$. Then $P_n(f, x)$ in (5) is called the pseudo-linear inverse DCT, see [3]. The pseudo-linear DCT has very good reconstruction property, *i.e.*, in image compression.

B. Pseudo-linear superposition principle for Perona and Malik equation

Partial differential equators are successfully applied to the relevant problem of image processing, see [1], [4], [20]. In that method, a restored image can be seen as a version of the initial image at a special scale. An image u is embedded in an evolution process, denoted by $u(t,\cdot)$. The original image is taken at time $t=0$, $u(0,\cdot)=u_0(\cdot)$ and is then transformed. The idea is to construct a family of functions $\{u(t, x)\}_{t>0}$ representing successive versions of $u_0(x)$. As t increases $u(t, x)$ changes into a more and more simplified image. We would like to attain two goals. The first is that $u(t, x)$ should represent a smooth version of $u_0(x)$, where the noise has been removed. The second is to be able to preserve some features such as edges, corners, which may be viewed as singularitis. The heat equation has been (and is) successfully applied to image processing but it has some drawbacks. It is too smoothing and because of that, edges can be lost or severely blurred. In [1] authors consider models that are generalizations of the heat equation. The domain image will be a bounded open set Ω of $\mathbb{R}^2$. The following equation is initially proposed by Perona and Malik [20]:

$$\begin{cases} \frac{\partial u}{\partial t} = \text{div}\left(c\left(|\nabla u|^2\right)\nabla u\right) & \text{in }]0, T[\times \Omega, \\ \frac{\partial u}{\partial N} = 0 \text{ on }]0, T[\times \partial\Omega, \\ u(0, x) = u_0(x) \text{ in } \Omega \end{cases} \qquad (6)$$

where: $c: [0,\infty[\rightarrow]0,\infty[$. If we choose $c \equiv 1$, then it is reduced on the heat equation. If we assume that $c(s)$ is a decreasing function satisfying $c(0)=1$ and $lim_{s\rightarrow\infty} c(s)=0$, then inside the regions where the magnitude of the gradient of u is weak, equation (6) acts like the heat equation and the edges are preserved.

We have proved in [18] that the pseudo-linear superposition principle holds for Perona and Malik equation.

Theorem 5:

If $u_1=u_1(t, x)$ and $u_2=u_2(t, x)$ are solutions of the equation

$$\frac{\partial u}{\partial t} - \text{div}\left(c\left(|\nabla u|^2\right)\nabla u\right) = 0, \qquad (7)$$

then $(\lambda_1 \odot u_1) \oplus (\lambda_2 \odot u_2)$ is also a solution of (7) on the set

$$D = \{(t, x) \,|\, t \in]0, T[, x \in \mathbb{R}^2, u_1(t, x) \neq u_2(t, x)\},$$

with respect to the operations $\oplus = \min$ and $\odot = +$.

The obtained results will serve for further investigation of weak solutions of the equation (7) in the sense of Maslov [9], [12], [16], [17], with further important applications.

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SPECTRAL SHAPE SIMULATION USING THE POLYNOMIAL REPRESENTATION

Hana Stefanović[1*],
Dejan Milić[2]

[1] School of Electrical and Computer Engineering of Applied Studies,
283, Vojvode Stepe St., Belgrade, Serbia

[2] University of Niš
Faculty of Electronic Engineering,
Niš, Serbia

Abstract:

In this paper, the spectral shape is estimated using polynomial model based on ARMAX structure (Autoregressive moving-average model with exogenous input). The stochastic signal with obtained power spectral density is generated in MATLAB, while the periodogram method for estimating the spectral density based on signal samples is used. The simulation of simple wireless system in which the motion is present is also given, based on generation of a process having a power spectral density representing the Doppler effect.

Key words:

ARMAX model, doppler effect, polynomial model, wireless system simulation.

1. INTRODUCTION

A polynomial model uses a generalized notion of transfer functions to express the relationship between the input $u(t)$, the output $y(t)$, and the noise $e(t)$ using the equation (Kovacevic and Djurovic, 1999):

$$H(z) = B(z^{-1}) \big/ A(z^{-1})$$

(1)

where $H(z)$ presents a pulse transfer function, $A(z)$ and $B(z)$ are polynomials in z or z^{-1}, while z^{-1} is the backward shift operator, or time-shift operator, stating that $z^{-1}y(k)=y(k-1)$. $A(z)$ and $B(z)$ are polynomials with respect to the backward shift operator, defined by (Golnaraghi and Kuo, 2009):

$$A(z^{-1}) = 1 + \sum_{i=1}^{n} a_i z^{-i}$$

(2)

and

$$B(z^{-1}) = \sum_{i=1}^{m} b_i z^{-i}$$

(3)

Equivalent time domain representation, relating the output sequence $\{y(k)\}$ to the input sequence $\{u(k)\}$ is given by:

Correspondence:

Hana Stefanović

e-mail:
stefanovic.hana@yahoo.com

$$y(k) = \frac{B(z^{-1})}{A(z^{-1})} u(k) = \frac{\sum\limits_{i=1}^{m} b_i z^{-i}}{1 + \sum\limits_{i=1}^{n} a_i z^{-i}} u(k) \qquad (4)$$

It can therefore be concluded:

$$y(k) - \sum_{i=1}^{n} a_i y(k-i) = \sum_{i=0}^{m} b_i u(k-i) \qquad (5)$$

When the system is excited by a random input sequence $\{e(k)\}$ and a deterministic input sequence so-called exogenous input $\{u(k)\}$, the model is written in the following form:

$$A(z^{-1}) y(k) = B(z^{-1}) u(k) + C(z^{-1}) e(k) \qquad (6)$$

where polynomial $C(z)$ is given with:

$$C(z^{-1}) = 1 + \sum_{i=0}^{l} a_i z^{-i} \qquad (7)$$

This model is known in the literature as the autoregressive moving-average model with exogenous input, or ARMAX model. The ARMAX model represents the general form for popular time-series and digital filter models:

- for $C=0$, the pulse transfer function or infinite impulse response (IIR) model
- for $A=1$ and $C=0$, the finite impulse response (FIR) model
- for $B=0$ and $C=1$, the autoregressive (AR) model
- for $A=1$ and $B=0$, the moving-average (MA) model
- for $B=0$, the autoregressive moving-average (ARMA) model
- for $C=1$, the autoregressive model with exogenous input (ARX)

The ARMAX model is usually used for signal processing purposes (Red-Horse *et al.,* 1996), since the time-series analysis based on ARMAX technique has many advantages over the traditional spectral method (Peng *et al.,* 2001).

2. MODELING OF STOCHASTIC PROCESS

A random sequence with autocovariance:

$$R_Y(nT) = a^{|nT|}, \quad 0 < a < 1, \ T = 1 \qquad (8)$$

is proposed. The power spectrum is:

$$S_Y(z) = \phi\{R_Y(n)\} = \sum_{n=-\infty}^{+\infty} R_Y(n) z^{-n}$$
$$= S_Y^+(z) + S_Y^-(z) - R_Y(0) \qquad (9)$$

with S_Y^+ and S_Y^- signifying positive and negative time:

$$S_Y^+(z) = \sum_{n=0}^{+\infty} R_Y(n) z^{-n} = \sum_{n=0}^{+\infty} (az^{-1})^n = \frac{1}{1 - az^{-1}} \qquad (10)$$

and:

$$S_Y^-(z) = \sum_{n=-\infty}^{0} R_Y(n) z^{-n} = \sum_{n=-\infty}^{0} (az)^{-n} = \frac{1}{1 - az} \qquad (11)$$

It can be concluded (Kovacevic and Djurovic, 1999):

$$S_Y(z) = \frac{1}{1 - az^{-1}} + \frac{1}{1 - az} - 1 = \frac{1 - a^2}{(1 - az^{-1})(1 - az)}$$
$$= H(z) H(z^{-1}) \sigma_u^2 = H(z) H(z^{-1})(1 - a^2) \qquad (12)$$

Since $S_u(z) = \sigma_u^2 = 1 - a^2$, transfer function $H(z)$ is:

$$H(z) = \frac{1}{1 - az^{-1}} \qquad (13)$$

By using the autoregressive model representation, it can be written:

$$H(z) = \frac{\phi\{y(k)\}}{\phi\{e(k)\}} = \frac{Y(z)}{E(z)} = \frac{1}{1 - az^{-1}} \qquad (14)$$

with the difference equation obtained:

$$y(k) = ay(k-1) + e(k) \qquad (15)$$

3. GENERATING THE STOCHASTIC SIGNAL WITH OBTAINED POWER SPECTRAL DENSITY

The stochastic signal with the obtained power spectrum is generated in MATLAB, using the periodogram method for estimating the spectral density based on the signal samples (Hayes, 1996). Periodogram is given by the modulus squared of the Discrete Fourier Transform (DFT) and is one of the simplest techniques to estimate the spectrum (Therrien, 1992).

Some numerical examples for different values of parameter *a* are given in Fig. 1, Fig. 2 and Fig. 3. The theoretical and estimated power spectral density is shown.
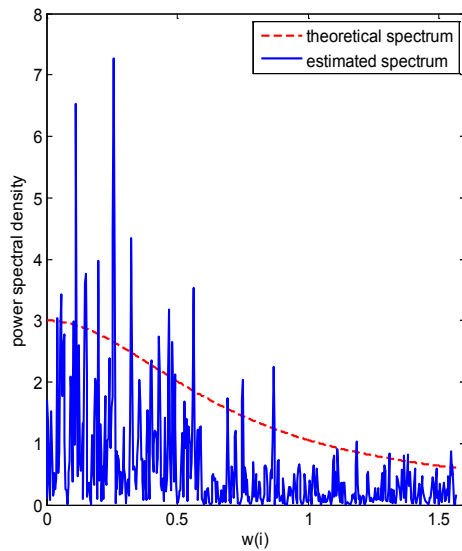
Figure 1. Power spectral density for *a*=0.5
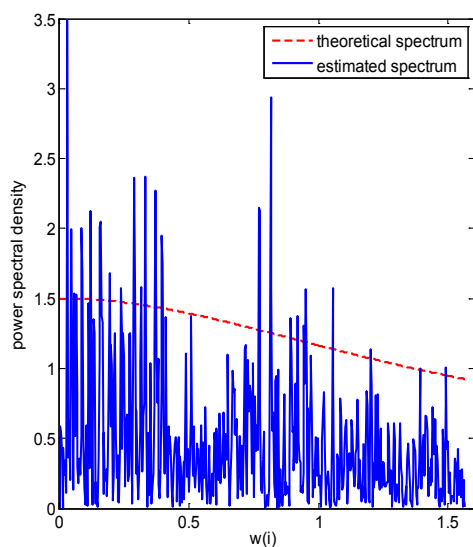
Figure 2. Power spectral density for *a*=0.2
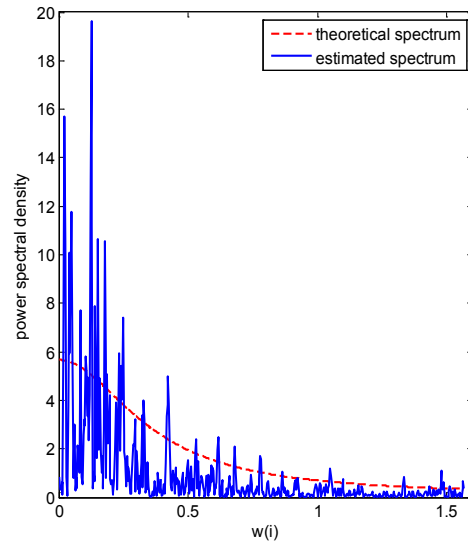
Figure 3. Power spectral density for *a*=0.7

4. THE SIMULATION OF WIRELESS SYSTEM WITH GIVEN POWER SPECTRAL DENSITY

A wireless communication system providing access to the communication infrastructure for mobile users is proposed. The presence of multiple paths between the transmitter and receiver is due to reflection and refraction. Multipath and motion-induced fading is one of the most severe performance-limiting phenomena that occur in wireless mobile communication channels (Proakis and Salehi, 2008).

In this paper, the power spectral density model assumes that there are many multipath components, each having different delays, while all components have the same Doppler spectrum. Each component is made up of a sum of simultaneously arriving unresolvable paths, having angle of arrival with a uniform angular distribution at the receiver side, like in Jakes model (Tranter *et al.,* 2004). The classical Jakes' Doppler spectrum has a form (Jakes, 1974):

$$S(f) = \frac{K}{\sqrt{1-(f/f_d)^2}}, \quad |f| \le f_d \qquad (16)$$

where $f_d = v/\lambda$ is the maximum Doppler shift, v is the vehicle speed and λ is the wavelength of the carrier. The Doppler spectrum defined by (16) is appropriate for dense scattering environments like urban areas. Typical Doppler bandwidths in mobile applications at 1 GHz will range from 10 to 200 Hz.

It is supposed that the noise samples are independent, so power spectral density (PSD) of system output $S_Y(f)$ is:

$$S_Y(f) = |H(f)|^2 S_X(f) \qquad (17)$$

Since the PSD of the input is constant, it can be written:

$$S_Y(f) = |H(f)|^2 K \qquad (18)$$

The required transfer function to establish the target power spectral density is:

$$H(f) = \sqrt{S_Y(f)/K} \qquad (19)$$

or equivalently (Tranter *et al.,* 2004):

$$H(f) = \begin{cases} \left(1 - (f/f_d)^2\right)^{-1/4}, & |f| \le f_d \\ 0, & \text{otherwise} \end{cases} \qquad (20)$$

This filter is implemented in MATLAB as a FIR filter whose impulse response is obtained by taking the inverse DFT of sampled values of $H(f)$. Therefore, the problem of shaping the power spectral density to meet the given requirements reduces to the problem of finding a filter with a transfer function $H(f)$ so $H^2(f)$ gives the required spectral shape.

The impulse response and transfer function are illustrated in Fig. 4 and Fig. 5, respectively, using Jakes' model.
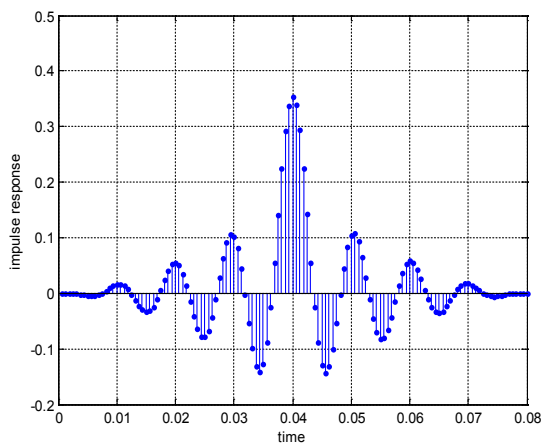
Figure 4. The impulse response

The effect of filtering a complex white noise is illustrated in Fig.6. and Fig.7.
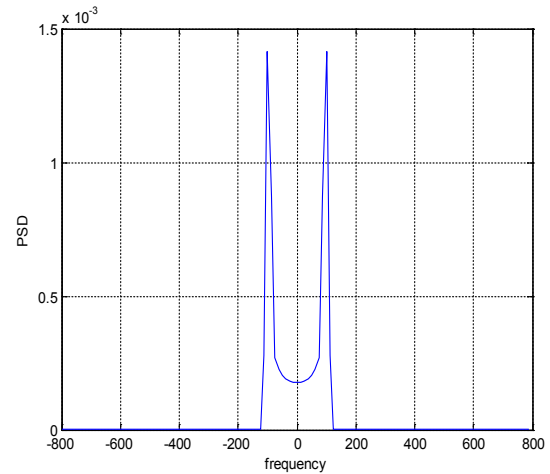
Fig. 5. Power spectral density

The estimated PSD at the filter output is given in Fig.6, while Fig. 7. illustrates the magnitude of the envelope, corresponding to the fading effect in mobile communications.
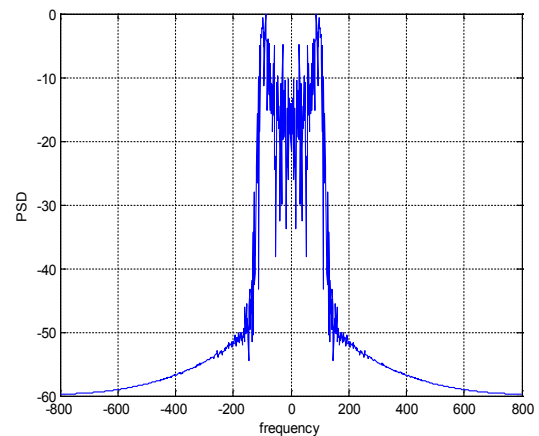
Figure 6. Power spectral density at the filter output
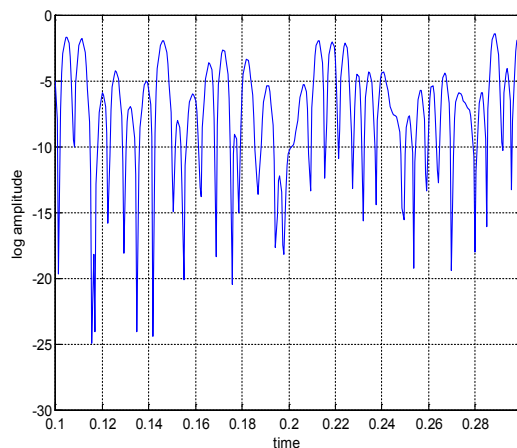
Figure 7. The the magnitude of fading envelope

5. CONCLUSION

In this paper, the distribution of the power over frequencies for different realizations of a random signal, generated by the same ARMAX model, using different realizations of the noise and different model coefficients, is analyzed. The power spectral density and an estimate of the power spectral density obtained from a short realization of the random process, are also presented, describing the fading effect in mobile wireless communications.

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ADVANCED COMPUTING AND CLOUD COMPUTING

THE USE OF ARTIFICIAL NEURAL NETWORKS IN CLINICAL MEDICINE

Miloš Jovanović[1],
Dušan Milenković[2],
Marija Perković[3],
Tatjana Milenković[4],
Vuk Niković[5]

[1] Singidunum University,
Belgrade, Serbia

[2] Institute for Emergency Medical Care,
Niš, Serbia

[3] Royal Holloway, University of London,
London, United Kingdom

[4] Public Health Institute,
Niš, Serbia,

[5] Institute for Emergency Medical Care,
Podgorica, Montenegro

Abstract:

Digital Agenda in Serbia involves the introduction of an electronic system for monitoring of the main characteristics of patients, disease progression and treatment outcomes through EHR (Electronic Health Record). Internationally standardized data set contains more than 150 variables, with a tendency to introduce new frequently. In addition to the increased demand for treatment, there are also demands for optimizing the health care system. In order to predict the likelihood of diagnosis, course and outcome of treatment, classically multivariate regression linear logistic model is being used. Recent studies have shown that the use of Artificial Neural Networks (ANN) may provide improved results in terms of likelihood of the final diagnosis and outcomes that include input variables which, by their nature, have non-linear interdependence. We reviewed current ANN models, their advantages and disadvantages compared to common regression models and their applicability in clinical practice. Also, we analyzed and suggested models that could possibly optimize the process of diagnosis, predict the cost and duration of treatment and rationalize medical and other resources by reducing the cost/benefit coefficient per patient.

Key words:

artificial neural networks, electronic health record, data mining.

1. INTRODUCTION

Digital Agenda in Serbia involves the introduction of an electronic system for monitoring of the main characteristics of patients, disease progression and treatment outcomes through EHR (*Electronic Health Record*) (Ministarstvo zdravlja, 2015). At the moment, it is estimated that the certified EHR covers approximately 50% of health facilities, whereas the centralization of systems at the national level is currently in the implementation phase. In 2015, only in primary care, the annual plan of preventive examination and for treatment of insured persons of all ages stood at over 45 million (RFZO, 2014). Such huge amount of data could be utilized for prediction of early accurate diagnosis, future adverse clinical events and treatment plans.

Healthcare System Optimization

In addition to the increased demand for treatment, there are also demands for optimizing the health care system. Decision to send patients for additional examinations or aggressive procedures is often based on

Correspondence:

Miloš Jovanović

e-mail:

mjovanovic@openlink.rs

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clinical protocols adopted by consensus, mostly tailored by cost/benefit criteria (Wang, 2003). However, having in mind that most of them are linear logistic-based, it is unclear whether these protocols get the maximum predictability of aggregated data in real world settings.

2. ELECTRONIC HEALTH RECORD (EHR)

Internationally standardized data set for the Electronic Health Record (EHR) contains more than 150 variables, with a tendency to introduce new frequently. It is based on ISO/HL7 Standards and provides various baseline and input variables. It contains administrative, socio-medical, general health data (main set - previous diseases, special problems, immunizations, risk factors, drugs, contact with healthcare system anywhere), organ recipient data, primary cause of death and additional metadata (Ministarstvo zdravlja RS, 2009).

Basically, EHR contains "raw" data aggregated initially and over a certain period, as patient's contact with healthcare providers sums up. Such huge data sets might represent an excellent foundation for further analysis and possibly clinical algorithms development.

3. MULTIVARIATE REGRESSION LINEAR LOGISTIC MODEL

To predict the likelihood of diagnosis, course and outcome of treatment, classically multivariate regression linear logistic model is being used (Sobb, 2008).

Since there is a linear relationship between variables, these regression models tend to yield mixed results in modeling some complex connections and relations, as seen in very diverse and multifactorial biologic systems (DiRusso, 2002).

On the other hand, when it comes to discovery of underlying relationships between variables, linear regression seems to be method of choice for modeling. On the weak side, such models demonstrate lower potential at predicting likelihood of final events during such complex interactions (Lin, 2010).

4. ARTIFICIAL NEURAL NETWORKS (ANN)

In recent years, studies have shown that the use of Artificial Neural Networks (*ANN*) may provide some quality results considering sensitivity and specificity of final diagnosis and outcomes that include input variables

which, by their nature, have non-linear interdependence (Casagranda, 2016; Freeman, 2000; DiRusso, 2002). The performance of ANN modeling is speculated to be superior than standard statistical methods in many scientific fields. Particularly, in medical research, there is a growing number of reports where ANN modeling provide better results compared to Cox regression, discriminant analysis, and logistic regression (Eftekhar, 2005).

Applications of ANNs in medical and healthcare fields cover many clinical and laboratory procedures. ANNs is found to be a convenient tool for predicting outcomes and mortality in trauma patients (Eftekhar, 2005; Abbod, 2011), in patients after invasive cardiac procedures (Freeman, 2000), for detecting abdominal diseases (Liew, 2007), for determining risk of serious conditions in emergency departments (Casagranda, 2016), for medical image studies (Jiang 2010), for evaluating cancer screening programs (Álvarez Menéndez, 2010), for correct interpretation of laboratory and intensive care results (Guo, 2010), etc.

Recent papers suggested the use of ANNs in evaluating implementation model of remote health observing based on suitable questionnaire (Huang, 2010) and implementing web-based health monitoring systems for spread use by patients in their home environment (Youm, 2011).

Similar to weather forecasting methods, ANNs could find their potential use in forecasting of overcrowding in emergency departments (Jones 2009), operating rooms or be utilized as a tool for proper positioning of ambulance vehicles in large density population areas (Nguyen, 2015). The strongest advantage of ANNs over logistic regression in these areas of research may be due to ANN's capability to explore some relations between variables and outcomes that are uncertain or poorly understood at the moment.

Analyzing big data sets and data selection

As the amount of data collected in healthcare system tends to rise over time, physician's ability to recognize important findings and certain patterns in overall patient's clinical condition tends to drop. Such amount of data may be sometimes hard to synthesize in a form of meaningful outcome, especially with mixed variable sets (Ghavami, 2012).

There is an ongoing debate as to whether ANN could or should be used in each clinical settings. A growing number of published papers and elevated interest in ANN as a tool for finding relations among apparently completely unrelated input variables for predicting clini-

cal outcomes raised some doubt considering validity of results (Freeman, 2000). To avoid such speculations, it is may be beneficial to build ANN models on initial subset of univariate predictors based on mathematical algorithms and established clinical knowledge.

Selecting proper variables is generally based on empirical data and basic statistical methods that identify variables with strongest predictive powers (Ghavami, 2012).

Basic ANN structure

Standard design of ANN is based on several mathematically-driven nodes structured in several respective layers (Fig. 1). Separate node is linked to all nodes in the preceding layer. In general, ANN structure is based on three layers: input layer (denotes input variable), "hidden" layer (denotes computation processing) and output layer (denotes outcome for the specified data record). Each ANN model consists of training and validation datasets.
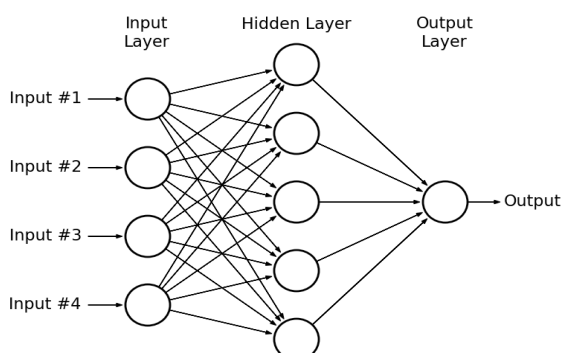
Fig. 1. Common ANN structure

Training sets are built with sequence of input variables with known outcomes. These data are commonly purely empirical (Amato, 2013). Variables at each input nodes are given randomly calculated numeric attribute values ("weights"). In the next step, the sum of weights of all input data is computed and introduced to every single node in the hidden layer. Finally, using transfer function, the weighted sum is utilized to calculate the power of single node's output by assigning it a scaled numerical value (Yamamura, 2003). Long story short, properly designed network has the ability to "learn" from a sequence of "examples" contained in the training database.

After the training process is done, the neural network can be tested and verified on new external data provided with only input values. Once verified by clinicians or researchers, the new data can be added to the existing database for further training, but only if they belong to the same observed cohort indicated by appropriate parameter value (Amato, 2013).

ANN limitations

The configuring of an ANN is mostly an empirical process, so there are no specific consensus recommendations for designing of an optimal ANN. Large amount of input variables are initially chosen at random and put to test. The final models are usually selected on the basis of desired cut-off probability values for expected events. ANN modeling is currently discussed as a form of "black box", for the reason that the correlations between the selected cluster of variables that make the correct output are not properly understood (Benitez, 1997).

EHR databases as a platform for modeling ANN

EHR was initially designed as a tool for collecting relevant patient's data over its lifetime with the aim to improve attending physician's decisions regarding previous, current and future treatment plans for specific health conditions and to follow up overall medical costs. The extent of EHR use has risen in many countries over the past decade, so naturally, the number of data stored surpassed human's ability to review and extract applicable information out of so much data considering treatment choice. In recent years, noticeable interest has been raised as to the possible use of ANN and other methods in data mining of EHR, specifically in genetics and family health history (Ross, 2014; Hoyt, 2016).

At the moment, clinical trials symbolize reference methods in making policies for developing and introducing new drugs, therapeutic procedures, clinical algorithms and more, enrolling on average few hundred or thousand subjects. Although the bias is excluded by subject randomization to receive or not certain treatment, conclusions made at the end of investigations are the result of basically "noise reduction" by carefully selecting cohort with desired baseline parameters. One of the questions unanswered, even with the large registries of events, is what other variables, omitted from the investigation, influence real-life performance of derived drug and therapeutic guidelines found in observational studies (Zhang, 2014; Balas, 2015). EHR data mining found some promising results that could improve clinical trials' cor-

rect preparation or proper subject selection (Ross, 2014).

EHR databases contain many input variables from various patients, but not all of them are at the same time given certain value, *i.e.* they remain empty until operator/physician interacts and inputs the data (laboratory findings, for example). One of the problems that should be addressed is that "missing values" could interfere with the expected ANN results, so the correct database pre-processing should be done. This could be more complicated when introducing new input variables, as "over-fitting" may occur because of ANN's tendency to pair input-output data too precisely. This can be resolved by cross-validation of input variables in a parallel clone database.

Another issue could be the determining the proper number of iterations ("epochs") that are required for ANN to reach it's optimized state. As this process can be time-consuming and varies with different ANNs used and verified (based on number of input variables, number of hidden layers and hidden nodes that each of them contains), and is set by user threshold that is reached for the mean square error change, cloud-based computational engines utilization for such fair amount of data processing seems to be the pathway to look after in these scenarios.

ANNs for remote health monitoring

As the portable diagnostic equipment evolves (such as portable ECGs and holter devices, blood glucose analyzers), there is an elevated interest in utilizing recorded data for forecasting adverse events in certain high-risk and chronic patients. ANNs have already shown some improved results compared to the mainstream logistic regression algorithms (Radhimeenakshi 2015). Sensors readings are transmitted over cellular lines or Wi-Fi networks, and together with patient's baseline known input characteristics and ANN trained dataset from large registries, aggregated data are processed for likelihood of heart failure, preterm birth or poor diabetes control. ANNs may be used to trigger alarms before critical events, or to imply clinician's decision to correct underlying cause of disturbance.

Building a suitable database may be achieved also by entering required data on a daily basis by patients themselves (Suh, 2012). Such data may be included as a separate variable list in an addendum to EHR. Specific online questionnaires are fed with current patient's data, such as daily symptoms (chest pain, headache, mood changes, *etc.*), calories intake, sleeping periods, heart

rate, blood pressure and many more, and the suitable ANN model reacts to threshold parameters. On the other hand, many of these ANN applications are prone to errors if missing data are not processed properly or data do not undergo supervised learning, so it's maintenance complexity often comes as a deal-breaker for long term reliable conclusions and deployment.

ANNs for Clinical Decision Support Systems (CDSS)

CDSS represent heterogeneous group of healthcare software and hardware largely built on rule-based statistical theory and Arden syntax that combine existing clinical knowledge (in a form of widely accepted guidelines or consensus papers) with physician's input to suggest further laboratory or procedure ordering, as seen in many EHR-based systems. One of the CDSS drawbacks is that suggested sets of laboratory tests or procedures are group-oriented, rather than patient-oriented sets (Castaneda, 2015).

Having also in mind that most of the current CDSS are prone to errors and malfunctions (Wright, 2016), ANNs may find their role in future CDSS designs aimed for patient-oriented or customized clinical decisions on patient-by-patient basis (Kyrgiou, 2015). Furthermore, CDSS hybrid data-driven and rule-based systems (*e.g.* multilayer neural network and C4.5. decision tree algorithm) could have the potential to return better results in the future (Bal, 2014).

Future directions for ANN implementation

Aside from ANN's power to predict outcomes based on initial dataset, diversity and complexity combined with huge number of possible variables makes ANN sometimes difficult to implement in real practice. On the other hand, one could always argue the strength of actual variables, as opposed to missed one's in the datasets. One step further would be, for example, the designing of ANNs to suggest which optimal number and type of input variables is needed to obtain fairly precise diagnosis or outcome of particular patient's condition based on a few clinical symptoms and patient's baseline characteristics.

5. COST/BENEFIT ANALYSIS

Introducing EHR already showed decline in the overall healthcare expenditure (Wnag, 2003). Clinician's decision to send patients for further analysis or interventional procedures generally raises funds needed for

managing patient's condition. There are several studies that addressed this problem, since additional tests and procedures do not always result in definitive diagnosis or termination of illness. There are several studies that suggest the use of ANN models in reducing the overall costs for proper treatment of clinical conditions (Walczak, 2000; Liew, 2007, Abbod, 2011; Teferra, 2014).

It may be reasonable to reveal real power of ANNs in minimizing healthcare costs by widespread implementation in screening programs, as seen in primary health care. Major savings are known to be the result of early detection and proper management of diseases. Although there are many well established screening programs aimed for diseases with greater incidence or prevalence among selected population (cancer, cardiovascular and metabolic diseases), the main advantage of ANNs lies in the ability to detect some unusual patterns in disease origin and progression, as well as to produce fewer number false-positive predictions.

Costs reduction and benefit optimization may also be found in proper ANN-derived strategic planning of healthcare personnel engagement during peak days or hours, proper geo-data positioning of ambulance vehicles, threshold settings for decisions to enter operating room, to have CT or MRI done, for entering program of in vitro fertilization, *etc*.

Current strategies are not consistent across countries, as healthcare budgets are not equal. It may be reasonable, for developing countries, to establish their own models based on EHR data sets and algorithms matching healthcare funds per patient and desired disease detection and control. Also, one should bear in mind that socio-epidemiological settings play an important role in determining quality of life and subsequent emerging of health problems. Chronic stress, quantifiable or not by ANN, remains inevitable trigger for many diseases.

6. CONCLUSION

With the development of microprocessor and cloud technology, mega-data sets can now be analyzed within a reasonable time by finding the model ANN that can optimize the process of diagnosis, predict the cost and duration of treatment and rationalize medical and other resources by reducing the cost/benefit coefficient per patient.

Logistic regression models seem to complement for major drawback of ANNs in terms of finding the relations between individual factors that determine proper data selection.

Further EHR dataset analysis using ANN could potentially improve healthcare system performance by "learning" global health tendencies among the observed population.

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A CONSTRAINED APPROXIMATE SEARCH SCENARIO FOR INTRUSION DETECTION IN HOSTS AND NETWORKS

Slobodan V. Petrović

Norwegian University of Science and Technology (NTNU),
Gjøvik, Norway

Abstract:

It is well known that most new attacks against computer systems and networks originate from the old ones. Namely, it is possible to change the old attack patterns in such a way that the modified patterns affect approximately the same targets on the victim system and pass undetected by signature-based Intrusion Detection Systems (IDS) or other detection tools. In this paper, we consider a scenario where an old attack pattern is changed by means of an automatic tool. The structure of changes must be kept under control in order for the attack to remain effective. For example, the number of changed symbols in an automatically crafted string in the attack pattern must be limited. Otherwise, this string would not affect the victim system in the same way as in the original attack. Under such an assumption, we describe the requirements for a search algorithm implemented in the detection tool (for example, an IDS) that would be capable of detecting the changes in the old attack signature. We present the basic structure of a generic search algorithm of this kind, describe some application scenarios and discuss the effectiveness of the algorithm under these scenarios.

Key words:

intrusion detection, misuse detection, non-deterministic finite automaton, simulation, approximate search.

1. INTRODUCTION

Intrusion detection in hosts and networks is automatic detection of security policy violations. Monitoring systems that perform this kind of activity are called Intrusion Detection Systems (IDS). Most IDS compare the incoming traffic (or security logs) with the records of attack signatures contained in a signature database. This process is called Misuse Detection. The attack signatures define what is abnormal for the defended computer system/network and every match is reported in the form of an alarm. The comparison is exact, which is a source of vulnerability since an attacker can easily modify the attack traffic in such a way that the signature present in the IDS does not match and the traffic launched towards the victim is still harmful. On the other hand, too many changes to the original attack traffic template performed by an attacker can make the resulting traffic behave unpredictably. Because of that, the number and distribution of possible changes to the old attack traffic pattern are limited. In addition, the attackers often use automatic tools to perform these changes since the amount of traffic to process is huge. These tools must be configured before the traffic is processed and configuration determines the number and distribution of changes, among other parameters.

Correspondence:

Slobodan V. Petrović

e-mail:

slobodan.petrovic@ntnu.no.

In order to cope with the vulnerability of IDS that is a consequence of using exact search, it is possible to replace the exact search algorithm with an approximate search algorithm. In such a way, up to a tolerance level determined in advance, the IDS would be capable of detecting several variants of the same attack by keeping just one attack signature in its database (see for example [1]).

There are two challenges related to the use of approximate search in intrusion detection. The first one is related to the efficiency of operation. Namely, the approximate search algorithms are slower than their exact search counterparts and we have to make sure that an IDS implementing an approximate search algorithm is efficient enough to process the incoming traffic and/or log files in real time. The second challenge is a possibility of generating additional false positives and/or false negatives due to the fact that an approximate search algorithm without any limitation regarding the number and distribution of changes performed on the original attack traffic pattern would report a match even on the traffic patterns that could not be generated by small modifications of the original attack.

In this paper, we define the criteria for approximate search algorithms that they must satisfy in order to be applied in intrusion detection. We propose a generic algorithm that would satisfy these criteria and describe some scenarios of its application. The effectiveness of the algorithm regarding the speed and false positive/negative rate is also discussed.

The structure of the paper is the following. In Section II, we define the basic criteria that any approximate search algorithm has to satisfy in order to be applied in intrusion detection and present a generic approximate search algorithm for intrusion detection. In Section III, we describe the application scenarios for this algorithm and discuss its effectiveness. The conclusion is given in Section IV.

2. THE GENERIC SEARCH ALGORITHM

Search algorithm quality criteria

Basically, the challenges related to the use of approximate search algorithms in intrusion detection that we enumerated above determine the criteria of their quality. Regarding the speed, real time operation of an IDS is essential since the attack traffic has to be alerted upon before any harm is done. This is a challenge even for exact search algorithms because of the speed of today's network traffic. Thus, the computational overhead intro-

duced by approximate search in an intrusion detection system must not significantly reduce its speed.

Regarding the false positive/negative rate, we have to reduce the probability of appearance of false positives and false negatives that are produced as a consequence of using approximate search since the false positives and false negatives are also produced in an IDS for other reasons and otherwise represent a great problem, reducing the trust of the users to the alarms generated by these systems.

To satisfy the quality criterion related to operation speed defined above, it is required that we use search algorithms that include parallel processing. The fastest known algorithms of this kind exploit so-called bit-parallelism phenomenon, *i.e.* the fact that it is possible to use computer words to simulate Non-deterministic Finite Automata (NFA) assigned to search patterns.

To satisfy the quality criterion related to the number of false positives/negatives, it is necessary to introduce some constraints in the approximate search. These constraints reflect the properties of the algorithm that the attacker uses in order to produce the new attack traffic patterns starting from the old ones. For this to be effective, we must know the probabilities of change/edit operations that the attacker uses in this process. The key fact here is that the changes on the old traffic patterns must be small. Thus, by studying the existing attack signatures, it is possible to predict what kind of changes are feasible on to the corresponding traffic and to define adequate constraints in search.

Satisfying the quality criterion related to the numbers of false positives/negatives is not independent of the operation speed criterion. The reason for this is the computational overhead that is introduced to the approximate search algorithm without constraints once the constraints are introduced in it. Because of that, we have to design the constrained approximate search algorithms for application in intrusion detection in such a way that we do not violate the satisfaction of the operation speed criterion. We have to achieve a trade-off between efficiency and (low) probability of false positives and/or negatives.

Bit-parallelism and search

We explain the bit-parallelism phenomenon by studying several examples. Consider the search pattern w="quick" of length $m=5$ and the search string S="The quick brown fox" of length $n=19$. A naïve search algorithm

would place the search pattern along the search string starting from the first position in the search string and compare the corresponding characters. An exact match would be reported if every character of the search pattern would be equal to its counterpart in the search string. Then the search pattern would be moved one position to the right and the whole procedure would be repeated. We would continue this process until the position $n-m+1$ in the search string. If we have as many computers running in parallel as we wish, then we can run $n-m+1$ character-by-character comparisons concurrently and finish the search in a single step. We can imagine that each time a new symbol from the search string appears, a new finite state machine performing the character-by-character comparison assigned to the search pattern is created and all the machines created before that point together with the newly created one perform the comparison of the current symbol from the search string with the current character of the search pattern. If any of the machines cannot match the current character from the search string it becomes *inactive* (*i.e.* it will not process more characters in the future), otherwise it remains active.

The problem with this kind of parallelism is that it is not binary (it involves character-by-character comparisons) and as such it can only be simulated on a digital (*i.e.* binary) computer. Consequently, simulation of parallel processing this way does not improve efficiency of the (exact) search algorithm.

Baeza-Yates and Gonnet [2] showed that it is sufficient to consider only the status (active or inactive) of the machines that were created while processing the characters of the search string S. This converts our parallel processing search algorithm into a binary one. Then we can use the binary operators (shift, OR, AND) on all the bits of the computer word of length m at the same time, which speeds up the search process by the factor m provided the search pattern is shorter than the length of the computer word (usually 32 or 64 bits).

Fig. 1 – Bit-parallelism (see text)

Consider the following example. Let the search pattern be w="gauge", $m=5$ and the search string be S="omegagauge", $n=10$". We assign a finite state machine performing character-by-character comparison to the pattern w. We keep track of the status of each machine created during the search process in a computer word D of length m. We call this computer word the *search status word*. A zero in the status word means an inactive machine and a one means an active machine. Whenever a new machine is created (before we process the next symbol from S) its status is active. After processing j symbols from the search string S, some machines are active and some are inactive. We can only have m machines at a time, so before processing a new symbol from S we have to eliminate the oldest machine. We do this by shifting the status word one position to the left. The fact that the newly created machine that will start processing from the j-th symbol of S is active before processing that symbol is equivalent to OR-ing the status word with 1. We now notice that if a machine is active waiting for a certain character only that character will keep it active and this fact does not depend on the search string. Thus, we can define bit masks $B[s]$ assigned to each character s of the search pattern w prior to processing the search string S. The bit mask $B[s]$ has the value 1 at the positions where the search pattern has the character s, read from right to left. In our case, $B[g]=01001$, $B[a]=00010$, $B[u]=00100$, $B[e]=10000$. For the characters outside of the search pattern w the bit mask is zero. After shifting the status word D by one position to the left and OR-ing it with 1, we AND it with the bit mask of the current character. We call this process *updating the status word*. The updating formula is then [2]

$$D_j = ((D_{j-1} << 1) \text{ OR } 1) \text{ AND } B[S_j], \qquad (1)$$

where Sj is the j-th character of the search string S.

Thus, the search process is reduced to updating the status word D for each input symbol from the search string S and checking whether the most significant bit (MSB) of D is equal to 1. In that case, we have an *occurrence* of the search pattern w in the search string S. Note that the original "Shift-AND" search algorithm from [2] based on bit-parallelism status word updating formula (1) is an *exact search* algorithm.

Unconstrained approximate search

Suppose we allow up to k errors in the search process and the errors can be results of insertions, deletions or substitutions of characters. A common way to design a tolerant search algorithm of this kind based on bit-

parallelism is to use the so-called Row-wise Bit Parallel-ism (RBP) [3]. In such an algorithm, instead of having a single search status word D, we use a search status array R containing $k+1$ search status words of length m (the length of the search pattern w). The 0-th row (R_0) of the array corresponds to exact search, the 1-st row (R_1) corresponds to the search with 1 error, *etc*. The search status array updating formula is more complicated than in the exact search case. To understand it, we have to imagine a Non-deterministic Finite Automaton (NFA) array that is simulated by the RBP. It is an array of machines performing matching of a single character connected with transition arrows. A horizontal arrow means a match of the current input character from the search string S. A vertical arrow means an insertion of that character, a solid diagonal arrow means a substitution of the current input symbol and a dashed diagonal arrow means a deletion of the current input symbol.

The status word updating formula for the 0-th row of the array is the same as (1), *i.e.* the "Shift-AND" formula. For the rest of the rows, each row status word depends on the previous one. So, the final status word array updating formula for the unconstrained approximate search using RBP is [3,4]

$$R_0' = ((R_0 << 1) \ OR \ 1) \ AND \ B[S_j],$$
$$R_i' = ((R_i << 1) \ AND \ B[S_j]) \ OR \ R_{i-1} \ OR \ (R_{i-1} << 1) \ OR$$
$$(R_{i-1}' << 1), \tag{2}$$

where R' represents the new status of the array, after the updating. Note that the status updating formula for the rows other than 0 consists of 4 parts corresponding to match, insertion, substitution and deletion, respectively. The contributions of all the operations are superimposed, which is represented by OR-ing in the formula.

Constrained approximate search

To cope with false positives and false negatives that are produced as a consequence of using approximate search, we have to introduce certain constraints in the search process, as discussed above. The constraints are taken into account in the Row-based Bit Parallelism algorithm by assigning special counters or counter arrays to each bit of the status array. The role of the counters is to keep track of allowed edit operations from a state of the NFA array. These operations depend on the nature of the constraints. For example, if the constraints are on the total numbers of edit operations allowed in the search process, then each counter contains the remain-

ing number of edit operations allowed from the corresponding state. The search status updating formula in the constrained case encompasses not only updating the values of the bits of the status array, but also updating the values of the constraint-related counters.

Generic constrained approximate search algorithm

After explaining bit-parallelism and the unconstrained and constrained bit-parallel approximate search, we are now ready to present a generic constrained approximate search algorithm. It contains counters that have to be updated after updating the status bits of the NFA array. To update these status bits, we first have to determine whether certain transitions are allowed from each state. This is done by introducing additional bit masks and AND-ing them with the status words corresponding to each row of the array. Such bit mask is always equal to 1m for the 0-th row of the status array. For other rows, the bit mask values depend on the values contained in the counters. If the values of the counters reach their allowed maxima (or minima, depending on the constraints), then the corresponding bit value in the bit mask will be 0. A zero bit in such a mask means that the corresponding transition will not be allowed at updating the status array.

The generic constrained approximate search algorithm is presented below. The concrete operations necessary to update the counters and produce bit masks depend on the constraints.

Algorithm 1 – Generic constrained approximate search

    Input:

        The search pattern $w=w_1w_2…w_m$

        The search string $S=s_1s_2…s_n$

        The number of allowed errors k; sometimes, k is determined by the values of the constraints

        The constraints, usually in the form of an array of numbers C; the meaning of the numbers depends on the nature of the constraints.

    Output:

A set of positions where w was found in S (can be empty).

1. Initialization – i least significant bits are set to 1 in the row i of the status array R, $i=0,…,k$
2. For $j=1,…,n$
      2.1. Update the row 0 of the status array
      2.2. For the rest of the rows of R:
         2.2.1. Check the values of the counters for each bit of the row

2.2.2. Generate the bit mask depending on the values of the counters

2.2.3. Update the status word for the row (equation, (2)) and AND it with the bit mask

2.2.4 Update the counter values for the row

2.3. Check the MSB of each row of the status array – if it is equal to 1 then we have an occurrence of *w* in *S*.

The model of the attacker behavior and the tool that the attacker uses to transform the known attack pattern to a new attack determine what constraints will be applied in the search algorithm. These constraints convert the generic approximate search algorithm into a concrete one.

3. APPLICATION SCENARIOS AND EFFECTIVENESS

We consider two scenarios for application of the generic constrained approximate search algorithm presented in the previous section. In the first scenario, the total number of edit operations (insertions, deletions and substitutions) represents the constraints. In the second scenario, the maximum lengths of runs of deletions and insertions represent the constraints.

If the total number of edit operations represents the constraint, then we associate the counter array C=[*i,e,s*] to each bit of the status array, where i denotes the number of insertions, *e* denotes the number of deletions (erasures) and *s* denotes the number of substitutions that are allowed for any transition originating from that status bit. If any of the numbers *i, e,* or *s* is equal to 0, the corresponding transition is not allowed. The initial values for the triples [i,e,s] are equal to [*I,E,S*] *i.e.* the constraints given in advance. Obviously, $I+E+S=k$ in this case. Each time a transition takes place, the corresponding number of allowed edit operations is reduced by 1. If an insertion takes place, i is reduced by 1 and copied to the corresponding constraint value of the destination status bit. If a deletion takes place, e is reduced by 1 and copied to the corresponding constraint value of the destination status bit. If a substitution takes place, s is reduced by 1 and copied to the corresponding constraint value of the destination status bit.

If the maximum lengths of runs of insertions and deletions represent the constraints, then we have to be aware of the fact that, in addition to the counter values of consecutive deletions and/or insertions, we have to keep track of other operations that, if they take place, reset these counters. For example, a deletion, a substitution or

a match resets the counter associated to insertions and an insertion or a substitution or a match resets the counter associated to deletions. The bit masks in this case become more complicated and must be associated to insertions and deletions at updating the rows of the status array other than 0.

By effectiveness of a search method in this paper we assume time and space complexities combined with probabilities of false positives and false negatives obtained with the IDS implementing the method. It is obvious that space complexity in both application scenarios is increased since counters (*i.e.* additional memory) are involved. However, as explained earlier, we are considering only small changes of the original attack patterns and because of that, the increase in space complexity cannot be such that it could threaten memory capacity on a sensor implementing the IDS. The same holds for time complexity. Increased time complexity is a result of updating the counters, in any application scenario. However, once the counters have been updated, operating the additional bit masks is as fast as other operations already present in the unconstrained approximate search algorithm. In addition, since the assumed changes of the original attack traffic pattern are small, very often just up to 1 operation, the use of the counters does not contribute too much to the overall complexity of the search algorithm.

Regarding the false positive and false negative rates, assuming small changes to the original attack traffic pattern and modeling such changes by the constraints introduced in the approximate search algorithm automatically prevents alarming on the traffic that does not correspond to the model. This traffic would be alerted upon without the introduced constraints.

4. CONCLUSION

In this paper, we gave an overview of possibilities to handle the situations in misuse-based intrusion detection, in which an attacker deliberately changes the attack patterns known to the defended host/network (*i.e.* the one, whose signature is present in the misuse database) in order to pass unnoticed by the victim. To this end, the attackers usually use tools since the amount of traffic to process is huge. Such tools must be configured regarding the number of changes to introduce and this number must be small since otherwise the transformed attack traffic might behave unexpectedly. This fact can be exploited on the defended side. First, to detect the transformed traffic pattern, the misuse-based Intrusion Detection System (IDS) can use approximate search instead of exact search

(which is otherwise almost always used). Second, to reduce the number of false positives and false negatives, certain constraints can be introduced in the approximate search algorithm, which model the behavior of the attacker/the tool that he/she uses. A generic constrained approximate search algorithm is presented in the paper, which takes into account general constraints (of virtually any kind). Then, two application scenarios are described that model the behavior of the tool used to transform the old attack traffic pattern. Each scenario has its particular definition of constraints, which can be substituted in the generic search algorithm in the corresponding application. The computational overhead introduced by introducing the constraints must be kept under control in order for the IDS to continue operating in real time. This is ensured by the fact that the changes to the original attack traffic pattern that the attacker can introduce must be small. On the other hand, using constraints guarantees reduction of the false positive and false negative rates since the traffic that does not correspond to the model of the attacker's/tool behavior is automatically discarded.

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TIME-MEMORY TRADE-OFF IN RFID SYSTEMS

Violeta Tomašević[1],
Milo Tomašević[2]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia,

[2]School of Electrical Engineering,
Bulever kralja Aleksandra 73,
Belgrade, Serbia

Abstract:

This paper elaborates on the application of Hellman's cryptanalytic time-memory trade-off approach in the RFID systems. First, the original method is briefly explained. Then, the situations and conditions that make the application of Hellman's idea possible in the RFID environment are discussed and analyzed. The effects of application of the time-memory trade-off method are illustrated for two RFID techniques: Ohkubo, Suzuki and Kinoshita's protocol, and constant-time identification protocol. For both of them the performance analysis is performed before and after application of the time-memory trade-off approach. Finally, the similarities and differences in modifications of the original method and its consequences in these two cases are pointed out.

Key words:

radio-frequency identification, time-memory trade-off, OSK protocol, constant-time identification.

1. INTRODUCTION

Radio frequency identification (RFID) technology enables the mass distant identification of objects (without any physical or visual contact) using radio waves. Along with the Internet, it is one of the most widely used technologies nowadays [1].

A lot of RFID protocols were proposed and developed [2-4]. Their efficiency heavily depends on the way of identification of tags associated with objects. Critical parameters of identification process are memory space and time needed for identification. Traditional contradiction between these opposing issues imposes the need for balancing between the two and calls for application of the time-memory trade-off (TMTO) approach in the RFID systems. This paper analyses the effects of applying TMTO methods in two RFID schemes: OSK (Ohkubo, Suzuki and Kinoshita) protocol and CTI (Constant-Time Identification) protocol.

Hellman's TMTO method is described in section II. General structure of an RFID system is given in section III accompanied by an analysis of possibilities to apply the TMTO approach in the RFID systems. Two examples of such an application of TMTO in the RFID schemes (OSK

Correspondence:

Violeta Tomašević

e-mail:

vtomasevic@singidunum.ac.rs

and CTI) are demonstrated in section IV. Similarities and differences of these TMTO-based RFID schemes are discussed in section V. Finally, the conclusion gives a short summary of elaborations from the paper.

2. TMTO APPROACH

Time-memory trade-off is a general method for enhancing the performance of various kinds of algorithms. It was applied for the first time in the area of cryptanalysis by Hellman, who proposed a TMTO attack on DES block cipher in [5]. However, it occured that this method solves more general problem of inverting one-way function, so it can be successfully used in different occasions.

Using the TMTO approach problem of inverting function $F: x \rightarrow y$ is solved in two steps: pre-computation phase and online phase. By means of intensive calculations pre-computation phase collects the information about F, and stores them into the appropriate data structure. Online phase for a given y founds the corresponding x by using data structures from pre-computation phase.

Hellman's proposal is based on generation of m chains of fixed length k in pre-computation phase. The nodes of the chains cover the value space to which values x and y belong. The head node of the i-th chain is a randomly chosen value SP_i. The chain is generated by consecutive applying F function on value from the previous node, as demonstrated in Fig. 1. EP_i is the last node of the i-th chain. In order to save the space, only ordered pairs (SP_i, EP_i), $i = 1,...,m$, are saved.

Fig. 1. Generation of the i-th chain

In the online phase starting with y value a chain is generated in the same way as in the pre-computation phase. For each new node a check is made whether it corresponds to some ending point EP_i. If not, a next node is generated. If an ending point is encountered, starting from corresponding SP_i from its stored pair, i-th chain is reconstructed until the node with value y is reached. The value from the node previous to y node is x we were looking for, since $y = F(x)$.

A problem in this procedure can happen because of false alarms. They arise because some value can have mul-

tiple occurences in the chains due to the fact that the output of F can be regarded as random. Consequently, it leads to merging of chains and results in irregular situations when either erroneous x is returned or x can not be found at all. A number of later proposals tried to overcome this problem of the Hellman's approach. One of the most significant improvements is based on *rainbow tables*, as described in [6].

3. TMTO IN RFID

With appropriate modifications Hellman's TMTO approach can be successfully applied in the area of radio-frequency identification (RFID).

RFID technology assumes three participants in the identification process: tag, reader and back-end server. The tag is a tiny device which contains a microchip with unique identifier stored into chip's memory and an antenna coil as a coupling element. It is inserted into an object which is to be identified. The reader communicates with the tags by radio waves (insecure channel), and with the back-end server using a secure channel. The back-end server has a database that contains information about the objects. It receives data from a reader and processes them (using own information) in order to identify the tag which sent the data.

RFID systems usually include very large number of tags, so the viability of their implementation practically depends on the unit cost of the tag. Necessity for a low-cost tag implies significant constraints on tag resources (predominantly memory space). It definitely guides some design decisions in choices/proposals of the protocols employed in RFID systems. The TMTO approach requires intensive calculations, so it can't be performed inside the tag. However, the back-end server has no such restrictions and can provide much more powerful resources. Rapid development of computer technology brings a constant enhancement of available resources. Consequently, some protocols are gaining the importance as time goes by *e.g.*, improved performance of state-of-the-art hardware can enable an increased number of tags that a system can support or speeding up the identification process of a tag. Also, it can enable the viability of some already proposed protocols practically infeasible at earlier stages of technology.

In an RFID system, TMTO approach can be used in the process of tag identification on the back-end server. The primary goal is to achieve the appropriate trade-off between available memory space and acceptable

tag identification latency. For a given back-end server configuration, we can establish the relations between parameters of importance (number of tags, number of tag accesses, amount of memory, precomputation time overhead, on-line identification latency) and determine its limits for which an RFID system can operate regularly. By adjusting these parameters one can influence the functioning of an RFID system.

4. CASE STUDIES

This section elaborates on two examples of the TM-TO-based RFID systems: OSK (Ohkubo, Suzuki, Kinoshita's) protocol and CTI (Constant-Time Identification) protocol. First, the original versions of the OSK and the CTI protocols are explained, and their TMTO-based enhancements are analysed afterwards.

OSK protocol

OSK belongs to the class of hash-chain protocols and it is described in [7]. In the preparation phase, every tag in the RFID system is initialized with two randomly chosen values. The identifier ID_i and inital state s_i^1 are associated with the i-th tag. State s_i^1 is stored into tag's memory, while the ordered pair (ID_i, s_i^1) is stored into database of the back-end server.

The protocol employs two hash functions, H i G, which can be executed both in the tag and on the back-end server. When i-th tag is queried by the reader, this tag generates $G(s_i^k)$, where s_i^k represents current tag state, and k is number of accesses to this tag until that time. The value generated in this way is sent to the reader. After that, the tag modifies its own state to value $s_i^{k+1} = H(s_i^k)$. Since the tag changes its state on each access, the set of subsequent tag states can be represented by a hash chain, where the value of the next node is obtained by applying H function on the value of the preceeding node.

After the reader receives some value it forwards this value to the back-end server which starts the identification of the tag that sent the value. In the process of identification, the back-end server generates hash chains by consecutive applying H function starting from tag's initial values s_i^1 (head nodes of the chains). The number of the nodes in a chain is m which also represents maximum number of the tag queries. The number of chains is equa to the number of tags. For each node in a chain G function is applied and obtained hash value is checked

on equality with the value received from the reader. If it is not equal, the next node is generated. If the current chain is exhausted, the next chain is started. If equality is found, then the head node of the current chain is the initial state of the tag that should be identified and its identifier can be easily found. The principal functioning of the OSK protocol is illustrated in Fig. 2. In this figure, comparator for matching the obtained value and result of G function is denoted by CMP.

For an RFID system with n tags, described identification procedure requires nm calculations (executions of hash functions, G or H). Because of its high computing complexity, the OSK protocol can be practically used only in systems with relatively small number of accesses (*i.e.*, $n = 2^{20}$, $m = 2^7$).

A significant enhancement of the OSK protocol (OSK/AO) was proposed by Avoine, Dysli and Oechslin in [8]. It was the first case that TMTO strategy is applied in the RFID area. An improvement is attained by more efficient procedure of tag identification on the back-end server. Following the TMTO approach, the pre-computation phase is introduced. During this phase, the OSK/AO protocol generates the chains whose nodes correspond to hash values that the tags can send. Hash values in a chain are intermixed and can be sent by different tags. The first and the last node of each chain is stored into a table. In the identification process, these stored data make the searching of tag state at the time it was queried by the reader more efficient. Unlike brute force approach of the original OSK protocol where on average a half of all chains are searched, the tag state in the OSK/AO protocol is found by reconstruction of only one chain.

The initialization of the RFID system with OSK/AO is performed in the same way as with the OSK protocol. Also, an additional overhead is incurred by generation of the chains with outputs of G function which the tags can send. It is considered that G function outputs the random values, so it isn't possible to produce next random hash value from a previous one directly during chain generation. Therefore, it was necessary to employ a reduction function R. From some random value this function produces a pair (p, q), where p is interpreted as an ordinal number of the tag, and q is the current number of accesses to the p-th tag. With (p, q) a value is calculated as $G(H^{q-1}(s_1^p))$, which represents one of the regular values that p-th tag can send. This value is assigned to the next node in a chain. This procedure is illustrated in Fig 3.
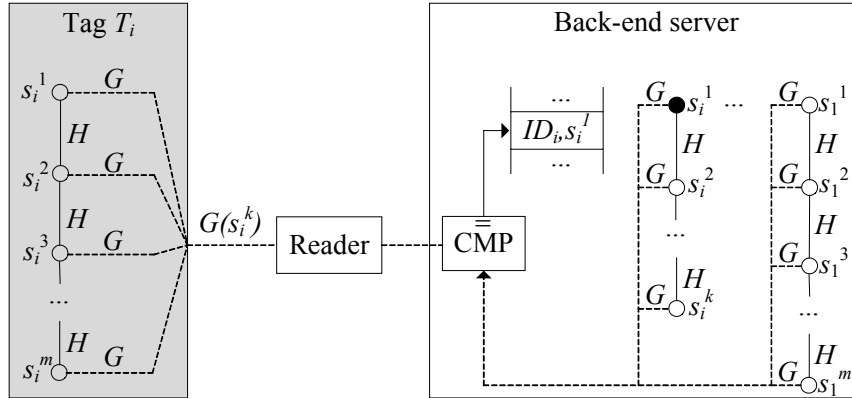
Fig. 2. Principal functioning of the OSK protocol
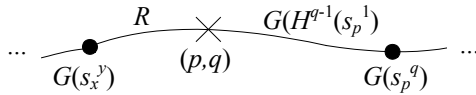
Fig. 3. Generation of the next node in a chain in the OSK/AO protocol

According to this procedure, the chains contain only hash values that the tags can regularly send, but in an arbitrary order. After a certain number of chains of pre-determined length are generated, only the values from the first and last node in each chain are memorized.

After the OSK/AO-based RFID system is initialized, its three components communicate in the same way as in its OSK-based counterpart. After each query, the tag modifies its state as explained previously.

When a hash value is received by the back-end server, the identification process for the tag which sent this value is started. Identification assumes the generation of an online chain whose starting node corresponds to the received value. Each subsequent node in the chain is generated in exactly the same way as in pre-computation phase illustrated in Fig 3. For each new node a check is made whether it corresponds to the ending node of any chain (searching the table stored in the initialization phase). If not, the next node is generated. If the end of some chain is encountered, the corresponding starting value is read from the found stored pair. Then, the chain is reconstructed until the node with the received this hash value is reached. By applying the R function on the value from the previous node, a pair of integers is obtained and the first element of this pair represents the ordinal

number of the tag which sent the value. In this way, the identification is successfully completed.

Since the output of the R function is a random pair (p, q), there is a possibility that the same hash value appears in the chain nodes more than once. It may result in identification of a wrong tag. Also, because of the restricted dimensions of the chains, it may happen that some hash value is not embedded in the chains at all, so the identification is impossible. In order to decrease the number of these irregular situations, in the initialization phase the OSK/AO uses the *rainbow tables* method [6].

The complexity of the OSK/AO algorithm in the preparation phase can be approximated to $nm^2/2$. Comparing to the OSK, an additional memory space is needed for storing the chain starting and ending points. However, complexity of the online identification in the OSK/AO is much lower since it can be calculated as a product of chain length and $m/2$, while it was mn in the OSK. Finally, an increased complexity of initialization phase is amortized by more intensive accessing of the tags.

CTI protocol

Just like the OSK, the CTI is a hash-based RFID protocol [9]. The basic idea of the CTI protocol is to achieve constant identification time for each tag in an RFID system at the expense of larger amount of memory on the back-end server. It is an entirely different approach from the OSK which has linear time identification complexity.

In a CTI-based RFID system, every tag has a secret key k, a secret pseudonym d and an internal counter c. The key and pseudonym are updated after each successful tag-reader mutual authentication, while the counter is incremented after each authentication (successful or

unsuccessful). When the counter reaches its maximum value C, it is reset to 0. The number of tags in the system is N_T, and the number of pseudonyms is $N > N_T$.

In the initialization phase, each tag is assigned with two random values k and d, while c is reset to 0. Also, a database with information neccessary for identification is built on the back-end server.

Functioning of the CTI protocol is illustrated in Fig. 4.

First, the reader addresses a tag by sending a random nonce r to it. The tag uses hash function h and calculates two values, $h(d,c)$ and $h(0,d,c,k,r)$, returns them to the reader which forwards the first value to the back-end server. Database on the server consists of three tables. The first table has 2^n entries, where n is the length of the truncated hash value $h(d,c)$. Each entry of this table contains a pointer to a mini-table inside the second table in the database. Each mini-table stores hash values $h(d,c)$ with the same position, i.e. the same n most significant bits. The second table with NC entries can store all the possible hash values that the tags can send. In addition to hash values, each entry is assigned with a pointer to an entry of the third table which stores the information about the tags corresponding to the given pseudonym. Each entry also contains the values c and d. The third table has N entries.

When a hash value M is received by the server, the identification process starts with extracting its n most significant bits. The extracted value (here dentoted as M^n) is used to address an entry of the first table. It further points to the appropriate mini-table containing hash values with the n most significant bits that correspond to M^n. If the mini-table has more entries, it is searched for the value M. When such an entry is found, its content is read and used as a pointer to the field of the third table which contains the data about tag currently associated to the pseudonym (secret key and identifier of the tag).

After that, a new pseudonym d' is selected from the pool of unused pseudonyms and it is sent to the reader, along with k and d. Then, the reader forwards these data to the tag in a way indicated by Fig. 4 preserving the authentication of the reader, as well as secure transfer and integrity check of the new pseudonym. After changing the tag's pseudonym, the pointers into the database must be updated. When the authentication of the reader is done, the tag sets its pseudonym to d', secret key to $k'=h(k)$, and c to 0.

Because of the multiple level of hashing, the CTI protocol is very time efficient. However, excessive large demands on memory makes its practical use questionable. For example, an RFID system with 10^9 tags, twice as more pseudonyms and 10^3 tag accesses demands the memory of 31TB (predominantly for the second table of the database - 19TB) [10].

In order to decrease the memory demands for implementation of the CTI protocol, in [11] Chang et al. proposed the modification of the original protocol by application of the time-memory trade-off approach in initialization of the database. The result is the modified CTI protocol named the CTI/TM. This protocol defines the function $F(i,j) = h(d_i,j)$ and the reduction function $R_t(x) = (i',j')$, where i' and j' depend on t and x. It can be regarded that these functions return the random values. The TMTO chains are generated by consecutive application of F and R_t functions on each node. The method of *rainbow tables* [6] is also used during this procedure. Finally, only the starting and ending nodes of the chains are stored into database.
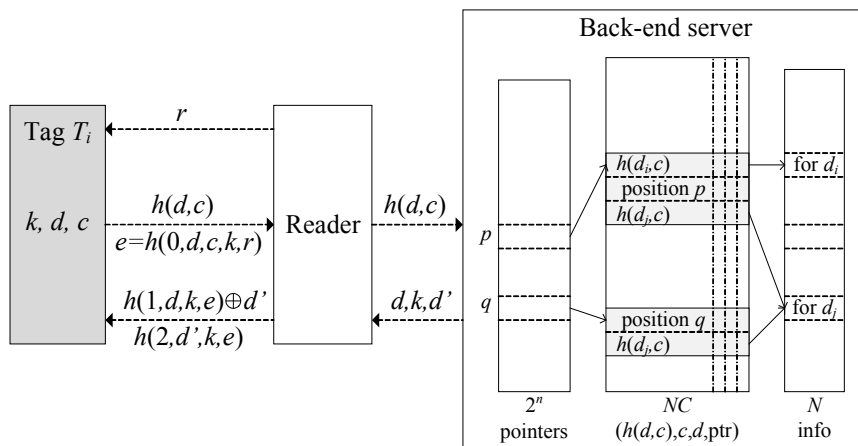
Fig. 4. Principal functioning of the CTI protocol

Besides the modified structure of the database on the back-end server, the CTI/TM implies some changes on the tags, too. Now, along with the h function each tag can use g hash function to increase randomness and decrease the probability of collisions.

According to the CTI/TM protocol, the communication starts when the reader addresses the tag by sending some random value r. Based on its current state, the tag calculates the following hash values: $m=g(c,k)$, $h(d,m)$ and $r'=h(0,d,m,k,r)$. Then, the counter c is incremented and two last hash values are sent to the reader which forwards them to the back-end server. Identification is performed by searching for the received value $h(d,m)$ in the stored chains in order to find the pair (d',c') which produced it. With the obtained pseudonym d', the key value k is read, and then an equality $r'=h(0,d',c',k,r)$ is checked. If it holds, the tag is properly identified and the subsequent procedure is the same as in the CTI protocol.

The CTI/TM protocol significantly reduces the memory demands. It can be shown that memory can be saved up to 89,5% in relation to the original CTI, still having large probability of successful identification.

5. DISCUSSION

As it can be concluded from the previous elaboration, the application of the Hellman's time-memory trade-off approach in RFID systems requires some modifications of the original protocol and its adaptation to a particular scheme. Although the OSK and the CTI schemes are quite different, the contexts of applying the TMTO method are very similar. Namely, in both cases, the chains store the hash values that the tags can send. Since these values can be regarded as random, its direct chaining (in the sense that one directly produces the other) is not possible. On the other hand, because of an enormous value space, the chains can not include all the values. A part of possible hash values that could be sent by the tags can be chained only by introduction of the reduction functions. During generation of each new node in the chain, the reduction function randomly selects the number of the tag and the ordinal number of the query for which the appropriate hash value is calculated. This procedure is probabilistic since it can happen that the same hash value appears in the chains more than once. Luckily, the probability of multiple occurence is insignificant (below 0,1%) because the tags use only a small part of value space.

Regardless of some similarities in applying the TMTO approach in to the OSK and the CTI protocols, the achieved effects are qualitatively different. In case of the OSK, the

TMTO approach led to the increase of the memory demands and decrease of the time overhead. Additional memory is spent for storing the starting and ending points of the chains, which enables faster tag identification by searching only one chain. In the CTI method, the TMTO approach exhibits the opposite effect. The memory demands are significantly reduced at the expense of increasing the tag identification time. The chaining of hash values from the second table on the back-end server and storing only starting and ending points of the chains saves considerable memory. However, identification was slowed down since the direct access to the tables is replaced by searching the chains.

6. CONCLUSION

It was demonstrated that cryptanalytical TMTO method can be effectively combined with the RFID technology for the sake of improving the efficiency and practical feasibility of an RFID protocol. Capabilities of the TMTO involvement are illustrated by the examples of two hash-based RFID schemes, the OSK and the CTI. In both cases, enhancements are achieved due to the chaining hash values that could be sent by the tags. Although these RFID schemes are the only examples of TMTO application in the RFID area, it is evident that the TMTO approach is quite flexible in balancing the time and memory complexity of the system for this specific purpose. Consequently, further research in applying TMTO in some other existing RFID system seems to be quite appealing.

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CRYPTOGRAPHY AND SECURITY

ATTACKS ON THE RSA ALGORITHM

Dragan Savić[1],
Slobodan Damjanović[2]

[1]Singidunum University,
Department for postgraduate studies
32 Danijelova Street, Belgrade, Serbia,

[2]Ministry of Defence Republic of Serbia,
Belgrade, Serbia

Abstract:

The aim of this paper is to provide an overview of the current achievements in the domain of public-key cryptography within the framework of existing knowledge in literature, international standards and best practice as far as the RSA algorithm is concerned. This paper is particularly dedicated to the attacks on the RSA algorithm, whereas the ways to defend are suggested. Methods of attacks on the RSA algorithm are given and further retrospective of results obtained during the research are separately treated in the final part of the paper through the description of attacks with use of force, low-exponent attack, chosen-plaintext attack and timing attack.

Key words:

RSA algorithm, cryptography, attack, symmetric and asymmetric cryptography.

1. ATTACKS ON THE RSA ALGORITHM

Cryptography based on the public key enables the access to the private key. With a couple of values (e, n) which represent the public key, the attacker can obtain the private key. By analogy, the attack on the RSA can be easily carried out if the exponent is known. In general, this type of the attack is called the brute forced attack.

The most effective attack against a RSA algorithm up to now has been the factorization of the number n. If the attacker factorizes n, he can easily discover $\varphi(n) = (p-1)(q-1)$ as well, and in this way define the secret exponent d from $d \equiv 1 \pmod{\varphi(n)}$ by using the Euclidean algorithm. The safety of the RSA algorithm lays in the factorization, namely at the factorization of n which has over 200 decimal digits with the primitive method of dividing by all simple numbers smaller than $\sqrt{n}$, with the help of a computer which is able to perform 10^9 divisions of this kind in one second, about 10^{81} years is needed for the factorization. Presently, the fastest algorithms need $O\left(e^{c(\log n)^{1/3}(\log \log n)^{2/3}}\right)$ operations for factorization, which means that not one polynomial algorithm is known for factorization. It is important to highlight that there are the cases when n is easier to factorize that normally. This is the case when the numbers p and q are very close to each other or if $p-1$ and $q-1$ have small simple factors. These cases should be avoided while choosing the parameter for the RSA's coding system.

Correspondence:

Dragan Savić

e-mail:

dragansavic.rm@gmail.com

Also, the attack based on the attempts to calculate $(p-1)\cdot(q-1)$, is possible, yet the time complexity of this attack is not easier than the previously described attack. It is possible to search directly for the number d, but it has been proven that this procedure is more complex that previously described possibilities.

There are several algorithms for factorization:

- division – represents the oldest and the least effective method, but it implies tryout of all primitive numbers smaller or equal to $n^{\frac{1}{2}}$ (the exponential complexity),
- quadratic Sieve algorithm – the fastest algorithm for the numbers smaller than 110 figures,
- Multiple Polynomial Quadratic Sieve – faster version of the previous algorithm,
- GNFS – General Number Field Sieve,
- SNFS – Specific Number Field Sieve.

The above-mentioned algorithms represent the best options for the attack on the RSA algorithm. The Sieve algorithms have the so-called super-polynomial complexity (sub-exponential), and the complexity of the Sieve algorithms with number fields asymptotically approach the polynomial behavior.

Table 1 shows the time in relation to the length of the code needed for a computer with 1 MIPS speed from the public key to the secret key[1]. Keys of 1024, 2048 or 4096 bits are used for the files encryption.

Time needed for calculating the secret key from the public one	
Length of the key in bits	*Time needed*
50	3.9 hours
100	74 years
150	10^6 years
200	$3,8*10^9$ years

2. THE ATTACK ON THE RSA ALGORITHM BY USING A SMALL EXPONENT

It appears that, if the e is relatively small, it does not influence the safety of the RSA algorithm itself. If the exponent for the coding is small (for example 3, 17, 65537), the operation of coding is much faster. The only drawback of the usage of the small exponent is visible in the coding of short messages if the exponent is chosen. If we assume that we have three users with various values of the public module n_1, n_2, n_3 and that they use the same public

exponent $e = 3$. Then, we assume that someone wants to send the identical message m. Yet, we have already seen if any relatively simple exponent with $\varphi(n)$ is fine, that we can easily choose $n=pq$ so that the number 3 is a relatively simple number $(p-1)(q-1)=\varphi(n)$. Now, the coding of m message, $m^3 \bmod n$. Only then the adversary can discover the following ciphertext

$$c_1 \equiv m^3 (\bmod\, n_1), c_2 \equiv m^3 (\bmod\, n_2), c_3 \equiv m^3 (\bmod\, n_3)$$

After that, the adversary can find the solution of the system of linear configurations by using the Chinese theorem on the remainder

$$x \equiv c_1 (\bmod\, n_1), x \equiv c_2 (\bmod\, n_2), x \equiv c_3 (\bmod\, n_3)$$

In this way, the adversary will get the number x with the characteristic $x \equiv m^3 (\bmod\, n_1 n_2 n_3)$

However, having in mind that $m^3 < n_1 n_2 n_3$ is equal to $x = m^3$, so that the adversary can calculate the original message m and discover $\sqrt[3]{x}$.

This attack has been described by Coopersmith, Franklin, Patarin and Reiter.

If we code an open text m and then $m+1$. The above-mentioned authors claim that m could be discovered. We have the following coded text:

$$c_1 = m^3$$
$$c_2 = (m+1)^3 = m^3 + 3m + 3m^2 + 1 = c_1 + 3m + 3m^2 + 1$$

Now we are trying to solve m. The next step is:

$$\frac{c_2 + 2c_1 - 1}{c_2 - c_1 + 2} = \frac{(m+1)^3 + 2m^3 - 1}{(m+1)^3 - m^3 + 2} = \frac{3m^3 + 3m^2 + 3m}{3m^2 + 3m + 3} = m$$

This can be generalized. Firstly you can generalize the message m and $\alpha m + \beta$ for the known α, β. Secondly, it works for the exponents bigger than 3. That the attack works in the timeframe $O(e^2)$ and it is possible for small exponents. Finally, it can work for k messages related to the higher degree of polynomials.

Another way – if we choose number 3 for e and if we take $M < n^{\frac{1}{3}}$ (the message shorter than $\sqrt[3]{n}$), the message can be easily decoded by the operation $M^{\frac{1}{3}} \sqrt[3]{M}$ as:

$$M^3 \bmod n = M^3, \text{ if } M \leq n^{1/3}$$

i.e.: $M < n^{1/3} = M$

Coding and verification of signatures with the help of the RSA algorithm are faster if the small value is used for e, it can be uncertain as well. If you want to code $\frac{e(e+1)}{2}$ of the linear dependent messages with different public keys which have the same values e, that kind of the system can be attacked. If a message has a smaller number or if they are not related, no problem can arise. If the messages are identical, the e message is sufficient.

The simplest solution is to expand the messages with independent random values. "A random pad" is added to the messages prior to the coding. In this way, we would never send entirely identical messages. It this way $m^e \bmod n \neq m^e$ is also secured. This is done in most of the realizations of the RSA algorithm, for example PEM and PGP. However, there are attacks based on the Coppersmith's result and LLL algorithm which indicate that neither the RSA coding system with small exponent e is safe.

More precisely, the Coppersmith's result is used (1997):

If $f \in Z[x]$ nominal polynomial s degree δ , also $n \in N$. If x_0 exists so that $f(x_0) \equiv 0(\bmod n)$ and $|x_0| \leq X = n^{\frac{1}{\delta - \varepsilon}}$, than x_0 could be found in the timeframe which is polynomial in $\log n$ and $\frac{1}{\varepsilon}$.

The next attack in this category is Hastad's attack (1985). If we assume that the data depending on the user is added before the coding at the beginning of each message, for example

$$c_i = \left(i \cdot 2^h + m\right)^e \bmod n_i, i = 1, \dots, k.$$

We have k of the polynomial $g_i(x) = \left(i \cdot 2^h + x\right)^e - c_i$ and we look for m with characteristic

$$g_i(m) \equiv 0(\bmod n_1)$$

If $n = n_1 n_2 \dots n_k$. By using the Chinese theorem on the remainder we can find t_i so that

$$g(x) = \sum_{i=1}^{k} t_i g_i(x) \text{ and } g(m) \equiv 0(\bmod n)$$
$$\left(t_i \equiv 1(\bmod n_i), t_i \equiv 0(\bmod n_j)\right) \text{ for } j \neq i$$

The polynomial g is normalized and the degree e . If $k > e$; $i.e.$ if we have several users (intercepted ciphertext) than the public exponent, than $m < \min_i n_i < n^{\frac{1}{k}} < n^{\frac{1}{e}}$, so m can be effectively found by using the mentioned Coppersmith's result.

The next attack of the type "low exponent of decoding" on the RSA algorithm was discovered by Michael Wiener (1990). This type of the attack d is reconstructed, where d could reach maximum of one fourth of n , while e is less than n.

$$ed - k\varphi(n) = 1$$
$$\varphi(n) \approx n \Rightarrow \frac{k}{d} \approx \frac{e}{n}$$

If $p < q < 2p$. If $d < \frac{1}{3}n^{0,3}$, than

$$\left|\frac{k}{d} - \frac{e}{n}\right| < \frac{1}{2d^2}$$

According to the classical Legendre's theorem from Diophantine approximations, d must be the directory of a convergent p_m/q_m in the development of the continued fraction of the number e/n, so that d can be effectively calculated from the public code (n, e). The number of convergent in total is $O(\log n)$, while each convergent can be tested in polynomial time.

Here we have to mention Verheul – van Tilborg attack as well (1997) which represents the expansion of Wiener's attack which is applicable when d has several more bitss than $n^{0,25}$. For $d > n^{0,25}$, their attack uses the search by brute force for $2t + 8beats$ with certain assumptions to partial quotient in a continued fraction, where $t = log_2(d/ n^{0,25})$.

Also, the Boneh – Durfee (1990) and Blomer – May (2001) attacks belong to this type of an attack. They are based on the Coppersmith's technique which uses LLL-algorithm for calculating the small roots of modular polynomial equations. These attacks are »heuristic«, and in the practice they are satisfactory if $d < n^{0,292}$.

It is believed that the secret exponent $d > \sqrt{n}$ should be used, as it is known that all the above-mentioned attacks are completely useless in that case.

A small modification of the Verheul – van Tilborg attack was made in 2004 based on Vorli's result (1981) from Diophantine approximations, which means that all rational numbers p/q which satisfy the inequalities

$$\left|\alpha - \frac{p}{q}\right| < \frac{c}{q^2},$$

For a positive realistic number c , are in the form

$$\frac{p}{q} = \frac{rp_m + 1 \pm sp_m}{rq_m + 1 \pm sq_m}$$

For a $m \geq -1$ and non-negative whole numbers r and s in the way that $rs < 2c$.

Ibrahimpašić (2008) claims that Vorli's result is the best possible, in the sense that the condition $rs < 2c$ cannot be replaced by $rs < (2-\varepsilon)c$ for $\varepsilon > 0$.

In the both mentioned expansion of the Winner's attack, candidates for the secret exponent take the form of

$$d = rq_{m+1} + sq_{m+1}.$$

All the possibilities for d are tested, while the number of all possibilities is roughly speaking (the number of possibilities for r) x (the number of possibilities for s), which is $O(D^2)$, where $D = d/n^{0,25}$.

More precisely, the number of possible couples (r, s) in Verheul – van Tilborg attack is $O(D^2 A^2)$, with

$$A = \max\{a_i : i = m+1, m+2, m+3\}$$

While in Andrej Duella's variant from 2004 is $O(D^2 \log A)$.

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The new modification of the Verheul – van Tilborg attack was proposed by Sun, Wu and Chen (2007). This modification requests heuretical search by brute force for *2t - 10* bits, so its complexity is also $O(D^2)$.

Drastic improvements cannot as Steinfeld, Contini, Wang and Pieprzyk (2005) proved that among the algorithms of this type there is not an algorithm with sub-exponential dependence on D.

3. THE ATTACKS ON THE RSA ALGORITHM BY USING THE CHOSEN CHIPERTEXT

The attack on the RSA algorithm by using the chosen chipertext attack is based on the presumption that the attacker in some way manages to find the chipertext of his choice.

The attacker taps the communication channel over which the RSA coded messages are exchanged, discovers the message C, in a way that he wants to discover its original content, *i.e.* mathematically he was to discover:

$$M = C^d \bmod\ n$$

With the assumption that the attacker knows the public key (e, n), in order to obtain M the attacker firstly chooses a random message R, where $R < n$, than he codes the message with the public key:

$$X = R^e \bmod\ n$$

Chipertext message C is multiplied by using the X: $Y = X \cdot C \bmod n$

Also, the attacker calculates the modular inverse values from R: $T = R^{-1} \bmod\ n$

While the attacker assumes that:

$$X = R^e \bmod n,\ and\ R = X^d \bmod n$$

The attacker must wait for the user to digitally sign Y with his private key, which is how he effectively decodes Y, and sends $U = Y^d \bmod n$ to the attacker. The attacker must calculate the following:

$$T \cdot U \bmod n = \left(R^{-1} \bmod n\right) \cdot \left(Y^d \bmod n\right) \bmod n =$$
$$\left(R^{-1} \bmod n\right) \cdot \left[\left(X \cdot C \bmod n\right)^d \bmod n\right] \bmod n =$$
$$\left(R^{-1} \bmod n\right) \cdot \left[\left(X \cdot C\right)^d \bmod n\right] =$$
$$\left(R^{-1} \bmod n\right) \cdot \left[\left(X^d \bmod n\right) \cdot \left(C^d \bmod n\right) \bmod n\right] \bmod n =$$
$$\left(R^{-1} \bmod n\right) \cdot \left[R \cdot M \bmod n\right] \bmod n =$$
$$R^{-1} \cdot R \cdot M \bmod n = M$$

4. TIME BASED ATTACK ON THE RSA ALGORITHM

Amelioration of the cryptography based on the public key has revealed some facts and regularities. For example the modular and exponential operations used for the RSA algorithm request discrete time intervals. If the RSA operations are carried out by using the Chinese Remainder Theorem, the attacker can use small time differences while conducting the RSA operations, and that way in many cases discover *d*. This type of the attack is based on passive tapping of the RSA operations.

The attacker passively observes k operation and measures the time T needed for calculating $M = C^d \bmod n$.

The assumption is that the attacker recognizes C and n. This method will enable someone who knows the exponents $d_0, d_1, ..., d_{s-1}$ to discover the bit d_s; obtain the exponent d, starting from d_0, repeating the attack until he discovers the entire exponent $d = d_0, d_1, ..., d_{s-1}, d_s, ..., d_\beta$. Now, we start from d_0 the least important bit in comparison to *d*. Having in mind that d is an odd number, we know that $d_0 = 1$. In this phase we have: $d_0 = 1$, $M \equiv C$, $C \equiv C^2 (\bmod\ n)$.

Than we consider d_1. If $d_1 = 1$ than the victim will have to do $M \leftarrow M \cdot C(\bmod\ n)$, $C \leftarrow C^2 (\bmod\ n)$ if $d_1 = 0$, than $C \leftarrow C^2 (\bmod\ n)$.

If t_i is needed for the hardware calculation $M_i \cdot C_i \equiv M_i \cdot M_i^2 (\bmod\ n)$. Of course, t_i is different one from the other, as the time for calculation $M_i \cdot M_i^2 (\bmod\ n)$ depends on the value of M_i.

This attack requests monitoring of the cryptographical operations in the real time, which to a larger extent limits the possibility to carry out the attack itself.

5. ATTACKS ON THE RSA ALGORITHM OF THE TYPE OF "JOINT MODULUS"

One of the possible realizations of the RSA algorithm gives the same value *n*, but different values for exponent e and d. Sadly, this does not function. The most visible problem is: if the same message is ever coded with two different exponents (both have the same modulus) and the two exponents are coprime (as in the general case), then the open text can be reconstructed without a single decoding exponent.

If *m* message is in the form of an open text, the keys for the decoding are e_1 and e_2. Joint modulus is n. Two decoded messages are: $c_1 = m^{e_1} \bmod n$ and $c_2 = m^{e_2} \bmod n$.

A cryptanalyst knows n, e_1, e_2, c_1, c_2. The description of the way it is being reconstructed m follows.

As e_1 and e_2 are coprime, by expanded Euclidean algorithm can be found r and s, so that: $re_1 + re_2 = 1$.

Assuming that r is negative (or r or s must be negative value, why we consider the r is negative), then the expanded Euclidean algorithm can be again applied in order to calculate c_1^{-1}. Than $\left(c_1^{-1}\right)^{-r} c_2^5 = m$.

There are two other treacherous attacks on this type of the system. One uses probability method for factorizing n. The other uses algorithm for calculating someone's secret key for factorizing the module. Both attacks are described in detail in [95].

Do not allow a group of users to share a single n.

6. THE ATTACK ON CODING AND SIGNING BY THE RSA ALGORITHM

It makes sense that a message is signed before coding, but not everyone sticks to this rule. When the RSA algorithm is used, the attack can be carried out on the protocols doing the coding before the signing.

Alice wants to send a message to Bob. She firstly codes the message with Bob's public key, then signs with her private key. Her key and the signed message look like this:

$$\left(m^{e_B} \bmod n_b\right)^{d_A} \bmod n_A$$

The description of how Bob can claim that Alice sent him $m`$, and not m. Bear in mind the following: as Bob knows the factors n_B (his modulus), he can calculate discrete algorithms in relation to n_B. That's why, he is supposed to discover x so that: $m' = m \bmod n_b$.

Then, if he can give xe_B as his new public exponent and keeps n_B as his modulus, sent him the message $m`$ coded with this new exponent.

7. CONCLUSION

It could be concluded that the RSA algorithm for four decades after having appeared still represents the safe solution, whose usage with up to know techniques of attacks is still safe. This claim is rooted in the fact that even though the detailed studying of the RSA algorithm is ongoing, a method has not yet been discovered that would completely destroy the RSA. Everything comes down to discover individual weaknesses, which gives a warning how to choose parameters for the implementation of the RSA. All this enables that the RSA, for the time being, is assessed as a safe cryptosystem.

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ON MITIGATION OF MODERN CYBERCRIME THREATS

Miloš Jovanović[1],
Nikola Rančić[1],
David Davidović[2],
Dragan Mitić[3]

[1]Singidunum University,
Department for postgraduate studies
32 Danijelova Street, Belgrade, Serbia,

[2]Union University,
Faculty of Computer Science,
Knez Mihajlova 6/VI, Belgrade, Serbia

[3]Metropolitan University
Faculty of Information Technology,
Tadeuša Košćuška 63, Belgrade, Serbia

Abstract:

As the infrastructure that humans heavily rely upon grows is dependent on modern technology and the Internet, the damage that can be done by exploiting vulnerabilities in these systems becomes more significant and worrisome. The extent of these threats' possible impact cannot be overstated, as the amount of sensitive information stored in information systems and the actions that they are permitted to perform have been continuously heightening since the beginning of the information age. We present a review of representative examples of security incidents that had put a large number of such systems at risk of abuse, with many of them having withstood documented exploitation "in the wild". We analyze the circumstances that lead to the presence of these security threats, as well as the way they were handled in terms of disclosure and urgent fixes to the affected software. Finally, we also suggest methods which could have possibly prevented these vulnerabilities or lowered their attack surface if they had been applied timely.

Key words:

cybercrime, information security, vulnerability mitigation.

1. BACKGROUND

As Christ (2002) points out, even almost 15 years ago, the growth of the Internet (more precisely, the metric considered is the total count of reachable web servers on publicly accessible IP ranges), exponential in nature, presented unique challenges to the technology underlying it. Today, the communication standards and protocols used at the time are long superseded by their newer versions or solutions that are completely redesigned from the ground up, which is only natural for quickly evolving technology that needs to keep pace with the explosion of its use. The same holds for software used as the backbone of these communications: from network drivers that provide advanced routing features to web and e-mail servers operating at the top of the OSI networking model (ISO/IEC 7498-1:1994). Some notable examples include:

- ◆ Protocols and standards:
  - HTTP/1.0, the first iteration of the Hypertext Transfer Protocol, has been abandoned in favor of HTTP/1.1 which is now the dominant method of serving web pages on the Internet. HTTP/1.1 is, in turn, being built upon and improved with the introduction of efforts such as Google's SPDY (Chromium

Correspondence:

Miloš Jovanović

e-mail:

mjovanovic@openlink.rs

Project 2009) and the recently standardized HTTP/2 (Belshe *et al.*, 2015) which is, as of the time of writing, supported by 6.7% of the top 10 million websites by popularity (W3Techs 2016a).

- Plain TCP as an unencrypted stream transport protocol for WAN communication is largely being abandoned in favor of protocols providing authenticity and confidentiality of the transmitted communication. These protocols themselves have gone through a large number of iterations, many of them because of identified security flaws. These include, among others, SSLv3 (Freier *et al.* 2011) and TLS, whose current standardized version is TLSv1.2 (Dierks and Rescorla 2008).

- HTML, CSS and JavaScript, the standards used for development of website front-ends, have undergone possibly the most significant changes of all, mainly because of the constant demand for more immersive and advanced web experiences by consumers, companies and enthusiasts alike. Among these, the most recent iterations are HTML5 (W3C 2014), CSS3 and ECMAScript 6 (ECMA 2015). It is important to note that for the former two, the version number is more of a formal nature, as new features are constantly being added and refined by means of feature proposals, browser adoption, and, finally, standardization.

- ◆ Software:
  - Networking drivers and routing strategies used by operating systems running on servers and on embedded routers, firewalls and other networking-capable devices have undergone heavy improvement in order to adapt to higher throughput and responsiveness requirements without the need for heavily increasing the needed resources.

  - The landscape of HTTP server market share, once unanimously led by Apache (which still leads with over 50% of total usage), is now significantly more fragmented, with newer technology (most notably the Nginx web server) taking up more than 30% of the total amount (W3Techs 2016b).

  - E-mail servers, CMS solutions, server monitoring, analysis and deployment tools, and many others used today bear no resemblance to the technology comparably used in the past.

It is thus evident that the requirement of fast-paced evolution and iterative improvements, also reflected in recent trends within software engineering itself, such as agile software development (Cohen *et al.* 2003) exists and dictates much of the development within this field. However, such a steep rate of innovation leaves a lot of space for mistakes and insufficient quality assurance of these types of products.

Wall (2007) suggests, and the authors agree, that the types of crime brought about by the information age present a more persistent and worrying threat than is perceived by many entities, most significantly, the organizations and individuals that develop and maintain software and standards needed to keep the rate of technological advancement constant or growing, and at the same time keep that software reasonably secure and immune to a wide range of security exploits.

Nevertheless, it is clear that the industry has mechanisms in place to appropriately deal with the existence and mitigation of such threats, but the level of adoption and enforcement of those mechanisms still has room for improvement, all in the interest of minimizing risk for consumers and organizations relying on these software systems for personal, business, financial or other needs.

2. VULNERABILITIES IN THE RECENT YEARS

As the topic of cybercrime is more popular than ever before among technology journalists, hobbyists, privacy advocates, security researchers, and other groups, it is of no surprise that high-profile security vulnerabilities garner much attention in the public. Below is given a brief and, unfortunately, incomplete list of some more heavily publicized and threatening instances of such oversights.

CVE-2014-0160 (Heartbleed)

A discussion touching on these issues cannot be complete without first mentioning one of the most significant and publicly known software security issues in the recent history of computing: CVE-2014-0160, or more commonly (and memorably) known as *Heartbleed* or the *Heartbleed bug*.

CVE-2014-0160 is a bug in OpenSSL, a software library aiming to provide a complete solution for implementing SSL/TLS protocols mentioned earlier in this article, both on the server and client side. OpenSSL, at the highest level, supports transparent secure communica-

tion between endpoints on a network where an adversary might be able to passively capture or actively alter the traffic (for a more in-depth description of the security guarantees these protocols make, refer to the relevant RFCs by the IETF). To achieve this goal, OpenSSL has had to provide many other features: it includes a library implementing a vast array of cryptographic primitives (ranging from symmetric block cipher and elliptic curve cryptography implementations to secure key exchange protocols) and support for parsing, verification and manipulation of X.509 certificates, among others. Bearing this in mind, it is not surprising that OpenSSL is a big library with many separate organizational units interacting in complex ways.

The root cause was a failure of code that dealt with packets regarding the TLS *heartbeat* extension to explicitly check if the advertised size of a byte string in a packet matched its real size. This effectively lead to an out-of-bounds memory read and subsequent disclosure of this information to the attacker, meaning that software using vulnerable OpenSSL versions would leak contents of arbitrary memory locations, leading to possibly disastrous scenarios (MITRE 2014a). The OpenSSL project was informed of the issue beforehand and had supplied a fix for the bug before it was disclosed to the public.

As a vast majority of web servers use OpenSSL as their library of choice for implementing HTTPS (HTTP through SSL/TLS) support, the impact of this bug was extremely high (Durumeric *et al.*, 2014) so high, in fact, that it spawned forks of OpenSSL such as LibreSSL (by OpenBSD developers) and BoringSSL (by Google) that aim to trim down OpenSSL's codebase and employ other methods of reducing the risk of such issues in the future.

CVE-2014-6271 (Shellshock or the Bash bug)

A vulnerability comparable to *Heartbleed* in scope and impact is surely CVE-2014-6271, which has also had considerable media exposure and thus gained the, among the public perhaps more recognizable, nickname of *Shellshock* or the *Bash bug*.

GNU bash (*Bourne-again shell*) is a Unix shell and language first released in 1989, as a replacement to the then-dominant but non-free *Bourne shell.* A shell has been an ubiquitous component of almost all Unix-based systems from the beginnings of Unix - it is used as the basic text-based user-system interface, a script language and a "surrogate process" capable of spawning new processes in a precisely defined environment. The latter use plays a key role on the discussed vulnerability, as there

are very few nontrivial programs that do not spawn the default shell at some point, and GNU bash, being the default shell on a lot of systems, presents an attractive and widely critical attack surface.

The bug is caused by a flaw in the parsing logic of GNU bash, whereby specially crafted and non-sanitized environment variables could cause arbitrary code execution in the context of the user and process spawning the shell: namely, the feature of function definition within environment variables could be abused to execute code regardless of whether or not the function is actually called (MITRE, 2014c). The GNU project was responsibly informed and had supplied a fix before the knowledge of the bug was made public.

Some web servers (those using CGI, a dated technology for dynamically generated web content that is still being used), e-mail clients and similar software did rely on the default shell for part of their functionality and supplied it with user-provided input, which led to a direct remote code execution vulnerability. The count of publicly accessible and servers vulnerable to this issue was considerable (Delamore and Ko, 2015).

Other examples

As a thorough analysis of other vulnerabilities is beyond the scope of this article, some examples which were not as publicized and whose impact was not as high, but nonetheless appropriately illustrate the nature of contemporary security-critical software bugs, will be given in more compact form.

- CVE-2016-0800, dubbed the *DROWN attack* by its creators, uses an SSLv2 and TLS enabled server to perform a cross-protocol attack that retrieves the plaintext of passively collected communication between the server and a user. It achieves this by using the SSLv2 endpoint as a Bleichenbacher padding oracle in order to unmask session keys negotiated with the TLS endpoint and a victim, and also relies on a previously known bug in OpenSSL to speed up the attack. According to the authors, more than 20% of tested hosts were vulnerable at the time of disclosure (Aviram *et al.*, 2016; MITRE, 2016).
- CVE-2015-0235, also known as *GHOST*, is a buffer overflow bug in *glibc*, the most widely used implementation of the C standard library, which almost every computer program directly or indirectly relies upon on modern systems. The bug was located inside a function whose task was to

perform network address lookups, and as such exposed almost all software that used the network in some way to risk. Qualys, the company that discovered the bug, claims that they have created a proof-of-concept exploit that uses this vulnerability to remotely execute arbitrary code via *Exim*, a popular e-mail server (MITRE, 2015). It is worth noting that the exploit in question was never made public.

◆ CVE-2014-3153, a serious vulnerability interesting for both its impact and difference from the ones previously mentioned, is a privilege escalation exploit within the Linux kernel where a non-privileged attacker could gain privileged access to a system, abusing a bug in the *futex* (*fast user-space mutex*) subsystem of the kernel where a paused privileged worker thread could be made to, by manipulating its stack, transfer execution to arbitrary locations when woken up (MITRE, 2014b).

3. MITIGATION

When looking at these vulnerabilities—subjectively—in hindsight, it would appear reasonable to believe that they are caused by carelessness on part of the developers. The steps to exploit most of them are not complex and are well within the budget or knowledge of any competent computer programmer or security researcher. However, these kinds of mistakes do happen in some quantity regardless of the amount of care or expertise of the development team or individual. Thus, it also seems reasonable for programmers to expect that there are the ways to of early discovery (before vulnerable code is released) and that tools and workflows they use should do their best in order to promote safe coding practices and prevent or minimize the impact of such issues.

In that spirit, we have identified some key areas which can possibly lead to minimization of these types of threats. Worthy of note is that it is exactly these kinds of threats that can be and are used, as has been demonstrated by Wall (2007), for nefarious purposes and serious compromise of individual privacy and safety and putting the whole businesses in jeopardy. Additionally, they pose a threat to state-level security and enable further and even more serious criminal activities.

Software testing

Automated unit and integration testing of software products has been practiced and its importance has been known for a long amount of time (Zhu *et al.*, 1997). The development of advanced fuzzy testing utilities such as the *American Fuzzy Lop* (Zalewski, 2016) has made it easier to find unexpected bugs and issues not covered by traditional unit and integration testing methodologies, and tools for static analysis of programs have come a long way to predict and pinpoint possible causes of bugs early in the development process of a particular feature or component. However, these kinds of tools are alleged not to be used by developers as often as they ought to (Johnson *et al.*, 2013).

On the other hand, 100% code/branch coverage requires a lot of effort in order to be maintained at that level, and programmers view writing tests as a notoriously unimaginative use of their time. This issue is something that is better dealt with economically, by giving programmers working on security-critical code better incentives for maintaining a high level of code coverage, or by (optimally) delegating that matter to competent quality assurance engineers whose only focus would then be to keep the product thoroughly automatically tested after every change.

Security audits

Independent researchers, mostly for economic-, reputation- or enthusiasm-driven reasons, often conduct security audits of popular software that is heavily relied upon for security, or is a component in a considerable amount of systems where it can cause further security issues if vulnerable to attacks in some way. Often, these reviews are performed by companies and organizations specializing in software security, cybercrime prevention and related fields, in order to gain recognition for uncovering one or more vulnerabilities and possible attacks, or for purely ideological reasons of improving the state-of-the-art.

In the wake of "Snowden revelations", cybersecurity has become a politically polarized subject, a characterization that can possibly be put to good purpose: security-minded individuals and organizations alongside those who care about the cause of secure computing and mitigation of related threats can sponsor (through donations, crowdfunding and similar means) big audits and reviews of existing and relied upon software in order to achieve further guarantees of its safety and proper design.

Of course, this is not limited to full-scale audits of software. Code review by a maintainer or a more experienced developer should be mandatory, not optional, and should be enforced on every code commit. This

allows developers who are more innately familiar with the codebase to spot early problems that may arise due to complex interactions between separate modules, which cannot be achieved with an incomplete understanding of the project's code.

Safer programming languages

OpenSSL, a library that has been the target of many recently uncovered vulnerabilities, is written in C, and so is the entirety of almost all Unix-compatible kernels currently in active use, which are the cornerstone of a majority of web servers in the world at 68% (W3Techs, 2016c), smartphone devices, routers, hardware firewalls and even home appliances.

C is a language first designed in 1978 and not receiving any significant, fundamental standards update since the present day. It is perhaps obvious that the kind of programming language which, for instance, does not provide any memory safety guarantees and which is, in comparison to presently available languages, a thin abstraction around low-level assembly, is ill-suited for the kinds of uses it is being put to today. With the availability of many safer, significantly more modern, less error-prone and mostly just as performant programming languages, a long-term goal of using them instead of lower-level alternatives (where possible) can lower the number of critical security vulnerabilities that are now being discovered on a monthly basis.

Among languages that are better suited for this particular use-case, the authors would like to highlight *Rust* (Mozilla, 2016), an open-source effort by *Mozilla*, which is explicitly designed for safe network and systems programming, and by design prevents several classes of behavior that are known to have been the biggest sources of critical vulnerabilities to date (namely, memory safety violations and race conditions).

Economical incentives

Software that is used to power most of the modern web is, in big part, free/libre software or open-source (among many examples are Linux, Apache, MySQL, PHP, Redis, *etc.*), which tremendously helps their users by allowing them to modify and tweak their behavior, benefit from the work of the community as a whole and remove the financial barriers to using fast, robust and safe software. On the other hand, developers working on free/libre and open-source software are mostly not compensated for their work, and consider it a hobby, yet are able to create

functional and well-performing tools that are used and relied upon by big organizations and causes.

Donating and encouraging donations to these projects, especially by entities that have significantly benefited from their use, can help in the long-term by creating a more favorable position and allowing the maintainers and active members of the project to dedicate more time to further refining the piece of software, testing it and improving its quality in terms of both performance and safety.

4. CONCLUSION

As we have seen, unfortunately, there is no shortage of high-profile security vulnerabilities that open up attack surfaces for serious compromise of information systems used nowadays. Most of these vulnerabilities have been brought about by either lack of manpower on complex software projects (as is mostly the case with OpenSSL), sparsely tested legacy code (as is mostly the case with Bash), and other factors and combinations thereof.

We believe that the proposed high-level means of mitigating these kinds of threats can prove fruitful in the long run, as the principles behind them have been well known and thoroughly proven effective in the software engineering and security industry for a long time, though their application, in our opinion, has not been widespread enough to prevent these issues or significantly lower their impact.

Finally, we believe that, while our proposed methods involve more up-front investment, the economic and humanitarian damage effected by the multitude of security-critical bugs that compromise individual, as well as corporate privacy and integrity, far outweighs the possible downsides of implementing these security practices. As such, we encourage organizations, individuals, software developers, project maintainers and other involved parties to consider the facts presented and draw their own conclusions about the usefulness of our proposed approach.

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NEW TRENDS OF BIOMETRIC SYSTEMS BASED ON FINGERPRINT

Edin Ćatović,
Saša Adamović

University of Sinergija,
Bijeljina, The Republic of Srpska, B&H

Abstract:

Generally speaking, biometrics can be defined as a recognition of individuals based on their behavior or biological unique characteristics. Fingerprints are taken by pressing a finger against a paper or platen surface on a sensor. However, due to skin deformations, external influences, irregularities in the sensor area, *etc.*, we often have incomplete or degraded sample images. When this happens, many issues within institutions that use this kind of technology can occur. For example, employees cannot check-in or checkout, which can sometimes influence important deadlines. As a result of many years of research, a whole new generation of Touchless 3D scanning devices was developed and is already available on the market. This new technology of scanning does not have these issues and it functions in a similar way, although it has many significant improvements. In this paper, a brief comparison of original methods, two-dimensional and three-dimensional biometric systems will be presented. [1] Hardware and software solutions will also be analyzed. Some of the key problems, such as shadows, background, reflections, sample irregularities, *etc.* will be mentioned as well.

Key words:

biometrics, fingerprint scanning, touchless, 3d fingerprint, recognition systems.

1. BIOMETRICS

Biometrics is a science that deals with the measurable physical characteristics and/or behavioral characteristics. This term comes from the Greek words bios (life) and metron (measure). Standardized definitions of biometrics are "automated identifying individuals based on their behavioral and biological characteristics" (Bidgoli, 2006, p. 498). Some of the most common biometric physical characteristics include: fingerprints, hand geometry, iris, retina, facial features, thermograf face, vascular patterns (arrangement of veins), smell and DNA. The examples of behavioral biometrics include: signing, contracts, walking and typing on the keyboard. Biometrics were regulated and defined in accordance with the ISO (International Organization for Standardization) requirements. [2]

Biometrics relies on the recognition of keystroke, gait, voice, signature, and unique biological characteristics like face, retina, iris, hand geometry, DNA, palmprint, *etc.* Fingerprint biometrics has a wide range of applications in the areas of civil society, military industry, legal proceedings, *etc.* One of the most important methods that biometrics realies heavily on is the Fingerprint Scanning. [3] This biometric method is based on

Correspondence:

Edin Ćatović

e-mail:

cattovic@gmail.com

enrollment databases, which are used in protection of our country borders, criminal identifications and identity recognition. Figure 1. describes and compares different types of biometric characteristics.

Type	Stability	Accuracy	Signal acquisition	Applications
Physiological characteristics	Relatively stable	Accurate	Easy	Widely applicable to all three functions of biometrics
Behavior characteristics	Not very stable	Somewhat accurate	Easy	Mostly used for authentication, or combined with other biometrics for authentication/identification
Psychological characteristics	Very unstable	Not accurate	Very difficult	It is still in the early stage of development. Possibly used for spoof protection in extreme high security environment

Figure 1. Biometric characteristics types comparasion.

2. BIOMETRIC SYSTEMS

The traditional security systems are based on swipe/ID cards, passwords, keys, tokens, and identity cards that proove a person's identity. As a result, passwords are often forgotten, stolen or used by an unauthorized person to access various private data, bank accounts, cars, houses, *etc.* Due to the rising importance of the IT in people's lives, new ways of data and bank account protection, that do not require memorizing numerous passwords, are on a high demand. One of the recently developed technologies for this purpose is biometrics.[4]

Biometric systems are mostly based on two steps, biometric enrollment (Figure 2.) and biometric recognition (Figure 3.)
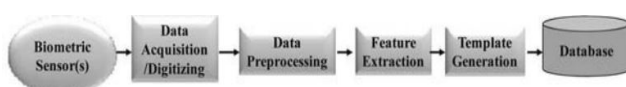
Figure 2. Biometric enrollment process
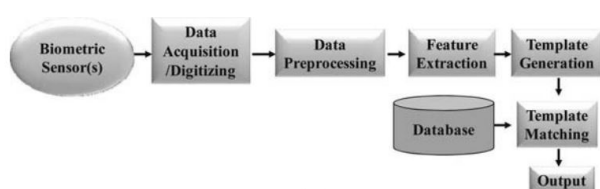
Figure 3. Biometric matching process.

Biometric technologies require a certain level of co-operation from users that is, *i.e.* users need to standstill while the devices scan their irises, faces, hands or fingers.

Iris systems are typically used for distances shorter than 30 cm and in front of cameras. Therefore, during the process of recognition, users must be motionless and look direcly at the camera. As these devices are based on infrared illumination techniques, this type of recognition does not pose any health risks.

On the other hand, recognition systems based on fingerprints and hand characteristics require from users to touch sensor surface and make contact in order to take a sample. This contact is sometimes characterized as unhygienic and some people do not want to use it. This and the fact that the fingertip sample can be misused, calls into question social acceptability of this method. pagination anywhere in the paper. Do not number text heads-the template will do that for you. [5]

Besides the above-mentioned reqirements, the presence of dirt on the contact surface can sometimes cause issues while taking fingerpint samples. Also, dirt can reduce the accuracy of the recognition process. Different finger pressures on the sensor can also make nonlinear distortions on the taken sample.

3. NEW TRENDS OF BIOMETRIC SYSTEMS

Touchless fingerprint recognition is a set of high-accuracy recognition techniques that help reduce issues while taking biometric samples. This also increases usability of devices and reduces the hardware costs. These systems can be applied in many areas, from acess control to high security required in goverments, military, research centers, *etc.*

One of the goals of this analysis is to present the areas in which these technologies can be used in the coming period. Our working hypothesis is that, although there are many others, the most important and lucrative field in which these technogies should be used is tablet and phone security systems, as well as ever more important the Internet of things.

In order to make biometrics more applicable and acceptable, researchers are developing new techniques. For example, iris recognition systems that can be used from a greater distance and while users are in motion, as well as touchless biometric systems for fingerprint and hand.[6]

The anaylsed touchless biometric technologies are based on few cameras and two-dimensional and three-diomensional fingerprint samples. Compared with the taditional biometric fingerprint use, this new technology provides more security, scalability, accuracy and is socially more acceptable.

It is important to mention that we have two techniques of touchless fingerprint based systems. First, two-dimensional systems, and second, three-dimensional systems. The difference between these systems is the classification of samples that are taken. The first method uses a single CCD camera for taking sample images, while the three-dimensional system uses more complex hardware to collect sample images and, as a result, it has a much better accuracy.

The majority of biometric applications and techniques are based on controlled procedures. For example, users have to touch a sensor or be motionless over the course of recognition or sampling. The developer's goal is to provide users with the most comfortable technology.

Less-Constrained Biometric Systems aim to:

- increase the distance between the users and sensors
- reduce the required level of user co-operation
- design a recognition method compatible with uncontrolled light conditions
- design highly usable adaptive acquisition systems
- design pre-processing methods for reducing noise and enhancing data captured under less constrained conditions
- develop new feature extraction and matching algorithms specifically designed to obtain accurate results, using data captured under less constrained scenarios
- design method that permits data compatible with the existing biometric technologies to be obtained from samples captured under less constrained applications.

4. TOUCHLESS FINGERPRINT BIOMETRICS, FEATURES AND TYPES

Touchless Biometric Features

Biometric features traditionally captured using touchless sensors are suitable for use in non-restricted recognition systems. Many studies have examined the reduction of limitations in these systems. Two of the most researched technologies consist of less restricted biometric systems based on the iris and face scanning.

Face recognition systems cannot provide sufficient level of security. The iris is considered to be the most accurate biometric feature and can be used with the assistance of CCD cameras. [1]

Touchless vs traditional fingerprints

Fingerprint biometrics is one of the most common biometric features in biometric techniques, due to its favorable characteristics: durability, user-friendliness and distinctiveness. The analysis of fingerprint samples can be performed on 3 levels. The first level is so-called global, the second level is called thin and the third level is ultra. These analyses usually include acquisition, quality evaluation, enhancement, feature extraction, and matching. Difference between traditional and touchless fingerprint is shown in Figure 4.

Most of fingerprint recognition systems use sensors that require contact with their surface. However, these systems often have issues specifically due to this contact (*i.e.* distortions in the captured images and latent fingerprints on the acquisition surface).[1] In order to overcome these problems and increase social acceptability of the biometric recognition processes, touchless recognition systems are being extensively analyzed. These systems are based on CCD cameras and can be classified into systems based on two-dimensional and three-dimensional fingerprint samples. Systems like these, in most cases, are supposed to have support for existing API-s.[7]

Figure 4 . Traditional (a) vs. touchless fingerprint (b).

Touchless Fingerprint Biometrics

This system has three levels of accuracy check. Complete application of this type of fingerprint is illustrated in Figure 5.

- First level: The overall global ridge flow pattern is recognized.
- Second level: The recognition is based on distinctive points of the ridges, which are
- called minutiae points.
- Third level: Ultrathin details, such as pores and incipient ridges, are recognized.
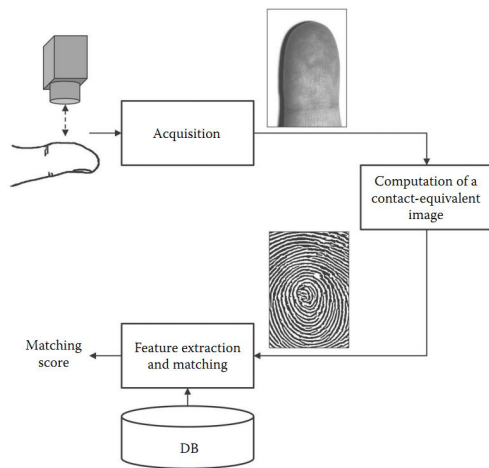
Figure 5. Application of touchless fingerprint system.

Touchless two-dimensional fingerprints

The analysed touchless fingerprint recognition systems include those based on two-dimensional systems designed to be integrated in low-cost and portable devices and those using more complex hardware setups in order to obtain higher-recognition accuracy.

Touchless fingerprint recognition systems based on two-dimensional samples use CCD cameras to capture details of the finger ridge pattern. These systems usually capture a single image and then process it in order to obtain a contact-equivalent fingerprint image. The purpose of this process is to compute a fingerprint image and make it compatible with the existing biometric recognition systems designed for touch-based images. Then, a biometric recognition is performed using well known algorithms for extracting features and matching touch-based fingerprint images. Other systems use features extraction and matching algorithms specifically designed for touchless two-dimensional samples. Some systems also use multiple-view techniques or specifically designed optics in order to obtain touch-equivalent fingerprint images not affected by perspective deformations and focusing problems. Some samples of two-dimensional fingerprints are shown in Figure 6.
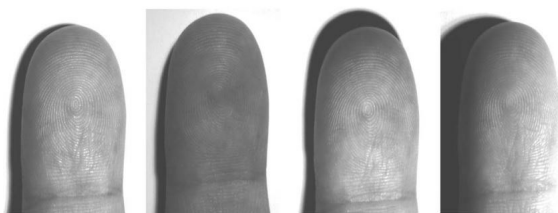
Figure 6. Two dimensional touchless fingerprint samples.

Touchless three dimensional fingerprints

Compared with biometric systems based on two-dimensional samples, systems that compute three-dimensional fingerprint models use more information and less distorted data. In fact, the analysed samples consist of three-dimensional structures that are not affected by perspective deformations and that show only the fingertip (Figure 7). Moreover, the feature extraction and matching algorithms can use additional information related to with the z-axis to improve the recognition accuracy. However, these systems require acquisition setups that are more complex and expensive than those for single Touchless images. Moreover, most reported methods require complex acquisition procedures. Figure 8. illustrates the scheme of three-dimensional fingerprint [8].

Figure 7. Example of 3d fingerprints (texture, depth rendering).
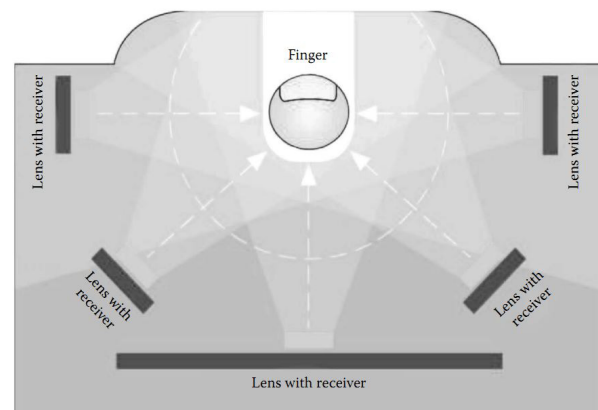
Figure 8. Three-dimensional scheme.

5. CONCLUSION

This paper presents new multidisciplinary technologies for Touchless fingerprint recognition compatible with less-constrained scenarios compared with traditional biometric systems. It is necessary to implement multidisciplinary approach to understand and implement this. The

described technologies include all aspects of Touchless biometric recognition systems based on two-dimensional and three-dimensional fingerprint samples, including methods for acquiring and processing biometric data.

New technologies were described and compared to the traditional ones. Also, they are comparable in many as pets as accuracy, speed, cost, scalability, interoperability, usability, social acceptance, security, and privacy.

The results that will tell us that in high-security application, Touchless biometric systems based on three-dimensional samples could achieve better accuracy than traditional touch-based fingerprint recognition systems.

On the other hand, two-dimensional solutions can be applied in some low cost systems, such as mobile devices. Therefore, the research demonstrated that touchless fingerprint recognition methods can be used effectively in different application scenarios where we have live touch-based techniques implemented.

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UPGRADING AND SECURING EXTERNAL DOMAIN SPACE IN THE CITY OF NIŠ ADMINISTRATION INFRASTRUCTURE

Đorđe Antić,
Mladen Veinović

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Being the key Internet infrastructure component, DNS (Domain Name System) is vital for any organization that requires external visibility and availability of its services. Public administration is especially sensitive, due to the nature of services offered to citizens. This paper describes the strategy, implemented to the administration of the city of Nis, for making external domain space more robust and resilient, as well as securing it with DNSSEC (DNS Security Extensions).

Key words:

DNS, security, cryptography, DNSSEC.

1. INTRODUCTION

Domain name system (DNS) is a distributed hierarchical database, operating as a mechanism for mapping hostnames to IP addresses. All Internet services rely on DNS as an infrastructure, making it essential and fundamental. Although robustly designed and improved over years, security was never its strong point. Most notable problems are DNS client flooding (a denial of service attack)[1] and cache poisoning, which makes it possible to insert false information into the cache of a DNS resolver, as was made widely known in 2008[2].

In order to improve the security of the system, the Domain Name System Security Extensions (DNSSEC) were introduced. It is a security protocol based on public-key cryptography, using asymmetric cryptography to generate digital signatures of data in DNS[3]. Through these signatures, resolving clients can be provided with origin authentication, data integrity and authenticated denial of existence. Signatures are following the hierarchical model of DNS architecture, forming a chain of trust from the root zone to all levels of subdomains.

The City of Niš administration relies on DNS for its presence on the Internet through various online services offered to citizens. Although not visible to end users, name resolution plays a critical role. Any disruptions can render the services unavailable or can, through abuse, provide false or misleading information to citizens, which can result in legal issues or material damage. This makes the need for reliable and secure DNS system even more emphasized.

Correspondence:

Đorđe Antić

e-mail:

djordje.antic@gmail.com

2. BACKGROUND AND SET GOALS

Background

DNS is a distributed database, deployed on name servers, linking domain names with IP addresses and other data. The data is organized hierarchically, similar to the structure of a tree. Root domain is on top, as shown in Fig. 1. The domain name system tree is divided into zones (such as .com, .net, .org). Zones are the sections of the tree delegated to a single administrative authority. Each zone is required to have multiple authoritative name servers that provide name resolution for all parts of domains contained within.

Auth. zones	Query for www.ni.rs
. (root) ●	1. Read from named.root:
	A.ROOT-SERVERS.NET. 3600000 A 198.41.0.4
.rs ●	2. Response from a.root-servers.net:
	;;Authority rs. 3600 IN SOA a.nic.rs
.ni.rs ●	3. Response from a.nic.rs:
	;;Authority ni.rs. 3600 IN SOA ns1.ni.rs
www.ni.rs ●	4. Response from ns1.ni.rs:
	;;Answer www.ni.rs. 355 IN A 194.9.94.234

Fig. 1. DNS hierarchy

DNS for ni.rs zone

In 2015, it was determined that the current DNS infrastructure of the city of Nis administration is in need of an audit and upgrade. The task was aimed at identifying the current state, weak points and shortcomings, setting the desired goals and proposing and implementing the appropriate solutions.

At the start of the project, current state of the DNS was reviewed. It was determined that the ni.rs zone (along with a number of others) was served by a pair of Networks Defender ND410 appliances, acquired in 2007, which were also used as antivirus scanning points for HTTP traffic. Internally, DNS service was provided by BIND

8, deprecated as of August 2007. Both of them were 9 years old, with no support or warranty or new antivirus updates. One device was put permanently offline due to hardware failure. The other device experienced occasional software problems that caused it to stop answering queries (rendering the zones it was authoritative for unreachable). This made the ni.rs and other zones hosted unreliable to reach, which was a problem emphasized by the fact that it was also the location where domains of various online services provided by the city administration were hosted. A solution was needed to replace the existing appliances and several goals for the project were defined.

Goals set

1. Any solution must take into consideration limited funds available for the project. Solution should be cost-efficient but with making as few compromises as possible.
2. Solution must follow best current industry practices for operation of authoritative name servers. Proper configuration and maintenance of name servers should have critical part in the project.
3. Special consideration should be given to security issues. DNSSEC extensions should be part of the solution.

3. DESIGN AND IMPLEMENTATION

In order to make the solution cost effective, decision was made to use the existing capacities on two older server machines with hypervisors and create name servers as virtual machines. Servers were both dual Xeon with 24GB RAM, both running VMWare ESXi hypervisors.

The software choice for virtual name servers was based on stability, security, hardware requirements and total cost of ownership. Linux was the obvious choice for operating system, and for diversity reasons, two different distributions were chosen, CentOS (Red Hat based) and Ubuntu (Debian based). Both distributions were installed in their minimal server variants.

The name server software was chosen among currently most widespread implementations. ISC's BIND was the first choice, being the industry standard. Others were NLnet Labs's NSD, CZ.NIC's Knot and EURid's YADIFA, all being high-performance authoritative only name server implementations. The most recent versions of the software were installed, with support for all important DNS
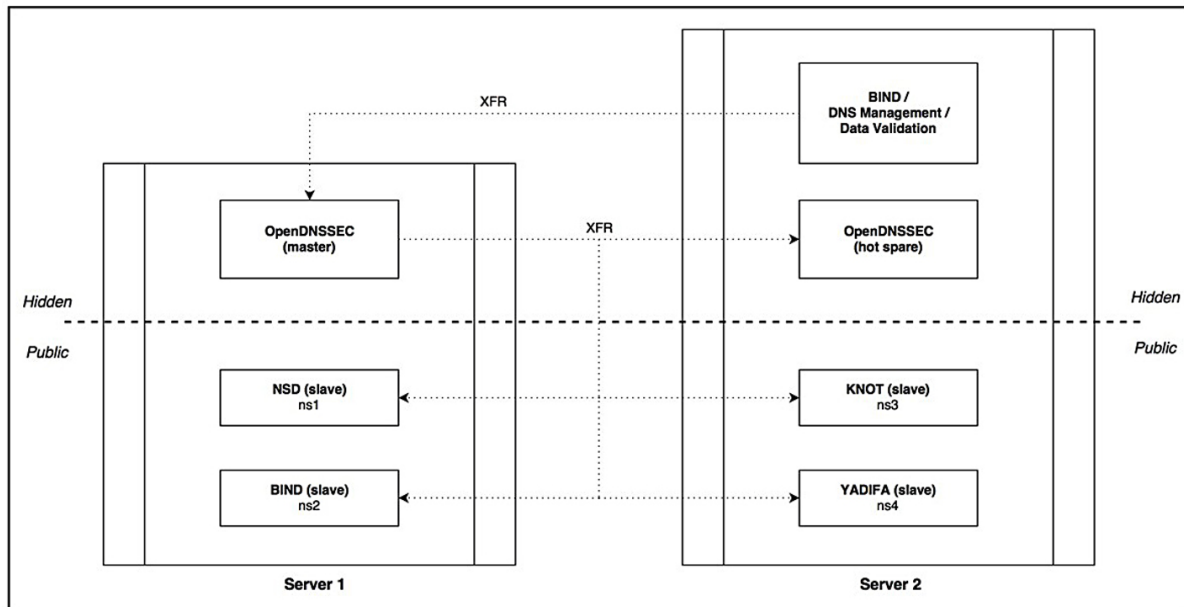
Fig. 2. DNS concept with hidden master and bump-in-the-wire DNSSEC signing

protocols, such as full and incremental zone transfers, dynamic updates, EDNS0[4] and DNSSEC extensions with NSEC3[5], response rate limiting[6] and NSID[7].

The concept, illustrated in Fig. 2, was to have one hidden server where zone data would be prepared, validated and loaded to a master server, running BIND. This server would then notify DNSSEC signing machine (running OpenDNSSEC) about the change in zone data. OpenDNSSEC machine would then initiate a zone transfer from the master server using an encrypted zone transfer (AXFR/IXFR). This machine works as a "bump-in-the-wire" between editing and publishing a zone. Transferred zones would then be signed with appropriate cryptographic keys. Keys are stored in a software implementation of a cryptographic store accessible through a PKCS#11 interface, SoftHSM, which is developed as part of the OpenDNSSEC project. After the zones have been successfuly signed, slave servers are notified about the zone change. The slave servers (public name servers, running NSD, BIND, Knot and YADIFA) would then initiate zone transfers, again using an encrypted zone transfer. All chosen name server implementations on slave servers use the same format of BIND's master zone file. Virtual DNS server machines are split among two physical servers.

Configuration of public servers

General recommendations for operation of public name servers have been implemented:

- Servers are running on virtual machines dedicated to DNS. This minimizes the risk of unau-

thorized access or negative impact of other applications on DNS. It also enhances the capability to monitor server performance or troubleshoot problems.
- DNS software is running as an unprivileged user
- Access control mechanisms are set to restrict zone transfers capability to master server only. Transfers are secured with HMAC-SHA256 TSIG.
- Recursion queries are not allowed, since servers are authoritative-only. Recursive servers intended for internal clients exist on separate part of infrastructure.
- Time to live (TTL) values of NS records and their associated A and AAAA records are set long enough to help reduce the impact of DDoS attacks, as recommended in [8].
- Response Rate Limiting (RRL) with appropriate values is deployed on servers.

Response Rate Limiting

Response rate limiting (RRL) is an enhancement that helps mitigate DNS amplification attacks. DNS amplification attack is a type of reflection attacks, in which an attacker sends traffic to the victim by reflecting it off a third party, effectively concealing his identity. Amplification is combined into this attack when the amount of traffic the victim receives is considerably larger than the amount of traffic sent by the attacker.

DNS servers are often misused for this type of DDoS attack because of the protocol characteristics. UDP (User Datagram Protocol) protocol is suitable for this purpose because it is relatively easier for an attacker to spoof his IP address over UDP (there is no source validation) than it would be over TCP protocol. As DNS replies can be significantly larger than a DNS query, an attacker can spoof a small query for which he knows will generate a large answer. Sending many queries in this manner to a large number of "open" DNS resolvers can generate enormous traffic directed to the victim. Target is flooded with unrequested DNS query responses, and although they are discarded on arrival, they have already consumed network resources, potentially rendering the target unavailable.

RRL mitigates this type of attack by limiting the rate at which servers respond to large number of malicious queries. RRL can detect patterns in queries that are received and, according to set parameters suggesting abuse, reduce the rate at which the replies are sent. Along with making the attack lose bandwidth, RRL decreases the attractiveness of the DNS system as DoS amplifier.

DNSSEC

DNSSEC introduces four new resource records: RRSIG (Resource Record Signature), DNSKEY (DNS Public Key), DS (Delegation Signer) and NSEC (Next Secure). RRSIG is a digital signature produced by hashing and RRset and encrypting it with a private key for a zone. That key is then published as a DNSKEY RR. DS RR, which resides with the parent zone, represents a hash of the DNSKEY of the child zone. DS RR is a point of delegation between the zones, which can be authenticated, because it works as a form of "certificate", binding the child zone with the parent. These relationships form a chain of trust that a resolver can follow through the DNS tree (as in Fig. 3).

DNSSEC in ni.rs zone has been implemented as a "bump-in-the-wire" between the hidden master and publicly visible servers. This has allowed for a gradual setup on dedicated machines, implementing DNSSEC only after the rest of the DNS system (without DNSSEC) has been put online and operating as expected.

OpenDNSSEC implementation has been chosen for several main reasons:

- Seamless integration into existing non-DNSSEC DNS environment without changes to the current model.

- High level of automation. When it is set up, no manual intervention is needed, but still possible if necessary (for example, in case of emergency key rollover). Also, since DNSSEC requires that certain number of procedures be performed in a strict timeframe, higher automatisation reduces chances of errors.

- Security – support for HSM. Current setup uses software emulation of HSM (SoftHSM) in order to avoid cost, but OpenDNSSEC can also use hardware HSM using industry standard PKCS#11 interface.
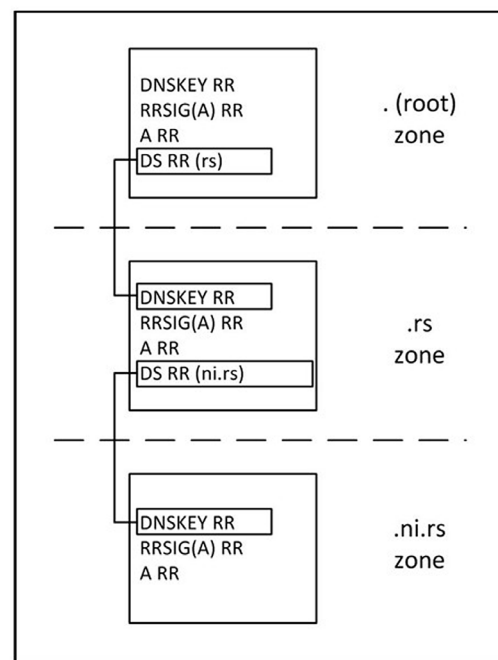
Fig. 3. DNSSEC chain of trust

Configuration of DNSSEC was done according to the practices described in [9]:

- Keys are operationally separated to have a role of Key Signing Keys (KSK) and Zone Signing Keys (ZSK).

- Zone Signing Key size is set to 1024 bits while the Key Signing Key size is set to 2048 bits.

- Algorithm used for KSK and ZSK is RSA/SHA-256, as referenced in [13] (algorithm number 8 per IANA registry[14])

- Maximum validity period of signatures is 14 days (both KSK and ZSK), with inception time of one hour.

- Resign interval (runs of signer engine) is 2 hours, with refresh interval (time after signature is refreshed) of 3 days.

Cryptography and security

- TTL values of signature resource records match the TTL values of the RRsets they cover, as recommended in [15].

DNSSEC Key rollover can take place in the event of compromise of existing keys or in case of policy demands. Two strategies for key rollover are implemented:

- For ZSK, Pre-Publication method is used, as recommended in [10]. New key is introduced to DNSKEY RRset, which is then resigned. After sufficient time, when all cached RRsets are considered to contain both keys, signatures created with old key are removed. Again, after sufficient time, after signatures created with old keys have expired from caches, old key can be removed from DNSKEY.

- For KSK, Double-Signature method is used. New KSK is generated and DNSKEY record for new key is added to the zone. Key is then sent to parent zone, and parent replaces old DS record with a new one. After sufficient time, when all cached RRsets are considered to contain new DS record, DNSKEY record for old KSK can be removed. Although [10] recommends Double-RRset as the most efficient for KSK rollover due to the ability to have new DS records and DNSKEY RRsets propagate in parallel, this method is not yet supported in OpenDNSSEC.

NSEC3

One of the things that DNSSEC provides is authenticated denial of existence, which is a mechanism that can prove that domain names and resource records do not exist. This is achieved by listing of all domain names and resource records that do exist and securing them with NSEC. However, this introduced the zone enumeration issue, which can allow an attacker to gather all domain names in a zone. To prevent this scenario, NSEC3 is used.

NSEC3 creates hash of each name in a zone and links these hashed names. Any query for these hashed names will give back a response stating that the requested name does not exist. Queries directed to names that do not exist will receive the same answer, as it can be proven that there is no hash record for them.

There are three main configuration parameters for NSEC3:

- Opt-Out mechanism: Since the ni.rs zone is relatively small and contains no insecure delegations, opt-out mechanism is not used.

- Iterations: This parameter is used to counter the brute-force breaking. Number of iterations is set according to recommendations in [5]. The limits are 150 for key size of 1024 bits and 500 for key size of 2048 bits.

- Salt: Used to prevent creation of a rainbow table. Salt size is set according to recommendations in [5], *i.e.* at least 64 bits long. It is worth noting here that according to the study[12], NSEC3 salt is ineffectual and inadequate. Since "the value of the salt is publicly accessible via DNSSEC RR lookup…any attacker may obtain the salt to use as input into its dictionary computation, effectively negating the required increasing in dictionary size."

NSEC3 TTL value is identical to SOA minimum TTL value, as recommended in [5].

4. FUTURE WORK

Anycasting

Anycast is a network methodology in which traffic is routed from a single source to several topologically dispersed targets using the same IP address. Layer 3 routing is used to send packets to the nearest server in the anycast group.

Adding anycast servers is planned as the next future upgrade of the name server infrastructure described here, as the benefits for using anycast for DNS servers are increased reliability, load balancing, improved performance, better protection from DoS and increased availability. The tradeoffs are complexity, cost and increased difficulty in troubleshooting and monitoring. Support for NSID by all implemented server software should help with anycast deployment.

DNSSEC Policy and practice Statement (DPS)

DPS is a document, written according to recommendations in [11], that describes the policies and procedures relevant to DNSSEC that have been implemented. The document should „provide a means for stakeholders to evaluate the strength and security of the DNSSEC chain of trust…comprising statements describing critical security controls and procedures relevant for scrutinizing the trustworthiness of the system"[11].

It is planned to prepare and publish this document as it should help with understanding of everything that has been done to secure our zone. It can be significant for all stakeholders, including regulatory authorities. It will also serve the purpose of helping people learn about

the security implemented in our zone and decide if they can trust it. Other implementators may find it useful for planning all significant aspects of using DNSSEC.

DANE

DNS-based Authentication of Named Entities (DANE) is a method of binding X.509 certificates to DNSSEC secured domain names, with the purpose of using the secure DNS infrastructure to „store and sign keys and certificates that are used by TLS (Transport Layer Security)" as described in [16].

DANE is another feature planned for testing and implementation in our zone, as it provides a potential alternative to trust currently placed in commercial Certificate Authorities and offers a standard for encrypted email, as described in [17].

5. CONCLUSION

DNSSEC is still in the test phase for our zone and our parent .rs zone has not yet been signed at the time of this writing. Thus, being still unable to verify DNSSEC operation in environment with established chain of trust, it is early to say that DNS setup and configuration presented here are final or fully optimized. All efforts were made to follow industry standards as well as recommended best practices. Experience gained during the project will serve to further improve DNS for our zone and other implementators may benefit from data presented herin.

Acknowledgment

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PRIVILEGED IDENTITIES - THREAT TO NETWORK AND DATA SECURITY

Dunja Pešić[1],
Mladen Veinović[2]

[1]OmnitechIT,
Belgrade, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Privileged accounts represent the biggest threat to enterprises. The number of cyber-attacks in which privileged accounts and insiders are involved directly or indirectly, has significantly increased in recent years. All-powerful access with the lack of accountability creates a risk which can certainly cause damage of immense proportions. The widespread use of virtual environments enhances the risk. The problem with the lack of accountability due to the use of shared accounts and passwords, little separation of duties and principle of "least privilege" not being followed is a massive occurrence in the use of virtual environments. Privileged identities are classified into groups of malicious insiders. They are involved in IP theft, espionage, fraud and IT sabotage.

Along with the argumentative idea of the technical approach towards the solution of the problem, other mentioned issues will be processed, because Insider threat is a people-centric issue. People are complex beings, hence the approach to a solution must be versatile.

Attention will be given to the positive practices of Identity based security, host based security, end-to-end security and compliance for cloud and virtual environments. Likewise, we will observe the negative practices and possible approaches to the problem of organizational factors contributing to insider attacks, with the aim to introduce environment where being an insider is not easy.

Key words:

IT security, insider threat, privileged access.

1. INTRODUCTION

Insider threats are becoming all too subtle, and the damage they can create is becoming greater. One of the major dangers of insider threats lies in the fact that they are usually the most difficult type to detect, due to their subtlety, or get detected after irreparable damage is done. Exercising an approach of remediation to this type of vulnerability is not effective because the theft of information or assets has already been done, making the approach of prevention and enablement the best possible choice.

Most organizations believe that the implementation of infrastructure security is enough to be protected of cyber-attacks, but the weakest link in the security of an organization is the user, for external or insider threats. When breaching a network perimeter, external attackers mainly seek to gain access to privileged accounts.

Insider threats can be classified into three groups: malicious insiders (which are the focus of this study), who deliberately steal information or

Correspondence:

Dunja Pešić

e-mail:
dunja.pesic@omnitechweb.it

cause damage; insiders who are unwittingly exploited by external parties and insiders who are careless and make unintended mistakes. Whichever the case from the foregoing, negative practice of social engineering is part of the issue. Better part of mitigation strategies is user awareness training. It can be argued that this necessary step is the ideal theoretical solution in general, but hardly widely feasible in practice. Mainly, because even if an organization funds training for employees, there is no guarantee that they will be highly motivated to embrace and implement knowledge of data protection. The risk of all three types can be reduced by ensuring accountability and implementing least privilege access.

For this reason, the subject of research in this study is privileged identity and access management solution, because it protects against both external and insider threats. During the research, an overview was performed of the best commercial solution.

The paper is intended for all those who care about the security of their data and applies equally to private and business users.

The scientific objective of this paper is to analyze the solution that offers:

- enablement of compliance for privileged identity access and virtualization security,
- greater control over superuser actions through fine-grained controls,
- support to both physical and virtual environments,
- reduction in costs and improved efficiency through virtualization - aware and automated security controls,
- proven scalability in some of the largest and most complex IT environments in the world.

2. OVERVIEW IN THE FIELD OF RESEARCH

The research in the field of threat to network and data security from privileged identities selected the best solutions on the market: Privileged Identity and Access Management by CA Technologies. From this point forward, the challenges of defending against insider threats and the problem with privileged identities will be presented. Privileged Identity Management lies at the core of any program to reduce insider threats [1]. Privileged Identities can be classified into two groups:

- High risk profile by position in the hierarchy of the organization *e.g.* CEO, CIO, CISO, CFO, etc. It is unlikely to refer this group as potential mali-

cious insiders. Assuming that by harming the organization, they are directly harming themselves, their main goal is the success of the company. They can be defined as privileged users who may be targeted and exploited by malicious attackers, due to their lack of awareness, vulnerable lifestyle and circumstances. Perhaps the rule that there should be no exceptions to the principle of least privilege applies to this subgroup of super users chiefly. Almost without exception, they have access to sensitive data of the organization.

- High risk profile by employment in the IT department of the organization *e.g.* administrators of various parts of the system and network. Some of the individual factors that should be considered in this subgroup are personality traits and workplace behaviour, which are exceptionally important but are not the key problem in IT departments. The greatest risk is when users with unrestricted, all-powerful access are not made accountable. This is usually because privileged accounts are typically being shared by several people. Virtualization magnifies these issues. In addition virtual environment is dynamic in nature, therefore it is difficult to control access to virtual machines. This subgroup of super users can be labelled as paradoxical. Their purpose is to maintain the network and system and to protect the organization from threats that could breach IT security, but evidently there lies the weakest link for possible insider threats. In the environment where all-powerful accounts are shared, one malicious person is enough to make irreparable damage. It would be superficial to incriminate IT department as the source of the problem. The situation there is the result from the organization ratio towards IT department, such as corporate governance, lack of awareness or communication between business areas.

Classification of insider threats as primarily a technical problem or as mostly hacker activity is a common misconception. This is a large part of the security breaches issue. Awareness is necessary, technology has become a dominant instrument in every aspect of everyone's everyday life, which is why the awareness of possible risks and exploitations should not be observed as knowledge principally reserved for IT professionals, but rather, it should become a matter of general education of individuals.

Organizations that belong to the private or state sector need to demonstrate maturity, considering that if

security breaches do occur, their members, managers or responsible people and the organization itself are not the only victims: customers and clients suffer financially, emotionally, mentally due to oversight of possible threat. And even if the attack is remediate, the trust of clients will be difficult or impossible to restore. Consequently, prevention and enablement is the best solution.

Before securing privileged identities, an organization needs to understand the types of accounts that exist, as well as their unique purposes and requirements. Classification is shown in the table below. [7]

Privileged Account Type	Description	Used By	Security Focus
Default Local Administrative Accounts (*e.g.*, root, administrator	"All powerful" accounts used to manage the system or device by administrators	Multiple types of administrators, often shared	Ensure accountability by individuals.
Named Administrator Accounts	Accounts for individuals that have administrative privileges	Named individual administrators	Ensure least privilege access.
Service Accounts	Accounts used by operating system services and applications that require privileged access, often used by web servers, e-mail servers, databases, *etc.*	System services and applications	Ensure unused accounts are removed or disabled and that passwords are changed regularly.
Domain Administrator Accounts	Accounts used to administer a domain instead of a local system	Domain administrators	Apply extra controls and monitoring.
Emergency Accounts	Accounts used only in the event of an emergency that requires temporary privileged access	Backup administrators	Ensure all emergency use is authorized and monitor all use.
Application Administrator Accounts	Application accounts with elevated privileges that are used to administer an application	Application administrators	Apply risk-appropriate controls, dependent on the nature of the application.
Hypervisor Administrator Accounts	Accounts used to administer virtual environments, such as VMware	Virtualization administrators	Applying best-practice controls to this class of administrator

Table I.

3. OVERVIEW OF THE PROPOSED SOLUTION

CA Technologies has been a leader in the field of Identity-centric Security for several years. Awards and recognitions are persuasive confirmation. As well Forrester Wave Report Names CA Technologies as the only leader in Privileged Identity Management [4].

From this point forward, the authors shall present their solution for Privileged Identity and Access Management.

CA Privileged Identity Manager is a comprehensive and mature solution for privileged identity management in both physical and virtual environments. CA Privileged Identity Manager is a highly scalable solution that provides privileged access and account management, including: shared account password management, fine-grained access controls, user activity reporting and UNIX Authentication Bridging across servers, applications and devices from central management console. CA Privileged Identity Manager for Virtual Environments brings privileged identity management and security automation to virtual environments from infrastructures to virtual machines. CA Privileged Identity Manager is the only privileged identity management solution that enforces access controls at the OS kernel level. Because of this, it is uniquely suited to protect your most critical systems and most sensitive data. [5]

Figure 1 shows how Privileged Access Management (PAM) helps to address five primary challenges [2] in the Organization, while Figure 2 displays the five essential capabilities of Privileged Identity Management (PIM) Solutions [3].
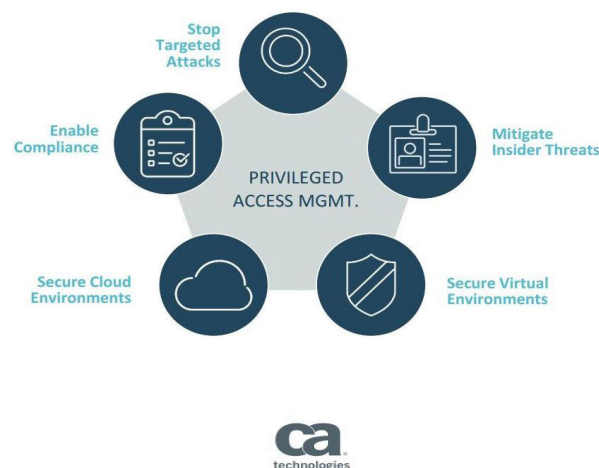
Figure 1. Five primary challenges
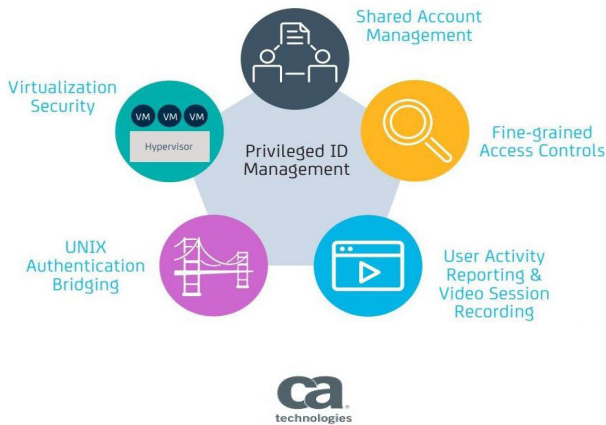
Figure 2. The Five essential capabilities of PIM

PIM Capability 1: Shared Account Management

Shared account password management controls access to privileged accounts. It stores passwords in a central location and helps provide accountability for user actions through secure auditing. Shared passwords must be stored, changed and distributed in a timely and secure manner in order to comply with corporate security policies. Additionally, many applications also use hard-coded passwords in shell scripts and batch files. These passwords are static and can be stolen by anyone who gains access to the script file, including malicious intruders. [5]

A solution should be able to make access to shared accounts simple, without compromising security. Features such as those preventing the user from seeing the password during an automatic login are essential. [5]

Shared Account Management helps organizations control access to privileged, administrative accounts (including "break glass" functionality) with password storage and automatic login capabilities (Figure 3). This is the starting point for most privileged identity management solutions. [3]
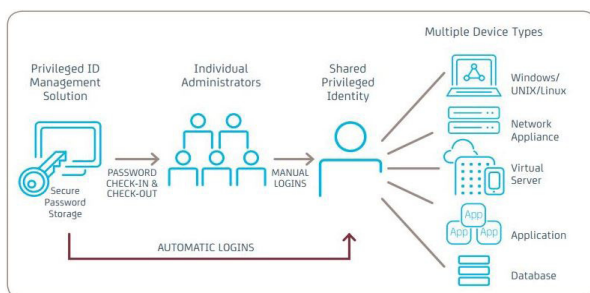
Figure 3. Shared Account Management

"Benefits include:

♦ A reduction in the risk of unauthorized users gaining access to privileged accounts

♦ Improved accountability via prevention of password sharing." [3]

PIM Capability 2: Fine-grained Access Controls

The use of shared accounts (such as "root" and "Administrator") typically results in privileged users having unnecessary access to critical systems and data. This violates the security principles of "least privilege" and "separation of duties." Operating systems do not have the ability to restrict actions and access for multiple people using a shared account. Fine-grained access controls go beyond OS-security to examine a user's original identity to determine whether an action should be allowed or denied. This enables true least privilege access. These capabilities are required to help ensure that administrators have only the privileges they need to do their job and nothing beyond that. [5]

Fine-grained access controls allow enterprises to control what access users have based on their individual identities, even when they're using a shared administrative account (Figure 4). [3]

"Benefits include:

♦ Reduced risk by providing administrators with only the minimum privileges they need to do their jobs."[3]

This capability essentially enables two or more users to be logged into the same administrative account, but have different access rights based on their original user ID and role. [3]
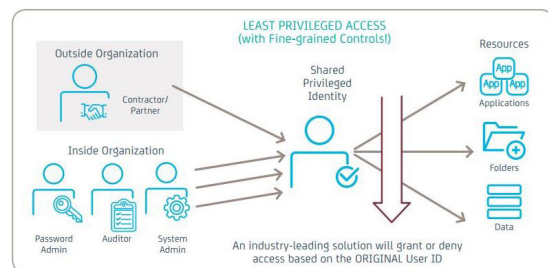
Figure 4. Fine-grained Access Controls

Figure 5 provides a summary of the common threats that affect privileged identities and relevant CA PIM countermeasures within the scope of the research project conducted by GDS Labs Security Research. [6]

Common Threat Vectors to Privileged Identities	CA Privileged Identity Manager Countermeasures
Network Service Compromise Exploits against external facing network services are a common way to gain entry to a perimeter system in order to pivot into an organization's internal network. This includes entry with a zero-day vulnerability, by running public exploits against unpatched services, or exploiting web application vulnerabilities. **Local Privilege Escalation** Once user level access to a system is obtained (compromised network service, spear phishing, etc), local privilege escalation is needed to gain root/administrator privileges. Privileged identities are useful for establishing persistence, gaining access to user and service credentials, and facilitating pivoting into internal networks. **Privileged User Compromise** Privileged accounts are frequently targeted since they provide the greatest return on investment. If an attacker is able to compromise a privileged identity, there is no need to spend time on escalating privileges. These types of attacks can occur through spear phishing attacks against administrators or compromise of a network service running with elevated privileges and/or permits remote administrator logins. **Malicious Administrator** Typically, certain individuals within an organization must be granted with privileged access to systems. Organizations that assign unrestricted administrator/root access to these individuals or engage in shared administrative account practices are at a much greater risk of the malicious administrator scenario materializing.	**Fine-Grained Access Controls** CA PIM provides a granular access control mechanism that can layer on top of native OS-level file system access controls. CA PIM administrators are able to assign user specific access control lists on various supported resource classes (files, network connections, kernel modules, etc). If the user performs actions in the context of a shared account (i.e. root, administrator), CA PIM tracks the original identity and applies the proper access control policy. This arms an organization with the ability to enforce the principles of "least privilege" and "segregation of duties" even if several accounts have the ability to run commands on the system as a privileged user. **Application Jailing** CA PIM's fine-grained access controls can be utilized in order to create jails for applications. CA PIM provides the ability to create logical users based on the account used to run an application. By applying a restricted policy on the logical user, it is possible to restrict a process to only access files that are required to function properly. This can provide strong mitigation against common web application vulnerabilities or 0-day vulnerabilities against Internet facing services. **Granular Reporting and Auditing** CA PIM's fine-grained access control mechanism enables accurate auditing of actions performed on the system. Auditing is customizable on a per resource basis and it can be configured to log all access requests to specific resources or only log failed access attempts. It is possible to track the user's true identity within the audit records, which helps reduce loss of accountability when administrative accounts are shared between users. Unlike a traditional 'syslog' log file that can be modified by a privileged user, CA PIM access control policies can be setup to restrict audit log access to only PIM auditors.

Figure 5. Common threats and CA PIM countermeasures

Example of Privileged User Compromise and Application Jailing is shown in Figure 6.
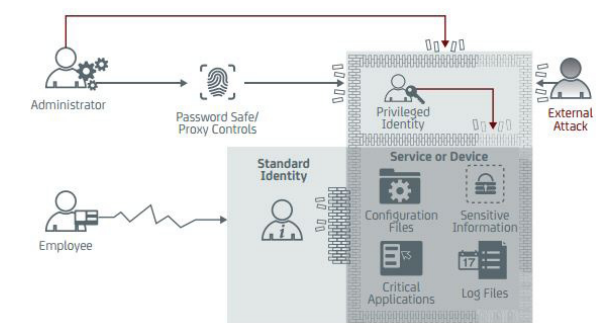
Figure 6. Application Jailing [5]

PIM Capability 3: User Activity Reporting & Video Session Recording

Video session recording can provide a deeper understanding of what actually happens on corporate servers and desktops. Video replay provides clear-cut evidence of precise user actions. Unlike system logs, video records can show exactly which applications were run and what files or URLs were accessed. This can eliminate blind spots that currently exist for applications that do not produce their own logs, including many of the most common desktop and cloud-based applications. Video logs sup-

ported by deep analytical capabilities can be essential in forensic investigation. [1]

Session recording for proxy activities enables Security Administrators to be able to record privileged sessions accessed through the proxy server. The solution records all screen movement in full resolution and Super-Administrators can then search and playback the sessions with DVR-like playback controls. Recordings are stored in an encrypted fashion and made available as soon as the privileged session ends. Advanced policies allow you to specify the endpoints that can be recorded. [9]

User activity reporting records all user actions-tracking by individual, even when a shared account is used. Ideally, this capability should trace an IT system in a video-like format, ensuring that all users can be held accountable for their actions (Figure 7). [3]

"Benefits include:

◆ A simplified way to determine "who did what" in a forensic investigation, via an easy visual record instead of the need to search through incomprehensible log files [3]

◆ Enabled accountability for users of IT systems [3]

◆ Authorized logs for applications that do not natively produce logs."[3]
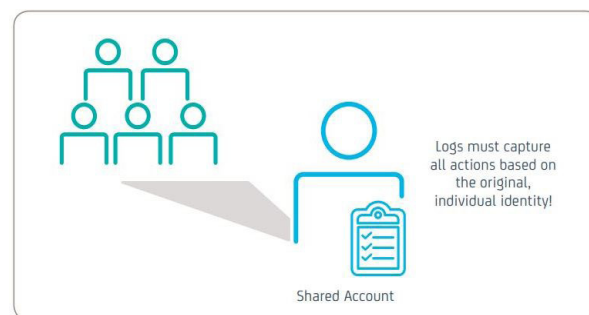
Figure 7. User Acitivity Reporting & Video Session Recording

PIM Capability 4: UNIX Authentication Bridging

„UNIX authentication bridging authenticates users on UNIX and Linux systems to the Microsoft Active Directory, thus providing a single place to determine access instead of a set of distributed password files."[3]

"Benefits include:

◆ Consolidated authentication and account information in Active Directory, as opposed to the need to manage UNIX credentials locally on each system

◆ Decreased administrative overhead."[3]

PIM Capability 5: Virtualization Security

In this diverse environment, it's important to enforce a consistent policy and enable consolidated logging across servers. An explosion in the number of servers and devices being managed has compounded these issues. Virtual machine sprawl means that there are many more servers to manage, and since it's irrelevant to hypervisors which operating system is a guest, this exacerbates the heterogeneity problem. Yet, maintaining the security of this expanded, virtualized data center is largely overlooked. Virtualization also creates a new class of hypervisor privileged users that can create, copy, move or otherwise manage these guest operating systems, further stressing the need for adequate separation of duties to prevent the data and applications running in these guests from compromising in addition to audit capabilities. [8]

Virtualization security requires a Privileged Identity Management solution that controls privileged users on the hypervisor, while providing virtualization-aware automation of security controls on virtual machines. It also tracks and audits access to the host operating system and supports auditability across all virtual machines to ensure compliance. [3]

"Benefits include:

♦ Improved compliance,

♦ Reduced risks of virtualization, including hypervisor administrators."[3]

CA Privileged Access Manager for VMware NSX

It is important to mention an addition (CA Privileged Access Manager for VMware NSX), which is a great boost to virtual environments security.

CA Privileged Access Manager for VMware NSX (Fig.8.) enhances VMware NSX's native security capabilities and adds fine-grained access control. Automatically discovers and protects ESX/ESXi hosts and guest systems. Automatically establishes and enforces policies across dynamic virtual resources by adding policy protections and access permissions in real-time, as virtual instances are created. Automatically define highly restrictive, micro-segmented, secure network access to NSX-based resources. Using synchronized security settings that are core of NSX Security Groups, automatically providing with short-term administrative access to select systems - or deny access and terminate sessions in response to security incidents. Monitor, react and record everything, including NSX REST APIs interactions. Delivers full audit

and response logs of all user events, including interactions with the powerful NSX Manager APIs. Captures continuous, tamper-evident logging and recording of administrative sessions. Generates alerts, warnings or even terminate sessions. Analyses logs using VMware vRealize Log Insight or other log managers. Manages privileged user credentials and simplify with single sign-on. Stores credentials in an encrypted credential safe. Gain faster access and productivity improvements with single sign-on. [10]
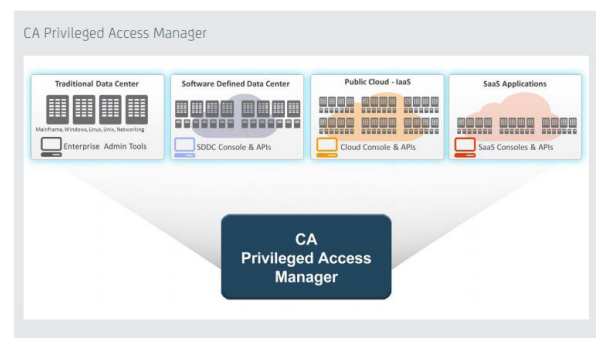
Figure 8. CA PAM for VMware NSX

Compliance challenge of PIM

Regulations and industry standards often require strict controls over privileged identities. Organizations must have correct policies in place, have those policies successfully deployed but also provide proof of being compliant with both corporate policies and regulatory standards, while accounting for any deviations from the policy. Privileged identities are a unique compliance challenge, as requirements for "least privilege access" and "segregation of duties" often conflict with traditional approaches of administrators having unrestricted access to systems and data. Shared accounts also present a compliance challenge, as all user activities must be tracked to individuals. When multiple administrators can log into a single account simultaneously, powerful tools are needed to track "who did what" at the individual level. [5]

4. CONCLUSION

This study mainly presents the challenges of defending against insider threats and the problem with privileged identities. Risks from insider threats by privileged identities were analyzed, and the best available commercial solutions were presented.

CA Privileged Identity Manager is a comprehensive and highly scalable solution for privileged identity management in both physical and virtual environments. It provides a proactive approach to securing sensitive information and critical systems without impacting normal business and IT activities. CA Privileged Identity Manager helps mitigate risk and facilitate compliance by controlling how privileged users access and use enterprise systems and data across the IT environment in order to achieve a higher level of security, reduce administrative costs and allow for easier audit/ compliance processes. [7]

CA Privileged Identity Manager is the only solution to implement access controls at the OS kernel level that is significantly harder to bypass than competing "sudo" and proxy-based solutions. It has a highly scalable architecture that has been tested to run on over 100,000 endpoints. [7]

It is important that the business environment can operate efficiently and to be protected from threats concurrently. This is a transparent solution to a very complex issue.

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CRYPTOGRAPHY AND SECURITY

BIOMETRICS AS AN INTELLIGENT PART OF THE B2C ENVIRONMENT

Milomir Tatović,
Saša Adamović,
Milan Milosavljević

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

This paper discusses the possibilities of behavioural biometrics in content analysis of the web site and the end user. By collecting data through the human - computer interface (mouse, keyboard or touch screen), it is possible to obtain sufficient amount of information to reliably identify users. With precise identification it would be possible to develop an adaptive web site model, which would represent a great contribution to the B2C environment.

Key words:

biometrics, mouse tracking, B2C.

1. INTRODUCTION

Look in the eyes, crossed hands or hands in the pockets during the conversation reveal much more than words. Candies in markets placed at the height of children eye sight and traditional painting of fast food restaurants with colours that cause hunger are some of the marketing tips that traders do in order to trick the customers. These tricks and reading body language are our real everyday life. However, the question is what happens in virtual life, where you cannot see or feel, and sometimes not even hear the reaction of the other side, where it is impossible to know if this person even exists or is it just a virtual world person - a bot.

Obviously, the question arises whether we can use real life psychological methods which are being used very successfully, and apply them in virtual reality. First question that needs to be answered is: Can we say with certainty that we are dealing with human? The answer to this question is quite interesting. Many programmers are trying to come up with an efficient system which will be able to distinguish human from each bot. On the other side, there is a large number of programmers who are trying to take the full advantage of artificial intelligence and create a machine-bot that is difficult to recognize.

Such systems, which allow the detection between a human or a robot are based on the elements of nonverbal communication. A computer program cannot detect waving hands but it can detect things like uncontrolled mouse movement, a large number of simultaneous clicks or many syntax errors. Owning to this we can claim with certainty that here is a human behind the computer, and we can also easily evaluate mental condition or characteristics of the virtual reality user.

Correspondence:

Milomir Tatović

e-mail:

milomir@tatovic.com

2. MONITORING SYSTEMS

As the greatest representative of virtual reality, web requires more end-users analysis. In real life, shop owners know exactly how to arrange their articles and that's how the Web developers want to make an appropriate Web page in virtual world. Here, the user analysis is more complex. Primarily, it is necessary to attract the attention of a potential buyer and to distribute items on a Web page exactly in the way the customer would prefer. In order to obtain such information from customers, it is necessary to pay attention to their activities on the Web, and on the page itself. In addition, time of expensive solutions is over. Web is full of free or "almost" free content. A large number of ads on websites are becoming an important source of financing solutions. Therefore, it is necessary to place advertising exactly where it will certainly be noticed by the end user.

The most common system of analysis, as well as in real life and on the Web, is a test system A/B[1]. In this way, we get reply from potential users or end users prototypes. Yet, it is sometimes impossible to provide the conditions necessary for testing. Then and it is necessary to monitor the activities of real users, and adjust the web page to their needs or to grow seamlessly up to the desired activity. This kind of a system requires a great source of data. In human-computer interaction, mouse movement is an ideal source. [2] Following the path of the cursor or places where the cursor is generally retained, the way how you scroll or intensity of the necessary and random clicks, can give us a lot of information about the site visitor. [3] Notable difference between visitors will be discussed in the next section of this document.

The number of available systems is not great. The problem is certainly a large amount of data generated every moment. However, with the constant growth of processor power and high availability of high-speed memory devices, these problems become less important. Therefore, it is nowadays possible to monitor eye view besides the mouse movement. When we combine mouse movement and eye monitoring of the end user, we get better data to analyse user interactions. In a study conducted by Kerry Rodden and Xin Fu [4], a correlation between the cursor position and views has been demonstrated. Rodden also presented four different approaches of using the mouse. The first is neglecting the mouse during reading the text, the second and third indicate that users use the mouse by tracking the mouse horizontally or vertically to read the text and the fourth shows that some users mark interesting results when reading the text. Guo and Agichtein

have proven in their study that they can predict with 77% accuracy where the user was looking by tracking the cursor.[5]

If we decide to follow a viewpoint on a website, we need to keep in mind that it is necessary that the user has a camera and has agreed to be filmed during the site visit. Namely, if we follow only the moves of the mouse, clicks, typing, or scroll, user does not know that he is being monitored and there is no need for performing an additional action. This way, we can provide high-quality data for analysis. With the results obtained from these studies, we can claim that we don't need monitoring views for this kind of analysis.

3. DATA COLLECTION AND RECONSTRACTION

Data collection systems can be desktop programs or Web-based applications. Desktop programs must be installed by the user, so they are not eligible for the analysis. A web-based system was made for the purpose of this study. Interactive visitor data interactions are collected directly from the browser with the help of java script functions and sent and stored in the database. In this way, the end user does not know that his interaction was monitored nor the functionality of the site was disrupted. This way monitoring result obtained can be considered relevant. Besides the exact URL, mouse movements, clicks, scrolls and typing on the keyboard, other user information is also obtained. Those are IP address, country and city, the name and version of the operating system and browser, also unique cookie that is created when you first visit the site, which is later stored in the memory of the user. Creating a cookie allows us to know with certainty that the same user has returned. When creating this system, in particular, we made sure that we enable a realistic reconstruction of the recorded content. For this reason, one of the JavaScript functions is responsible for the source site collection and works on the principle of mapping elements, and collected clicks or mouse movements are not based on pixel values, but on the percentage of the actual position of some HTML DOM elements. [6] Using the hash function on the mapped DOM, we can easily monitor any changes that occur on the site. Apart from that we have provided simple analysis of website content because when you add a new DOM element and change the Web site appearance, we still retain all the previous information about the previous items. With the collection of data on the size of the entire page (the page size), the size of the visible part of the site (the window size), and the constant tracking

of the scroll values, we are able to know the exact part of the site which was viewed by the visitors.

The data collected needs to be reproduced. For the purpose of this paper, several different types of reconstruction were realized. Reconstruction is divided into three parts, in which data were taken into account.

Reconstruction based on visits
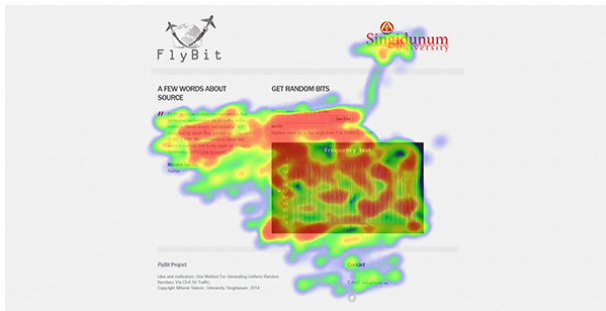
Figure 1. Heatmap of Mouse move
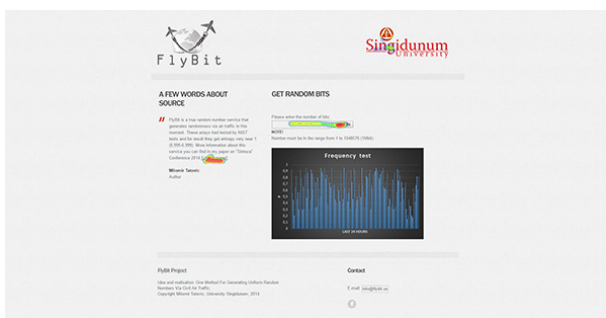
Figure 2. Heatmap of clicks

If we want to analyse the visit of a website, we need the reconstruction based on all the visits of that URL for the selected period. This type of analysis is best seen through a Heat map. The first heat map is created based on the scroll values and resolutions users had while navigating the site. It shows the visibility of the site, or precisely the number of users that has seen a certain part of the site. Second heat map shows a map of clicks on a web page. As already stated, all data is collected on the basis of mapped DOM, as in the case of Heat Map e-clicks makes us easy to show, because we don't need to take care of the different visitor's resolutions, and therefore the position of elements on the site, but only about those elements that were clicked on. Finally, the third heat map, the map that represents mouse movement. This map and map of clicks work on a similar principle, only mouse movement map takes a larger amount of data.

Reconstruction based on one visit

Figure 3. Single mouse tracking

This type of reproduction allows us to follow a specific user in real time or after completing a visit to the site. With the help of data collected, it is possible to display all visible changes that the visitor had, and even those made by some external script. This form of reconstruction was necessary primarily because of the following type.

Reconstruction based on the dependence between one and all visits
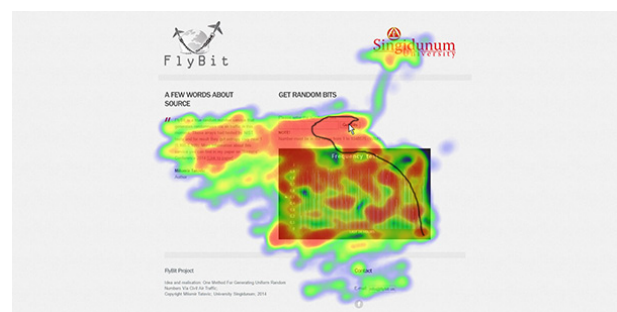
Figure 4. Single mouse tracking on mouse move heatmap

This type of reconstruction was necessary for continuing the paper. Here we can see how a visitor uses the site (real time or later after the visit), while in the background we can show a Heat map of all visits of all users or all visits of one particular user. In addition to this, it is possible to analyse the interaction with certain elements on the site. For example, we can see how often a certain button is clicked on the site. Some users always clicks on it when they enter the site, but on average basis, the button is clicked by every third visitor. These data are of great importance for further work.

4. TRACKING WITH BIOMETRIC ELEMENTS

Systems such as described above are based on monitoring of a particular user only via cookie. Such an approach is good if users do not delete cookies on their own or if they disable deleting cookies in browser settings. The question is why would someone do that? The largest number of ads that appear on websites are specifically based on cookies. As the user surfs the internet, the browser assigns a specific cookie on advertisement web pages. Later when the user visits a site where there are advertisements he gets the advertisements about a specific product he searched for. If the user does not have a cookie enabled like in the most cases, the advertisement cannot be displayed because there is no saved cookie data.

If we take such a system and add biometric knowledge, we get a complex system. It is known that it's very difficult to imitate anyone, so it is ideal for biometric systems such as this one. In those kind of systems, it is necessary to conclude whether the user is human or bot and later analyse if that user has already visited the web page.

The data we collect are essentially the same or substantially similar. Operating system or browser version are not so important. IP address, can mean a lot, but still cannot say anything. However, the mouse movement and clicks, like we discussed earlier give us a lot of information about visitors. Let's define the initial moment as the time when the user moves the mouse across the web site. In the first testing, we can observe the trajectory of mouse movement. If we decide to keep track of user in real time, or track a recorded session, we can activate the heatmap of mouse movement and thus immediately see if this session stands out from the rest. If this is the user who has visited previously, we can tell the probability based on the collected data whether it is the same user or not. The trajectory of the mouse movement and the cursor input at the visible part of the page carries a large amount of information. After the comparative tests it can easily be shown that the angle of the trajectory path is the best option for detecting the similar mouse movements. Straight or diagonal movement are most often characteristics of bot scripts. As shown in Figure 5., if we follow the new entry of the old visitors, we can detect similarities in movement. In addition to mouse movements, the second biometric characteristic is certainly the way a person is clicking or scrolling.
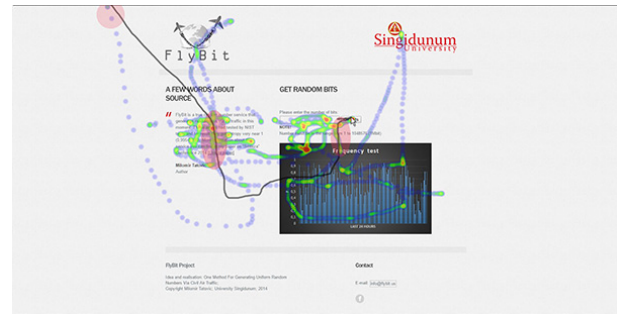
Figure 5. Live Mouse tracking on same Visitor mouse move heatmap

5. CONCLUSION

The system can provide more effective site analytics with the help of biometrics. In case of e-commerce, which is growing popularity, it can facilitate business to dealers and to customers and also secure sites from malicious impact. The development of this system as a proposal for future work should be undertaken more detailed visitor analysis, with the use of the psychological elements of real life, which would also facilitate research and save time.

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CRYPTOGRAPHY AND SECURITY

AN OVERVIEW OF STEGANOGRAPHIC TECHNIQUES AND METHODS APPLIED ON JPEG IMAGES USING DIFFERENT TRANSFORMATION TECHNIQUES

Dejan Uljarević[1],
Vladan Pantović[2],
Aleksandar Mišković[1],
Nataša Aleksić[3]

[1]Singidunum University,
Belgrade, Serbia

[2]Faculty of Business Economics and Entrepreneurship,
Belgrade, Serbia

[3]University of Kragujevac,
Faculty of Engineering,
Kragujevac, Serbia

Abstract:

Since steganography is a science that hasn't been fully researched, this paper gives an overview and analysis of current stenographic techniques and methods applied on different multimedia files. The emphasis is on applying steganography on JPEG images, where secret message encoding is done through various transformational techniques. Therefore, the paper gives an overview of the methods for detecting secret content through steganalysis.

Key words:

steganography, steganalysis, JPEG compression standards, DCT.

1. INTRODUCTION

Today, there is hardly no aspect of human activities where computers do not play a significant role. With that, human activities are made significantly faster and easier. Nevertheless, problems with information security often occur, as information is transferred through various channels and mediums in digital form. Business Information Systems and human communication functioning through a computer network increase codependence between the information and communication channels. Therefore, pieces of information become the target for many malicious users. This certainly leads to the necessity to protect the data in a business environment. To protect such data, besides applying such software as RSA, DES, AES, *etc.*, it is also possible to apply stenographic techniques that enable data protection by hiding behind harmless looking objects. Steganography is the practice of concealing messages in other data, so that the existence of ciphertext is hidden in the information carrier. The word steganography combines two words of Greek origin, στεγανοσ (steganos) and γραφο (grapho), which translates to concealed writing. The goal of steganography is to transfer the information from sender to receiver by imprinting the message in the information carrier, which needs to be intelligible and comprehensible to the target destination.

Unlike cryptography where the malicious user intercepting the encoded message is aware of the secret communication, with steganography the secret communication can remain undetected, since it is not possible to detect the differences indicating the presence of steganography [1].

Correspondence:

Dejan Uljarević

e-mail:
duljarevi@gmail.com

As the digital world doesn't have perfect and impenetrable data protection systems, it should be noted that steganography carries risks that can endanger this security approach, because in the process of modifying *i.e.* encrypting the secret message, some of the parameters in the structure of the file – stego object, can be altered and disturbed compared to the original stego medium[1]. By monitoring and comparing the occurring changes, there is a possibility of an attack on these systems, which will be described in detail in this paper through various methods and techniques used in Steganography and steganalysis. The rest of this paper will deal with describing steganography systems applied on JPEG images where the secret message is hidden through various transformation techniques.

2. STEGANOGRAPHY

Steganography is a scientific discipline whose goal is to protect certain confidential messages in the best way by skillfully hiding them [2]. The main principle of steganography is based on using the mediums that are available to a wide range of people. Nowadays, modern steganography is most commonly applied in the world of digital technology, within the contents of a multimedia file that can be an image, an audio or a video recording, *etc*. The secrecy of the message is tied to the steganographic system[2] and a secret key under which the secret message is hidden. Modifying the stego medium creates the stego object which is sent through one of the known communication channels. When the stego object arrives to a certain destination it is unpacked using a previously defined secret key and the steganographic system, and the secret message is revealed. A model of how a steganographic system functions is shown in Figure 1.
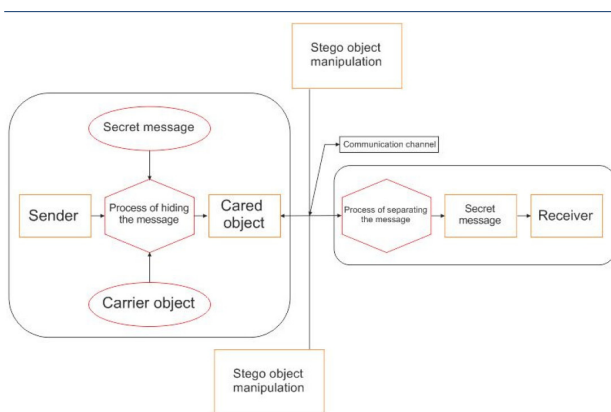
Figure 1. Schematic diagram of how a steganographic system functions

1   The original object in which the secret message is inserted
2   Algorithm for hiding the secret message in the stego medium

Information protection can this way exist in the form of a visible digital watermark and in the form of digital steganographic techniques which include three very important aspects in its functioning [3]:

- Capacity – the amount of information that can be hidden in a stego medium
- Security – the degree of inability of a detection device to uncover the secret
- Robustness – the amount of modifications that a stego medium can endure

Visible Digital watermark system is mostly used for protecting digital media copyrights and its goal is to achieve a high level of robustness – *i.e.* to disable removing the certificate without reducing the quality of the object data, while other steganographic techniques have a wider application, are invisible to the naked eye, and can be applied through the following categories [4]:

- Substitution techniques: Excess parts of the message carrier (medium) are used to insert the secret information. The most prominent technique in this category is LSB (Least Significant Bit) which makes the least significant bits the carriers of the hidden message.
- Transform domain techniques: Modification is performed in a transformed domain. The techniques most commonly used are Discrete Cosine Transformation, DCT and Discrete Fourier Transformation, DFT.
- Spread Spectrum, SS techniques: Narrowband information signal is hidden within the medium. The secret message is modified by a noise signal and added to the medium: only by knowing the key can the seemingly random signal produce the hidden message. There are two spread spectrum methods used in digital steganography - Direct Sequence Spread Spectrum, DSSS and Frequency Hopping Spread Spectrum, FHSS. These methods are typically used for transferring data in wireless systems, they increase resistance to jamming and enable multiple users to transmit simultaneously in the same frequency band.
- Statistical methods: The carrier is divided into the number of blocks corresponding to the size of the message. Each block is used to hide one bit of the secret message. If the bit of the message equals 1, the block is modified so that the message receiver can determine if the block has been changed by statistically analyzing the hypothesis. If the bit of the message is 0, the block remains unchanged.

- Reshaping Techniques: The secret message isn't hidden directly in the medium, it is reshaped to convey the secret message. The receiver is required to know the original version of the medium in which the message is hidden, which is the key to revealing the secret content.

- Creating the hidden information medium techniques: The secret message is not hidden in the medium, but the corresponding medium is created based on it.

3. JPEG FORMAT

Although steganography is applicable to a variety of multimedia content, this paper will focus on analyzing hiding data in JPEG images (steganography and steganalysis techniques and methods) [5]. Steganographic systems for JPEG format are particularly interesting because the systems function in a transformed space and are not affected by visual attacks.

JPEG format is one of the most popular and most commonly used image formats on the Internet, because it is convenient and practical when it comes to compression. This standard provides very good, or even excellent, both black & white and color image quality. It is simple to implement, and its software algorithms are at an acceptable level of computational complexity. JPEG belongs to the class of transform coding techniques, meaning that the compression isn't performed directly on the signal, but on its transformation. When it comes to image editing, most commonly used transformation is Discrete Cosine Transform (DCT). The main characteristics of DCT are a high degree of data "packaging", as well as availability of fast algorithms for its computation. The rest of this paper will deal with the methods and techniques for applying these systems.

4. JPEG COMPRESSION STANDARD

JPEG standard is the first standard in the area of image compression which applies to black & white and color image compression and it is a common standard for three international organizations: ISO, IEC and ITU [6]. The popular name JPEG is an abbreviation for the name of the working group that worked on its creation for many years (Joint Photographic Experts Group). The main goals achieved by adopting JPEG standards are [7], [8]:

- Standard enables compression of any digital image, greyscale or color, with or without loss.

- Standard is applicable to a digital image regardless of its resolution. If the number of pixels of

any dimension is indivisible by 8, the image is internally expanded by an adequate number of pixels.

For compression with loss the number of bits per pixel of a black & white image (or per color component) can be either 8 or 12, while for a lossless compression the number of bits per pixel can range from 2 to 16.

The standard imposes the methods that provide a high level of compression, ensuring very good or excellent quality of the reconstructed image. The standard enables setting a parameter in order to reach a compromise between the degree of compression and the quality of a compressed image.

The standard recommends compression methods that are computing efficient and convenient for software implementation on different processors and operating systems, or for hardware implementation in the VLSI technology with moderate production costs.

Standard enables performing a luma component reconstruction from a compressed color image, with no need for decoding the chroma components.

JPEG standard enables four methods for compressing an image:

1. Sequential coding: the image is coded from left to right, top to bottom.

2. Progressive coding: the image is coded in several waves, so that in applications with long data transfer time the user gradually receives the more detailed structure of the image.

3. Lossless coding: the reconstructed image is identical to the original, although the degree of compression is lower.

4. Hierarchical coding: the image is coded in different resolutions, where reconstructing a lower resolution image doesn't require knowing the data about coding a higher resolution image.

Figure 2 shows links between four methods of compression specified by the JPEG standard.
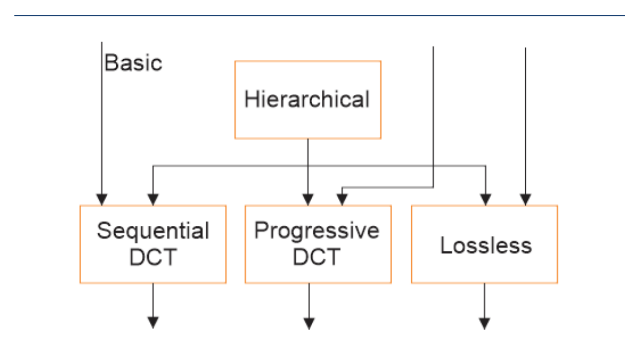
Figure 2. Scheme of four methods of compression specified by the JPEG

JPEG sequential coding

The basis for the JPEG standard (except Lossless coding) is consists of the process of transform coding the image with Discreet Cosine Transform [9]. Based on the subjective analysis and computing efficiency, a division of the image to blocks of 8×8 pixels was adopted. Since the pixel values are 8-bit positive numbers, 128 is subtracted from the value of every pixel before entering the coder, so that the value of input pixels f (x, y) lies in the range [-128, 127].

By using the Discreet Cosine Transform, every block of pixels is transformed to a group of 64 DCT coefficients representing amplitudes of orthogonal basis functions, *i.e.* a "two dimensional spectrum" of the input signal.

Unlike black & white images, color images require a more complex way of applying this system, and it is done by first performing the RGB→YCbCr transformation, and then dividing every luma component Y into blocks of 8×8 pixels. Images of chroma components Cb and Cr are first divided into blocks of 16×16 pixels, which are then divided into 2, and thus reduced to the size of 8×8 pixels. So, on every four blocks of the Y component there is one block of chroma components Cb and Cr. Then all three components of the image Y, Cb and Cr are independently transformed by applying DCT.

In order to achieve data compression, output data from each DCT block i. e. 64 DCT coefficient, must again be quantified and coded. Quantifying is done by dividing each DCT coefficient by an adequate element of the quantization matrix which can be seen in Fig. 3. and by rounding to the nearest number according to the following equation (1):

$$Fq(k,l) = int \frac{F(k,l)}{Q(k,l)} + 0,5 \qquad (1)$$

16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

Figure 3. Quantization matrix for 8×8 pixel block.

The last step in compressing the image according to JPEG standard is entropy coding. In this way, the DC coefficients F (0,0) are treated in a different way than AC coefficients. Namely, since DC coefficients of nearby blocks are very similar, the difference between DC coefficients of two nearby blocks in a block sequence is subjected to entropy coding. The order of processing DCT AC coefficients is in the shape of a zigzag sequence which is shown in Fig. 4.
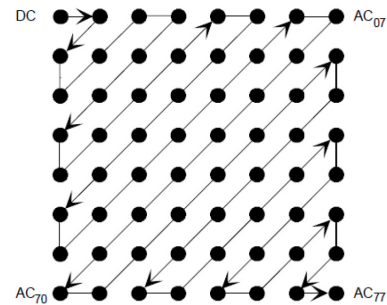
Figure 4. The order of processing DCT coefficients in 8×8 block.

This pattern facilitates entropy coding because the higher value coefficients are at the beginning of the sequence. Entropy coding is compact coding of DCT coefficients based on their statistical features. Huffman code is used for entropy coding in JPEG sequential method. The first step in entropy coding is converting the zigzag sequence of quantized coefficients into a sequence of symbols. The second step is converting symbols into a sequence of data where it is no longer possible to identify the ends of those symbols. To apply the Huffman coding, it is necessary to specify one or more coding tables used on both input and output side. JPEG standard does not provide a single coding table, this is done by the system user, but Huffman tables used while testing in the process of developing the standard are provided in addition. Block diagrams of JPEG coder and decoder for sequential coding of a black & white image and individual components of a color image are shown in Figure 5.
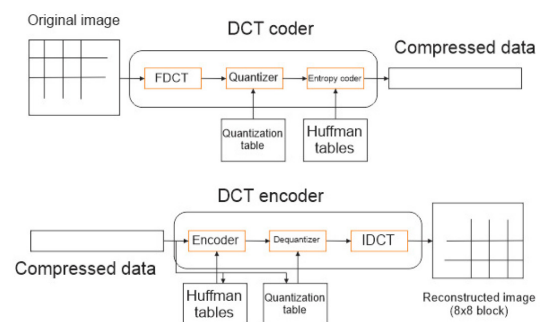
Figure 5. Block diagram of JPEG sequence system for compressing a component of a color image: (a) coder, (b) decoder.

JPEG progressive coding

Progressive coding of an image differs from sequential coding in the fact that the coding of DCT coefficient is done in several wavelets, with every wavelet transferring only a part of quantified DCT coefficients. In progressive coding, there are two procedures for dividing DCT coefficients.

- ◆ Spectral selectivity
- ◆ successive approximation method

Organization of DCT coefficients and division of DCT coefficients in both ways is shown in Figure 6.
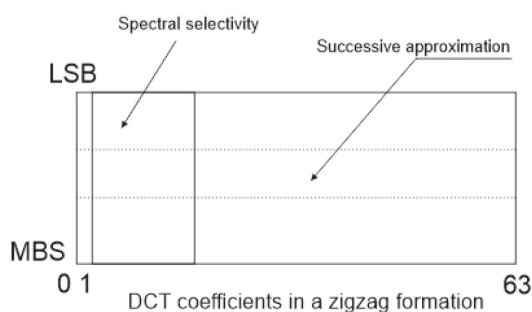
Figure 6. Editing DCT coefficients for progressive coding

In order to carry out progressive coding of an image, it is necessary to add a buffer memory behind the quantizer and before entering the entropy coder for all DCT coefficients. Minimum required capacity of this memory for compressing a black & white image is given in the following equation,

$$C = MN(b + 3) \qquad (2)$$

where M and N are image dimensions, and b is the number of bits per pixel in the original greyscale image. Increasing the number of bits per pixel by 3 is the result of energy compression, which is why some of the DCT coefficients have significantly bigger values than the original pixels. In the case of color images, minimum required memory capacity is 50 % bigger.

In the process of Spectral Selectivity DCT coefficients are grouped into spectral ranges. First, the DC DCT coefficient is transmitted, then two most significant AC DCT coefficients, and then in the following wavelets groups of three AC DCT coefficients are transmitted. On the receiving side, the image initially has a block

structure which is gradually lost during transmission. For an acceptable image quality, it is usually enough to transmit DC and the first five AC DCT coefficients. When all of the DCT coefficients are transmitted, it results in getting the same image as with the application of the sequence algorithm. With successive approximation methods, DC DCT coefficients are transmitted in full accuracy. Then, in the second wavelet, four of the most important bits of all AC DCT coefficients are transmitted. In the following wavelets, image quality is improved by transmitting the rest less important bits. Successive approximation method provides a better quality image with smaller bit rate. It is interesting that the spectral selectivity method and the successive approximation method can be successfully combined.

JPEG lossless coding

For lossless coding of an image, JPEG standard uses simple predictive methods of compression[3]. The standard specifies seven methods of prediction, which are defined by the equations (3) and (4).

$$f\hat{}\ (m,n) = A \qquad (3)$$

$$f\hat{}\ (m,n) = B \qquad (4)$$

What is used for the first line of the image is the prediction method (3), and after subtracting the estimated values from the actual values of the pixels, the result image of the difference is entropically coded by applying the Huffman or an arithmetic coder. Even though the standard supposes that each pixel of the innitial image can be represented by 2 to 16 bits, JPEG standard is practically used to decompress images represented by at least 4-5 bits per pixel, when getting a degree of compression of around 2. If the number of bits per pixel is smaller, better results can be produced by applying other lossless image compression methods.

JPEG hierarchical coding

Hierarchical coding method is intended for progressive image transmission, because it is performed in several wavelets. However, unlike regular progressive coding, here, with every wavelet, spatial resolution of the image is altered by the factor of 2 on both dimensions. This provides a hierarchical representation of the image in the shape of a pyramid, which is shown in Figure 7.

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3   Lossles methods for compressing JPEG image
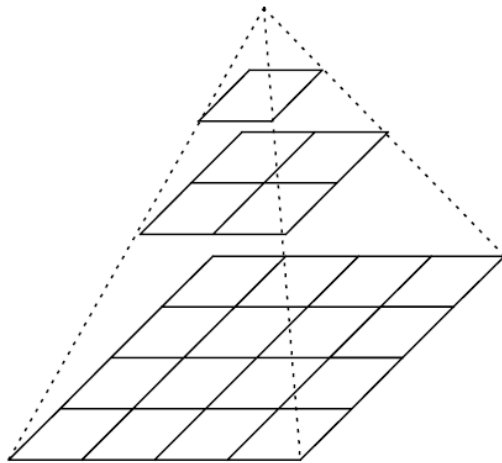
Figure 7. Hierarchical representation of an image.

The procedure of hierarchical coding can be divided into the following phases:

- The original image is filtered by a low frequency filter and is decimated by a factor of 2 on each dimension.
- Reduced image is coded using the previously described sequential DCT method, progressive DCT method, or using predictive lossless coding.
- The reduced image is decoded and interpolated by a factor on both dimensions, using the same interpolation filter used on the receiving end.
- The difference between the interpolated image (serving as an estimate) and the original image in the same resolution is formed, and the difference image is coded using the previously described sequential DCT method, progressive DCT method, or using predictive lossless coding.
- This process is repeated until the image is coded in full resolution.

Hierarchical coding is very useful in instances where a very high resolution image must be shown in a low resolution. This scenario occurs when an image is scanned and compressed in very high resolution for printing on a high-quality printer, and it needs to be shown on a video monitor of a computer with a significantly lower resolution.

Of the three JPEG coding methods based on using DCT, hierarchical coding provides the best quality of the image with extremely small bit rate. However, when excellent image quality is required, progressive transmission demands a somewhat bigger bit rate than sequential or hierarchical methods.

5. STEGANALYSIS

Steganalysis or third party steganography detection, is a relatively young research discipline with the first articles on the subject published in 1990s. The main task of steganalysis is to solve three main tasks: detecting, defining and decoding a hidden message.

To detect hidden messages, steganalysis uses methods of spotting changes: visual detection (files with jpeg, bmp and gif extensions), audio detection (files with wav, mpeg extension), static detection (change in the pixel pattern or LSB) or histogram analysis and structure detection or unusual structure detection (content review of the file, its length, change in date and time, content modification and checksum – limit number of bits).

Attacks on hidden information can have several forms: detection, separation or destruction or decoding the hidden information. System is already unsafe if the attacker is merely able to prove the existence of the hidden information. The initial assumption is that the attacker has unlimited computer resources and is able to apply a variety of attack algorithms. Attacks on steganography systems can theoretically be divided into three types, based on the end goal of the attacker: passive, active and intentional.

Passive attacks include techniques that merely detect the existence of a hidden message, for example, static testing of a hypothesis in which there are two possibilities of error: I-type error occurs when existence of a secret message in the carrier is detected, and it doesn't actually exist, and II-type error occurs when the secret message is undetected, and it actually does exist.

Active attackers are able to modify a stego carrier during transmission, but not too much, because in that case perceptual and semantic properties would be altered. Active attacker, often unable to detect the existence of a secret message, can add a random signal to the stego carrier and destroy the secret information. Attackers can be accidental and intentional. An example of an accidental attacker can be an accidental noise accumulated during a signal emission through one of the outside connections. That is why one of the more significant demands a steganographic system must meet is robustness, so that the imprinted secret information cannot be damaged without drastically altering the stego carrier. It is important to emphasize that there is a compromise between security (secrecy) and robustness. Security requires that the secret information is hidden in the areas

which are perceptually conspicuous because that way it will be more difficult to damage the information without significantly degrading the quality of the carrier. There are generally two principles to make a robust steganographic system. The first system predicts possible attacks and then projects a procedure for implementing the secret message that is robust to that kind of modifications, so that the modification doesn't completely destroy the information. The second strategy is to apply inverse modifications from those used in an attack in order to reconstruct the original secret information. Intentional attackers try to falsify a message or start a steganographic protocol by impersonating a communication partner. In an intentional attack robustness is not enough. In cases when implementation process doesn't depend on a secret information only known to the sender and the receiver, the intentional attacker can falsify the message, considering that the receiver isn't able to verify authenticity of the sender's identity. In order to anticipate this, the implementation algorithm must be robust and secure. This is why a secure steganographic system is presented with four main demands it must meet:

- Messages must be implemented in the carriers using public algorithms and secret keys.
- Only the holder of the right key can detect, separate and prove the existence of a secret message.
- Even though the attacker manages to select the contents of a secret message, they cannot detect other messages
- From an informatics standpoint it is impossible to detect a secret message.

6. CONCLUSION

As it can be seen from this synoptic paper, steganography has at its disposal very efficient and powerful solutions, which can be of great significance to quality security and protecting confidential information. Steganographic techniques are very simple to use, extremely difficult to detect, and very reliable. Steganography's main goal is to keep the existence of a secret message undetected. The secrecy of the message is tied to the steganographic system (algorithm) and the secret key under which the secret message is hidden. Apart from the positive side, steganographic methods can be used for illegal purposes, which is why, in recent years, steganography has been the main subject of many discussions about its misuse. The main argument in its defense and disclosure

is steganalysis which is a younger scientific discipline than steganography. Various steganalysis methods listed in this synoptic paper can very successfully uncover and prevent any illicit actions.

This synoptic paper analyses existing steganographic systems which can use JPEG images as stego mediums. Applying discrete cosine transform, the first step in JPEG algorithm is compression of the original where successive blocks of pixels are turned into individual DCT coefficients in which the confidential data is inserted. The paper also shows recent research on detecting them through statistical steganalysis. Other analyses focus on the general use of hiding and protecting information and give an overview of detection algorithms.

Considering all of the listed methods and techniques, steganographic or steganalysis, there is a lot of space for further development and improvement, and therefore, for use of these systems in everyday human activities.

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CRYPTOGRAPHY AND SECURITY

METHODS AND TOOLS FOR PLAGIARISM DETECTION IN ARABIC DOCUMENTS

Intisar Abakush

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Due to the great revolution of data streams, people search for new ideas in miscellaneous fields of knowledge. As a consequence, there are various types of plagiarism issues. Excellent treatises have emerged with the aim of detection and protection from plagiarism. Statistics, methods, and software rwith more details and applications will prevent from overlapping and facilitate creating of something new in a clear and short manner. In our paper, we have focused on the plagiarism detection methods in Arabic documents and their systems. We have also highlighted some software which seemed to be useful in detecting plagiarized materials.

Key words:

plagiarism definition, plagiarism detection tasks,
plagiarism detection tools, Arabic.

1. INTRODUCTION

Due to the great extent of development in the world of technology and communication, plagiarism has become a significant challenge. Plagiarism has been found everywhere: on different levels of academic writing (school, institute, university, *etc.*), engineering, medicine, music, painting, literature, *etc.* It has been dubbed as illegal quotation, theft, cheating, and, piracy and alike.

2. PLAGIARISM AND ARABIC LANGUAGE

Plagiarism Definition

Derived from the Latin "plagiarius" which means "kidnapper, seducer, literary thief."[1] From the earlier English word "plagiary" is "the one who takes someone's words or ideas unjustly".

For the time being, the word "plagiarism" does not have the unique term in Arabic. Current conditions are literary theft, scientific theft, arrogation, *etc.*, but there is a tendency of using the word ''/انتحال''intihal" which means arrogation of authorship.[2]

We may define plagiarism as an illegal quotation of someone else's effort, whatever effort was it (an idea, invention, writing, methodology, design, *etc.*), and in different ways such as copy-paste function, by paraphrasing without exact citation.

Correspondence:

Intisar Abakush

e-mail:
ntsrbksh@gmail.com

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Arabic Language Characteristics

As aforementioned, the plagiarism problem is still a challenge, particularly owing to significant technological revolution. Still, it has been the biggest challenge in Arabic language.

The Arabic language belongs to Afro-Asian language group and it has been ranked as the fourth language in taxonomy of languages around the world. It has lots of specificities that make it so different compared to other Indo-European languages [3]. The Arabic language has many features and we have summarized them as follows:

- Arabic language has 28 characters [,أ, ب, ت, ث..,ي], three of them are vowels, [و, ى, ا] and others are consonants.

- A character's shape sometimes changes depending on its position in the word. For example: [ي، Y] in [See, رظني Yndr].

- Unlike other languages which are written from left to the right, Arabic language is written from right to the left and it does not have capitalization. There are two types of writing: ةعقرRogaa and خسنNasaha writing.

- Arabic documents are read and understood clearly by adding some diacritics above or under each character in word,[ُ , ِ , ّ], for example [عَرَقKaraa, knock, while ,Kara عُرَق Zucchini]

- The root of every word in Arabic has just three characters, and new word is formed by adding some suffixes [name, verb, number, *etc.*]; for example: [Wrote, Ktabبتك], [بتكمmaktb. office].

Person and verb have three forms (singular, dual, and plural).

The remainder of this paper is organized as follows: the next section is related work, then plagiarism detection taxonomy; we classified the plagiarism into two definitions: plagiarism detection define types and plagiarism detection set tasks. Then, we demonstrated textual features in glance. After that Plagiarism Detection Tools in Arabic Documents, and plagiarism detection tools in Arabic documents, by highlighting some software as a good example of automatic plagiarism detecting in Arabic documents. The final sections presents concluding remarks.

3. RELATED WORK

The academic plagiarism is not a new phenomenon. Since year 1920, researchers have analysed the problem by focusing on North American colleges, where most of studies use self-report surveys to evaluate plagiarism behavior [4]. 1970 code clones and software misuse detection has started [5]. In 1990 plagiarism detection in natural languages was manual detection, while in 2005 researchers used automated plagiarism detection in text documents [5].

Since 2009, it actually started the work for detecting the plagiarism in Arabic world. We have to mention the biggest competition, by name "PAN plagiarism detection competition", where the evaluation corpora were mostly English. While "AraPlagDet"[Arabic Plagiarism Detection] share tasks is the first plagiarism detection competition on Arabic documents in 2015 and still continuous till now involves two sub-tasks, namely External and Intrinsic plagiarism detection[6].

"AraPlagDet"[Arabic Plagiarism Detection] is the first shared task that addresses the plagiarism detection in Arabic texts in "PAN plagiarism detection competition". Many researchers adopted this idea for their knowledge development and raising of the awareness level on the plagiarism problems and the importance of its detection in the Arab world.

4. PLAGIARISM DETECTION TAXONOMY

Plagiarism detection taxonomy sets two major types of plagiarism. First, one is: plagiarism detection sets types, and second one is: plagiarism detection sets approaches, which also called plagiarism detection tasks. Both also have two subtypes, as we shall soon find out.

Plagiarism detection set Types

As we can notice from the plagiarism definition and the related work, there are two types of plagiarism: plagiarism programming language and natural language plagiarism.

Plagiarism Programming Language the main attention of this type of plagiarism detection is tracking the metrics of that program, such as lines number, variables, data and part of program calls to another part of program in other program. There are many tools for detecting this kind of plagiarism [7]. For instance, but not limited:

- MOSS (Measure Of Software Similarity): It is free code plagiarism tool system for academic usage only. MOSS supports different operating system. The software uses finger print method to evaluate the similarity between evaluated codes.

- ◆ YAP/YAP3 (Yet Another Plague): A code-based it treats programs as a sequence of strings; the latest version YAP3 introduces an utterly novel algorithm for facing with the presence of block-moves in programs.

- ◆ SID (Software Integrity Diagnosis or Share Information Distance): Plagiarism detection system like MOSS and YAP proceeds with coding the input sequence and then comparing the coded sequences [8].

Natural Language Plagiarism deals with many textual features and diverse detection methods. Natural language plagiarism may also be called the textual plagiarism detection, and comprises two main classifications.

Plagiarism detection Language according to natural languages plagiarism detection, there are two types of lingual plagiarism detection, unilingual and multi-lingual plagiarism detection.

a) Unilingual plagiarism detection - most researches seek for developing the plagiarism detection system for unilingual plagiarism detection. It addresses the automatic identification and elicitation of plagiarism in unilingual, for example: Arabic-Arabic.

b) Multi-lingual plagiarism detection - researchers have been focused on this type of plagiarism detection just recently. It addresses the automatic identification and elicitation of plagiarism in multilingual contexts. For example, French - Arabic.

Textual plagiarism detection - is classified into Literal and Intelligent. Each of them has its sub-classification of plagiarizing and techniques of plagiarism detection.

Literal Plagiarism – the easiest and most common one, in which the plagiarist obviously copies the text from the original source and uses it as its won. Verbatim Plagiarism occurs in three cases: exact copy, near copy and modified copy (restructuring), with the last one being most challenging for detection [9].

Literal plagiarism ——
- Exact copy
- Near copy
- Modified copy
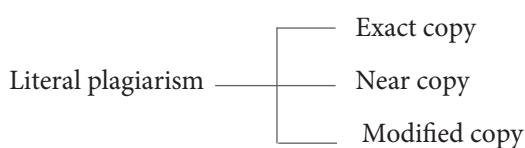
Intelligent or masterly plagiarism is a grave fraud where the plagiarist tricks readers by presenting contributions of others as their own. Intelligent plagiarism

appears in various intelligence phases such as manipulating text, translating text and adopting idea[10].

Text manipulation plagiarism - obscures the text manipulation mostly by changing its appearance, but not the idea. Words are being replaced by their synonyms/antonyms, and restructure the sentences in a text into shorter form.paraphrasing, by using a sentence reduction, etc. All of this is just one more form of plagiarism, unless being cited properly.

Translation is a form of plagiarism that occurs by original text translating from one language into another. This translation can be done automatically, by using some translating engine such as "Google Translator", or manually, by people who speak both languages.

Idea adoption is the most serious plagiarism that refers to the use of ideas of other people without citing the source of the idea. These could be results, contribution, findings, conclusions, *etc*.

Plagiarism Detection Tasks

Plagiarism detection is a hypernym for computer-based approach which supports identification, plagiarism detection information retrieval task supported by specialized IR (information retrieval) systems, called plagiarism detection systems which implement one of two generic detection tasks.

Extrinsic Plagiarism detection compares a suspicious document with a reference collection, which is a set of genuine documents. The comparison requires a document model with defined similarity criteria and the task is to retrieve all suspicious document [11].

Intrinsic Plagiarism Detection examine conditions of plagiarism by searching into doubting documents in isolation. Intrinsic plagiarism detection is highly percentage represented, human's ability to detect the plagiarism; by noting, analyzing different style of writing for the same author [12].

5. TEXTUAL CHARACTERISTICS

There are several textual characteristics to evaluate and characterize texts before applying a plagiarism method, especially quantifying according to plagiarism detection tasks and characterizing according to methods and tools used for detecting plagiarism in documents.

Textual characteristics in extrinsic plagiarism detection [13]

According to plagiarism detection tasks, textual features of representing documents in extrinsic plagiarism detection include:

Lexical characteristics, it works on character or word grams level. such as character n-gram and word n-gram, both called the fingerprints or shingles, in retrieval of text in detection of plagiarism in research.

Syntactic characteristics is plagiarism extraction by quantifying the similarity of sentences, phrases, part of speech, *etc*. the text in a syntactic way, such as conjunction of sentences, position of adverbs, preposition, and so on.

It is usually difficult to measure semantic similarity between documents, comparing with measuring just word similarity. And it useful when measured semantic similarity between documents to base on a similarity index that measures the number of similar words based on several possible algorithms [14]. These features and all previous are also called flat document features.

Structural characteristics also called tree features, reflected text formation, therefore detecting more documents semantics. We can find structural characteristic in header, title, sections, paraphrasing, *etc*. Structural characteristics could be used to create some web pages and special kinds of files, such as xml file.

Textual characteristics in internal plagiarism detection

According to Intrinsic Plagiarism detection tasks, textual features for representing documents in Intrinsic Plagiarism detection include just stylometric features. We know that Stylometry is extremely important in the context of internal plagiarism detection, and due to the truth that, each individual has its own specific writing style and hence, it is the only possibility to distinguish authors from each other [15]. Simon *et al*. defines Stylometry as "a discipline that determines authorship of literary works through the use of statistical analysis and machine learning" [15]. Textual characteristics fall into the following categories:

1. statistics of text: operate at the character level
2. Syntactic characteristic.: measure writing style at the sentence-level [15].
3. "POS characteristics: to quantify the use of word classes" [15].
4. "Closed-class word sets: to count special words" [15].
5. "Structural characteristics: which reflect text organization" [15]. According to these findings, each category refers to one specific text layer [15].

6. PLAGIARISM DETECTION IN ARABIC DOCUMENTS

Despite the lack of large-scale studies of the widespread plagiarism in the Arab world, this problem had attention from the large number of news which attest its pervasiveness. There are also some studies that show the lack of awareness on the definition and seriousness of plagiarism among Arab educative[16].

In the last years, many types of plagiarism detection research have been conducted, yet those concerning the text in Arabic language have remained quite limited. To the best of our knowledge, the sole works in this area are those of Alzahrani *et al*., Menai *et al*., and Jaoua *et al*. All of them used the external approach [17]. However, Intrinsic approach was the best reference of Bensalem, *et al*. As already mentioned, the greatest competition "PAN plagiarism detection competition" has widely opened the door to researchers for the methods development and plagiarism detection tools of the plagiarism in Arabic documents. "AraPlagDet" is the first common task that has been addressed to the plagiarism detection in Arabic texts.

These studies have suggested the use of plagiarism detection software as one of the problem solutions.

As we see in the table below, these are useful tools used to automatically detect the plagiarized Arabic documents, in good time and accurate way:

Turnitin/ Turnitout

This software is very good and its accuracy is high.

Turnitin has special and strict rules; if applied at university or faculty level, it achieves the best results. The disadvantage of this software is that it does not support individual work, respectively the system user has to be employed in some firm. Also, the user has to pay for every feature added in his system. Moreover, nowadays there is another software called Turnitout which works similar to Turnitin, , but it is intended for private users only. Although it is not deal with Arabic documents, turnitout gives good result in English materials.

Software	Language	Document extension
QARNET	Arabic, English	Microsoft Word, doc, txt, HTML, RTF
Turnitin/ Turnitout	31 language and Arabic, English	All files: power point, Excel, HTML, images, *etc.*
Ferret Copy Detection software	English, China, Arabic	Text documents (.txt) Word processor formats (.doc, .docx, .rtf, .abw) . and pdf documents (.pdf)
Aplag	Arabic	
Iplag	Arabic	
Plagiarism Checker	More than 190 languages supported.	Almost all files.

Table 1. plagiarism detection tools

PlagiarismChecker

Free, easy and detailed instructions, ideal for educators to check whether a student's paper has been copied from the Internet. The "Author" option allows a check if someone has plagiarized your work online.[18]

7. EVALUATION

We built our corpus *i.e.* suspicious documents adapted from various resources, like Bensalem, *et al.* Also, Almenai *et al.* Among these sources were web sites www.alwaraq.com (Al menai) and http: //ar.wikisource. org. (Bensalem) in order to evaluate automatic plagiarism detection methods and their precision and speed in the Arabic language.

For the same documents, we conducted our tests on three types of software (plagiarism.net, plagiarism detector, and QARNET). As shown in the following table and figure below, the results are almost close, but the time required showing the result is very different. Note that both software (plagiarism.net and QARNET) are considered as the most accurate gauge of plagiarism detection in Arabic documents, although Plagiarism detector software is faster than the hand to show the result.

Time/sec	Plagiarism%	Doc./Size	Software
109	58	Doc1/ 323word	Plagiarism. net
57	71	Doc2/Word148	
4800	57	Doc1/13	QARNET
	20	Doc2/12	
10	55	Doc1/14057	Plagiarism Detector
6	90	Doc2/12741	

Table 2. Plagiarism detection tools evaluation

The table discloses tha every software has its won technique to calculate the size of examined documents, the percentage of plagiarism alert threshold and the information retrieval sources (candidate documents), which are compared with suspicious documents to get the results as in the figure below.
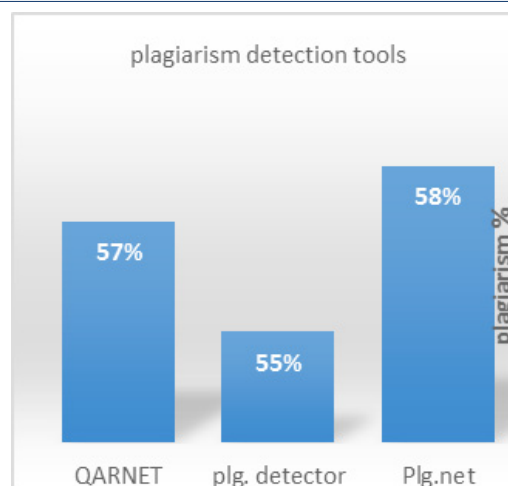
Figure 1. Plagiarism detection tools evaluation %

8. CONCLUSION

Methods that were developed and tested in Arabic documents are very few. As mentioned above, they were evaluated using different strategies and corpora, which makes them difficult to draw a clear conclusion on their performance. There was an effort to build annotated corpora in Arabic for external plagiarism detection and also Intrinsic plagiarism detection. So far, they have been used only by their authors [19]. In our study, we plan to improve our statistics of plagiarism detection in Arabic documents, to reach a new stable point at which the evaluation tools within the framework could be run

smoothly from the box. In particular, we will encourage software submissions accurate and fast not only for detailed comparison but also for candidate retrieval, again using experimentation platform to facilitate this goal. Our vision is to implement accurate and fast automatic plagiarism detection evaluator, available to all researchers in this field.

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CHECKING CORRECTNESS OF HARDWARE RNG ARCHITECTURE SPECIFICATIONS

Igor Fermevc,
Saša Adamović

[1]Singidunum University,

32 Danijelova Street, Belgrade, Serbia

Abstract:

In this paper we will show one possible implementation of hardware randomness generator. The device in question is based on widely available electronic components comprised of double analogue comparator operating as a free running oscillator and RISC microcontroller used for post processing. Finally, we incorporated an USB interface for communication with the device in order to acquire and evaluate its practical use in cryptography. Data generated by our device show very good randomness characteristics and have high entropy.

Key words:

random number generators, cryptography, registers, FRO, noise.

1. INTRODUCTION

Starting from the assumption that only physical processes that occur in nature can be fully unpredictable, undetermined or random, constant efforts are made in the field of modeling sources of randomness whose product will satisfy mathematically defined characteristics established in theory of probability and statistics [1]. By observing the characteristics of electronic noise, we can conclude that they comply with the basic principles of randomness, such as normal probability distribution of values and uncorrelated sampled values. With the help of surrounding electronic components, the first half of analogue comparator chip has been set to free running oscillation state in order to produce a wideband noise signal which, from mathematical point of view, has the proper characteristics as stated earlier. This noise signal is digitized with the use of the second half of comparator chip and is forwarded to input of microcontroller for further sampling and maintenance of randomness pool. Besides input signal sampling routine, the running microcontroller code implements the mechanisms for noise signal quality, randomness pool quality and protection for the user of randomness in case of potential attack or external electromagnetic interference. The communication with the user of randomness is accomplished by the use of USB/RS232 protocol translator chip, which is, from the aspect of cryptology, only part of the device we delegate the trust to.

Correspondence:

Igor Fermevc

e-mail:

igor.fermevc.12@singimail.rs

2. RELATED WORK AND MOTIVATION

According to the type of device and randomness source, hardware based randomness generators can be roughly divided as shown in Figure 1.
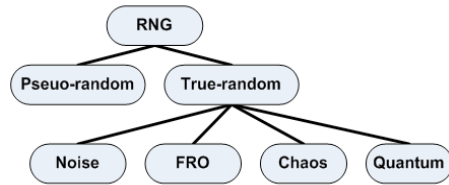
Fig. 1. Types of randomness generators

From the hardware randomness generators survey given in [2], we can assume the general block diagram of operation given in Figure 2.

Fig. 2. TRNG operation block diagram

Commercially available devices presented in this paper are using USB interface for communication with the user. This feature allows the ease of use and high portability, so we have accepted it as a good solution and implemented it in our device. Source of randomness of generators shown in Figure 3 is based on a physical process occuring in reverse biased PN junction [5]. Potential problem with this solution is high dependency of noise characteristics on physical properties of used semiconductors. To be more precise, besides the fact that these electronic components are working in an environment close to their breakdown, their physical properties deteriorate with time. Additional complexity in terms of design of these devices lies in the fact that USB interface provides low voltage, so one must implement power step-up circuit in order to produce

good characteristics of noise signal from simple PN junction. Our goal was to simplify the design and increase reliability, so we opted for the solution proposed in [6] and based on the signal which is a product of free oscillating analogue comparator.
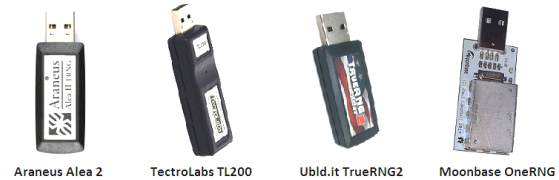
Figure 3. Commercially available randomness generators [8,9,10,11]

3. EXPERIMENTAL WORK AND EVALUATION

Hardware implementation of cryptography randomness generator

To create randomness generator the schematic diagram shown in Figure 4 was used. In order to keep the device footprint as small as possible, we opted for SMD electronic components. The circuit in Figure 4 contains a couple of segments which correspond to operation block diagram shown earlier. First, there is a double analogue comparator LM393 which functions as noise source and digitizer. Microcontroller Atmel Attiny85 is next in line and has the role of processing the digitized noise signal, randomness quality control, post processing and random pool maintenance, randomness data delivery and communication protocol. In the end, there is FTDI FT232RL chip which translates RS232 protocol to USB. During device development, we decided not to implement any kind of hardware protection against electromagnetic or other external interference in order to be able to test and confirm the protection mechanisms implemented in MCU code. As part of future

Model	Speed	Randomness source	Power consumption	Price
Alea II	100 kb/s	PN junction	max 250 mW	120 EUR
TL200	2 Mb/s	PN junction	max 100 mW	199 USD
True RNG2	350 kb/s	PN junction	No data	50 USD
One RNG	350 kb/s	PN junct. / RF noise	No data	50 USD
Our device	72 kb/s	FRO / El. noise	max 100 mW	15 EUR

Table 1. The most important characteristics of hardware based randomness generators we used for comparison with our device TRNG characteristics

work or in case of using this device in production environment, EMI shielding and power filter circuits are highly recommended.

Sinthesys of personal randomness source - TRNG

Double analogue comparator LM393 serves two purposes. The first part of this chip generates a noise signal, while the second part amplifies the noise signal and converts it to a digital signal with variable pulse length, which is further fed to appropriate input pin of MCU. MCU oversamples this "digital noise" and fast binary counter of MCU is incremented until there is a change of value in input signal. When the change occurs, LSB of counter register is stored in temporary register. The process is repeated until the whole byte is formed. The newly formed byte value is XOR-ed with previously formed and stored byte. The resulting value of XOR operation is then pushed into SRAM and this procedure constantly refreshes the randomness pool of 500KB. Due to the fact that the value of binary counter is related to input signal pulse width, this information is used to activate the security mechanism. If there is no change of value in input signal for a period of a couple of milliseconds, MCU code blocks the communication with the user of randomness, restarts the device and refreshes randomness pool prior to the establishment of a new communication with the user. Device operation test is done with the help of software application called XR232 [6] which allows us to request the certain amount of random data from generator. Data received from generator are stored in file and put to further statistical testing using NIST test battery described in [8]. Some of the results are shown in

Table 2 and physical appearance of the device is shown in Figure 5. For comparative analysis, we have tested two sets of random data. One set is 16KB of data from our generator, and other set is 16KB sample collected from "random.org" service. The limitation in the amount of data is given by "random.org" service.

Test type	Data from our device (*p-value*)	Data from random. org (*p-value*)
Runs test	0.4390	0.0353
Serial test	0.3900	0.0870
Entropy (H)		
Mnobit:	0.99999670	0.99997561
Bigram:	0.99998785	0.99996795
Trigram:	0.99998438	0.99996382
Matrix 4x4:	0.99997163	0.99995819

Table 2. Comparative analysis of a couple of NIST test results (P > 0.01)
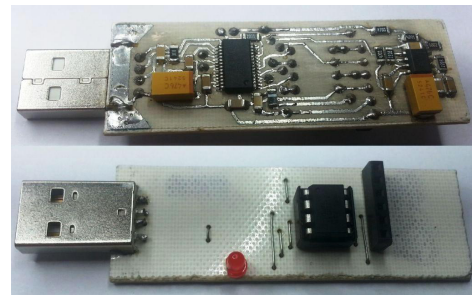
Figure 5. Physical appearance of randomness generator
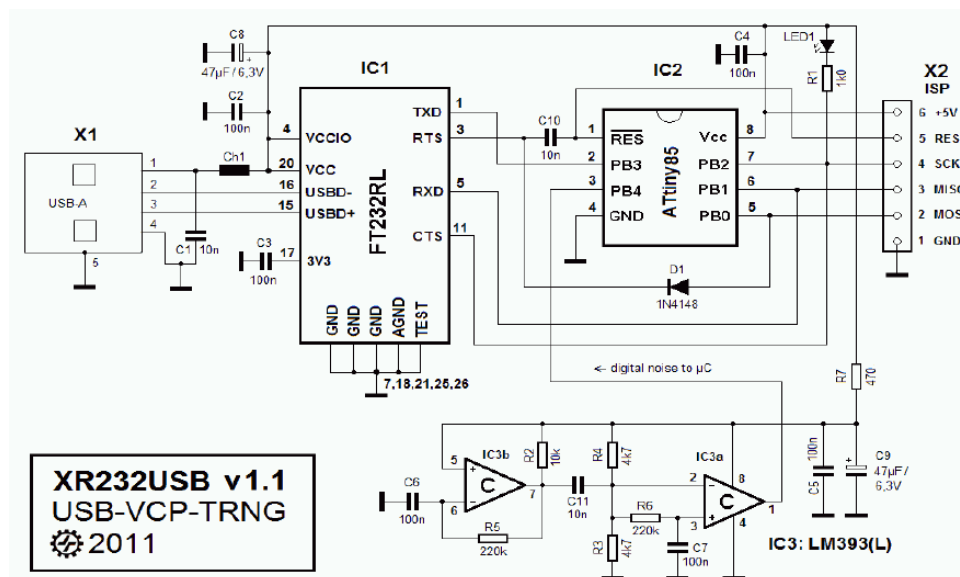
Figure 4. Circuit diagram, source [6]

Statistical testing and analysis of the results proved our initial hypothesis that our device conforms to all criteria concerning randomness characteristics. The speed of random data generation and delivery was tested by doing simple measurement of time needed for writing 1MB of random data in a file on user PC. Having repeated the process a number of times, for 1MB of data an average time of 114 seconds was obtained, so we can state that our device can deliver 72Kbs of random data. During the testing of our device, we have also simulated electromagnetic interference with the smart phone in close proximity to our device. Our device continues its normal operation until smart phone activates its GSM or WiFi transceiver. If disturbance is shorter than 2ms, our device recuperates without interrupting the communication with the user. Otherwise, the security mechanism is activated which prevents the delivery of corrupted, no random data to the user.

4. CONCLUSION

In this paper, we presented a theoretical concept for the use of electronic noise as a source of randomness and we explained one possible way of hardware implementation of this concept using widely available electronic components. In doing so, we experimentally proved good statistical properties of hardware random generators. Another contribution of our work is implementation of cryptographic element which warrants high level of security and trust. The performed testing confirmed high level of entropy and unpredictability of generated sequences. We've also verified our results using comparative analysis, in which our generator is compared with atmospheric noise. The device we've presented can be used for various purposes, mainly as an educational tool for different kinds of simulations and with minor modifications. It can also be used in real life cryptography applications with minor modifications.

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ENERGY EFFICIENCY AND DISTRIBUTED SYSTEMS

ON THE PERSISTENCE FORECAST OF SINGLE HOME ELECTRICITY POWER CONSUMPTION

Naser Farag Abed[1],
Milan Milosavljević[2]

[1]Singidunum University
32 Danijelova Street, Belgrade, Serbia

[2]University of Belgrade,
Faculty of Electrical Engineering,
Belgrade, Serbia

Abstract:

This work analyzes an electricity power consumption forecast for a single home using various types of generalized persistence models. The predictor composes of parallel banks of simple averaging models (SAM) for each hour within a day. Fitting SAM is performed separately for each day of the week using the appropriate training sets of past electricity power consumption. The performance of the predictor was evaluated using real data which represents power consumption per minute measured over almost 4 years for a single home near Paris, France (approximately 2 million data points). Experiments show that the proposed system for predicting power consumption one day ahead gave mean absolute value of relative percentage error (MARPE) lower by more than 18% compared to ordinary persistent prediction, without significant computational cost.

Key words:

energy consumption prediction; mean absolute value of relative percentage error, persistent prediction, growing window, sliding window.

1. INTRODUCTION

Electricity load forecasting has gained substantial importance nowadays in the modern electrical power management systems with elements of smart greed technology. A reliable forecast of electrical power consumption represents the starting point in policy development and improvement of energy production and distribution. At the level of individual households, the ability to accurately predict consumption of electricity power significantly reduces prices by appropriate systems for energy storage. Therefore, the energy efficient power networks of the future will require entirely new ways of forecasting demand on the scale of individual households [4], [5].

In this paper we present our electricity power consumption forecast results for single home data, which we call PARIS data. In order to compare our results with previously published, we choose data set which is comparable with TUM and REDD data sets, for which the prediction accuracy are publicly available [1]. In this way, we have three different data sets with possibility to control same granularity, window of training and forecast horizon. It enables us to crosscheck results and despite different complexity of this three data sets, render fair comparison.

Correspondence:

Milan Milosavljević

e-mail:
mmilan@etf.rs

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2. GENERAL PROPERTIES OF PARIS DATA SET

The data set which we named PARIS data was obtained from the UCI data set repository [2]. It represents electricity power consumption per minute measured between December 16th 2006 and November 26th 2010 (47 months) for a single home near Paris, France, containing over 2 million data points. The data set contains nearly 1.25% of missing values. All experiments were performed in the MATLAB programming environment using Machine Learning Toolbox, [7]. We replace missing values by simple linear interpolation filtering.

All data can be analyzed at different level of time granularity, *i.e.*, sampling frequencies, from one minute to one day. In order to compare our results with the related work in the area, we chose time granularity of one hour. That means that one day of electricity power consumption is represented by 24 data points. Thus, the whole data set is represented by 34440 sampling points. In Figure 1 electricity power consumption is shown in the granularity of one minute (left) and one hour (right) during one day. Change in granularity is implemented by the appropriate moving average filtering. In Figure 2 shows three dimensional representation of whole PARIS data set at hourly granularity, where x axis denotes days (1435 days) while y axis denotes hours (1 -24).

Figure 2. Three dimensional (Days, Minutes, Power) representation of original PARIS data.
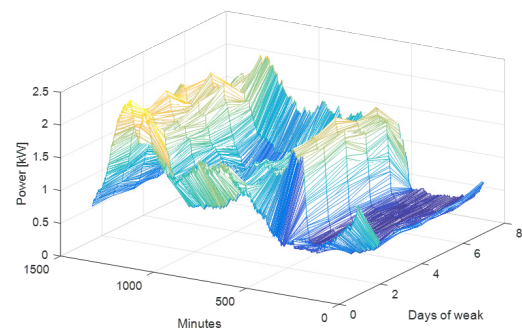
Figure 3. Average of original PARIS data taken over particular days of a week

Figure 1. Electricity power consumption in the granularity of minute (left) and hour (right). In the granularity of one minute and one hour, one day is represented by 1440 data points, and 24 data points, respectively.

In Figure 3 shows average of original PARIS data taken over particular days of a week in the form of three dimensional representation (minutes, day, power), while Figure 4 shows long term average over all days. All these findings are the evidence of the fact that the main cause of electricity power consumption behavior is working dynamics of inhabitants during a week. This illustration gives clear evidence as to how hard it is to predict behavior of one day consumption based on long term averages. In this particular example MARPE=98.88%.

Figure 4. Average of original PARIS data taken over all days. If we use long term averages as prediction for actual data, we get MARPE=98.88%, which is pretty high error.

It is obvious that granularity of data at level of 1 minute produces very large quantity of data, beyond the practical interest for such high resolution. More practical scenario is granularity at level of one hour. Therefor we transform original PARIS data at hourly granularity. In this case, each day is represented by 24 measurements obtained by averaging 60 data for each hour.

3. PERSISTENCE FORECAST

The persistence method assumes that the conditions at the time of the forecast will not change, *i.e.*, all forecasts are equal to the last value before staring forecasting horizon. We will refer to this method as PERSIST. Corresponding MARPE has a form

$$MARPE_{per} = \frac{1}{n-1} \sum_{t=2}^{t=n} \left| \frac{x_t - x_{t-1}}{x_t} \right| \cdot 100 \ [\%] \qquad (1)$$

We extend the notion of persistence forecast to the broader class of simple predictors, which gives forecast according to formula

$$\hat{x}_{t+1} = \frac{1}{N} \sum_{n=t-N+1}^{t} x_n, \qquad (2)$$

i.e., by simple averaging past observations within window of specified length N. We refer to this method as MA_PERSIST (moving average persistence). Corresponding MARPE has a form

$$MARPE\_MAper = \frac{1}{n} \sum_{t=1}^{t=n} \left| \frac{x_t - \hat{x_t}}{x_t} \right| \cdot 100 \ [\%]. \qquad (3)$$

Persistence forecast based on long term average

We start our analysis by simplest persistence forecast model, where predicted value is equal to long term average over whole data. Mean value across whole data is 96.8±79.03 %. Figure 5 shows MARPE obtained by persistence forecast based on the long term average across all days of PARIS data in function of granularity, precisely for granularity at level of 1, 5, 10, 15 30 and 60 minutes. Notice that MARPE decreases with higher granularity, which is the expected effect. Namely, for higher granularity data exhibits lower variability, rendering persistence forecast more accurate.
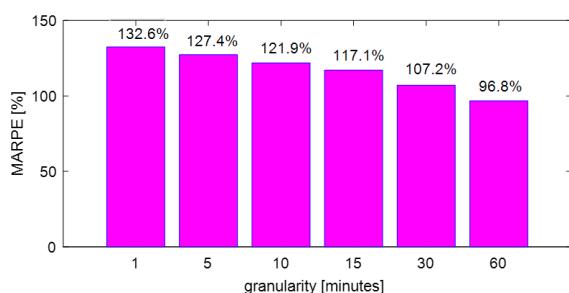
In the remaining part of the work, we finally accept granularity of 60 minutes, which is in some sense the compromise between precision of modelling and practical usefulness of obtained results.

Ordinary persistence forecast

We will name persistence forecast based on formula (1) as the ordinary persistence forecast. Notice that the mean value of MARPE is 81.68% compared to 96.8% mean value of MARPE for long term average, provided the same granularity on the level of 60 minutes. Decrease in the forecasting error can be explained by the fact that ordinary persistence forecast better exploits local behavior of data.

Persistence forecast based on moving window average

Another class of simple persistence forecasting is forecast based on simple moving average within the sliding window of fixed length N, see formula (2) and (3).

First question we posted is what optimal length N is. In Figure 6 we present our experimental relationship between MARPE_MAper and length N of averaging sliding window. From Figure 6 we can see two interesting points, first minima at window size 7, and second minima at window size 1020. This findings suggest that all information needed for optimal forecast are strong local, just 7 days in the past. Therefore, optimal short term moving average persistence forecast system has accuracy 74.55%, and is shown in Figure 7. On the other hand, more information we can get only after very long period of time (minima at 1020, which is equal to the period of more than 2.5 years of observation), with negligible gain in accuracy of just 1.5% MARPE. These findings are important for our main thesis that PARIS data exhibits strong local dynamics.

Figure 5. MARPE obtained by persistence forecast based on long term average across all days of PARIS data in function of granularity, ranging from 1 minute to 60 minutes.
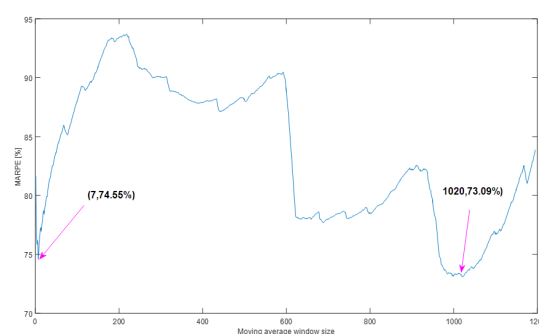
Figure 6. Relationship between moving average window size and MARPE_MAper for PARIS data at granularity level of 60 minutes.

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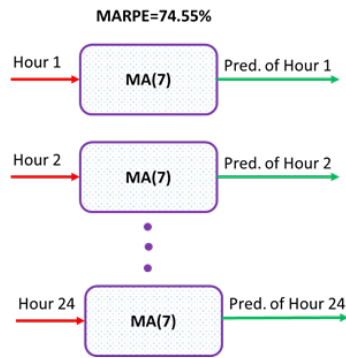
MARPE=74.55%

Figure 7. Optimal short term moving average persistence forecast system for PARIS data. Mean accuracy in terms of MARPE = 74.55%.

Persistence forecast based on growing window average

Let *al*low in our moving average persistence forecasting system that each hour has its own predictor and that for each of them we find optimal window size. The results are presented in Table 1 and Figure 8 and Figure 9.

It is interesting to note from Table 1 that there two groups of hours: night, early morning and early non hours (1, 2, 3, 4, 5, 6, 7, 12, 13, 14, 15, 16, 17, 18), with extremely large window sizes, and other hours which are characterized by very short optimal window length (8, 9, 10, 11, 19, 20, 21, 22, 23). If we permit that window size of first type of hours grow unlimited, then we obtain very interesting forecasting system based on combined moving average, and growing window persistence forecasting, which means that the value of MARPE for whole PARIS data is 66.53%, see Figure 8 and Figure 9.

In Figure 10 is shown general architecture of this combined forecasting system. It is interesting to note that hours which cover growing window subsystem are locally unpredictable, and need as much information as possible. This hours are very close to subset of night and working hours, see Table 1.
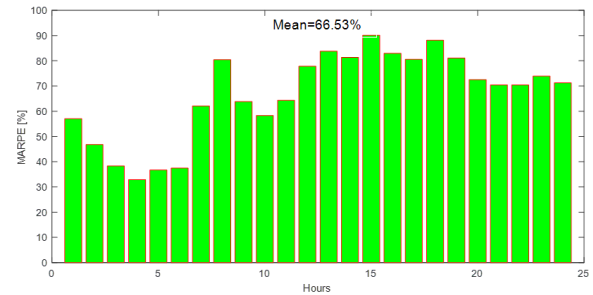
Figure 8. Distribution across the hours of MARPE obtained with combined moving average and growing average persistence forecast optimally designed for each hour of a day.
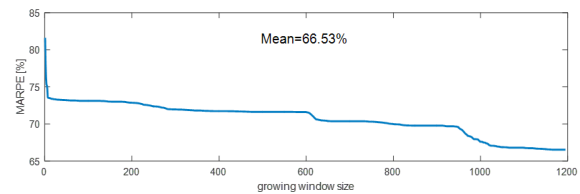
Figure 9. MARPE of combined moving average and growing window average persistence forecasting system in terms of length of growing window.

MARPE=66.53%

$n_i \in \{\infty, 1, 2, 3, 4, 7\}$,
$i = 1, 2, \ldots, 24$
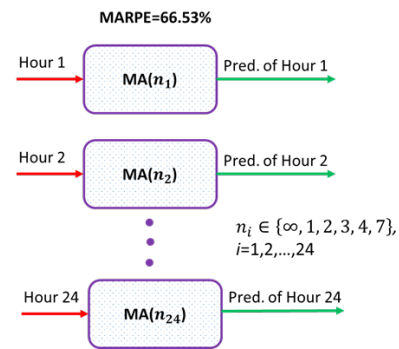
Figure 10. Combined forecasting system based on moving and growing size window averaging. On the PARIS data system gives MARPE=66.53%.

Hour	1	2	3	4	5	6	7	8	9	10	11	12
N	∞	∞	∞	∞	∞	∞	∞	1	1	4	2	∞
Hour	13	14	15	16	17	18	19	20	21	22	23	24
N	∞	∞	∞	∞	∞	∞	7	3	3	3	7	∞

Table 1. Optimal window length N for hourly persistence forecasting based on growing window average. The symbol ∞ means, that window is permanently growing. Table Styles

Machine learning based forecasting

In order to get an insight into accuracy of SAM models, we just quote results of our broader investigation encompassing all relevant machine learning methods [6]. Especially, we include three classes of most promising approaches: Multilayer Neural Networks, Support Vector Machine (SVM) and K Nearest Neighbor (KNN) Regression, see Table 2.

4. SUMMARY OF OBTAINED RESULTS

Table 2 shows accuracy of all applied forecasting models on PARIS data, along with their mutual ranking. The most accurate method is KNN regression with so called combined forecasting function and number of neighbors K=12 [6]. The same findings are shown in Fig.11, along with so called modeling gain.

METHOD	MARPE	Rank
Persistence – global average	98.81%	7
Persistence - ordinary	81.68%	6
Persistence - optimal moving average	74.55%	5
Persistence – optimal growing + moving average	66.53%	4
Multilayer neural networks	61.16%	3
Linear kernel SVM	58.79%	2
KNN regression – combined method (K=12)	47.83%	1

Table 2. Summary accuracy of all applied forecasting models to PARIS data, along with their mutual ranking. The most accurate method is KNN regression with combined forecasting function [6].

If we consider persistence forecast with global average as our starting point and KNN regression with combined forecasting function as our end point, then equivalent modeling gain is over 50% (98.81% against 47.83%). In the class of SAM models, the best model is optimal combination of moving and growing window model, which gain is 32.67% (98.81% against 66.53%) when the baseline model is Persistence - global average. If the baseline model is Persistence – ordinary, the gain of best SAM model is 18.5% (81.68% against 66.53%).
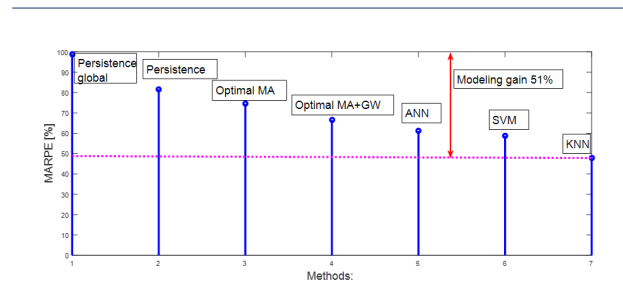
Figure 11. Final comparison of all method applied on PARIS data.

If we consider persistence forecast with global average as our starting point and KNN regression with combined forecasting function, equivalent modeling gain is over 50% (98.81% against 47.83%). The gain of the best SAM model is 32.67% for the same baseline model – Persistence – global average.

What is the main reason for such large modeling gain? Our explanation is the following:

1. PARIS data set possess large variability over days, weeks and seasons during a year. This fact supports high MARPE of persistence forecast (81.68%).

2. Moving average window forecasting method, shows that optimal value for window length is just 7 days. This fact supports strong local dynamics of PARIS data.

3. Good forecasting systems must exploit this two findings in an efficient way.

5. CONCLUSIONS

In order to build efficient forecasting systems, we must encompass all relevant information about past consumption data in very short window located as close as possible to the present time. Our feature engineering, did this job generating 36 features, which satisfy locality conditions [6]. This explains our unexpected good results for both SAM and Machine learning based forecasting methods. It is opposite to the statement from [1], where the authors claimed the following: "For short forecasting horizons and high granularities of consumption data, persistence forecasts are known as hard to beat by the other methods". In this respect, we believe that the combination of local modeling of features and choice of the appropriate machine learning algorithm will be a good guide for building efficient electricity power consumption forecasting systems at the single home level.

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ENERGY EFFICIENCY AND DISTRIBUTED SYSTEMS

SOME FACTS ABOUT OIL AND GAS INDUSTRY

Dragan S. Marković,
Dragan Cvetković,
Dejan Živković

Singidunum University
32 Danijelova Street, Belgrade, Serbia

Abstract:

The population has doubled in the last half century and there are currently over seven billion people on the planet. During this period, a constant growth of Gross Domestic Product was recorded on the global level. As known, the population and income are the key factors which affect the growth of energy demand. Although the use of alternative sources of energy is growing annually, the increase is relatively modest and during next two or three decades they will be more supplement than the substitute for fossil fuel. Growing energy demand on the world level in the next two decades will be a great challenge which is to be successfully met only by revolutionary scientific-technological discoveries applicable in the oil and gas industry. This paper elaborates on the current circumstances and challenges that oil and gas industry face with. Nanotechnology with its fascinating, newly discovered nanomaterials offers some solutions for this sector and makes it more efficient and successful and thus makes the energy supplies in the future more certain.

Key words:

oil, gas, sustainability, efficiency, nanotechnology.

1. INTRODUCTION

According to the assessment of the demographers [1], the largest growth of the population will be recorded in the developing countries while the countries which are already developed will remain relatively stable. High rates of growth are expected in India, which will probably be the most populated country in the world by 2020, as well as African countries, because of the estimated improvement of the social-economic conditions and upgrading health services. With the growth of population, developing countries will be characterized by migrations from the rural areas to the cities, *i.e.* urbanization.

As McKinsey Global Institute [2] assesses, by 2025 440 cities from the developing countries will bring the half of the global GDP growth. Urbanization and increase of consumers in the developing countries will create real estate demand, infrastructure, automobiles, comfort and energy resources.

According to the statistic reports of relevant world institutions [3], the world economy is growing. Global BDP has been growing on average by 3.5% since 1970 and this trend shall continue by 2035.

Correspondence:

Dragan S. Marković

e-mail:

dsamarkovic@singidunum.ac.rs

As the consequence of population and economy growth, the energy consumption grows. In the last two decades, the demand for energy has grown up to 50%, and is expected to keep growing up to 40% in the next two decades. Strictly mathematically speaking, this slowdown will not matter much because the growth of 40% up to 2035 roughly speaking means adding combined present energy consumption of USA and China.

Meeting this demands entails at least three questions. First is sufficiency, *i.e.* is there enough energy to satisfy the demand? The second is safety, *i.e.* can different countries have access to the energy they need? The third is sustainability, *i.e.* can the demand for energy be satisfied without the unacceptable influence on the eco system of the planet?

Regarding sufficiency, if we take into consideration the fact that civilization today relies on fossil fuel up to the amount of 80%, it can be said that energy is sufficient. Expert analysis [4] shows that the world has abundance of technically renewable resources to satisfy energy demand up to 2050. There is about 45 trillion barrels of the discovered reserves of the oil and gas equivalents. This amount has nearly doubled by the unconventional sources including shale and gas. These are mainly onshore sources and only 1.7 barrels have been produced up till now.

If we talk about safety great energy consumers should be considered, nations or group of states (like EU), because not all of them are great producers of energy as well. So, they relay on supplying from other countries. Thus, energy safety is one of the dominant geopolitical questions and the world is undeniably in the phase of significant geopolitical turbulence at the moment.

Despite the above mentioned, the price of oil is dropping. That is, by all means, the result of complex geopolitical situation and regarding supply and demand. The market shows resilience and keeps supplying the world with energy despite considerable disturbances like wars, sanctions and weather disasters. All mentioned implies that the world instead of being divided into the countries which are energy-dependant and those that are energy-independent becomes in reality energy-interdependent. This fact leads us to the problem of sustainability.

Sustainability is defined as „the development which satisfies the needs of present generation without endangering the possibility of satisfying the needs of future generations." [5]

Because of the growing influence of eco- movements and general concern over the evident climate change, the goal of the companies in this sector is redefined and is related to making value for the company shareholders, upgrading employees standard and quality of life as well as contribution to economy, ecology and social benefit of the users, suppliers and states where companies are placed.

Energy is necessary for all general operations in this area and its participation considerably effects final operating expenses. By using energy effectively, the companies reduce their costs and make their product more accessible to final users, enabling them to be more profitable. Because of this companies put considerable means into energy-efficient technologies.

Activity in this area is detected in promotion of renewable energy sources. French TOTAL is one of rare companies which increased investments into green energy and is actively included into photo-voltage energy area. Norwegian STATOIL has significant long-term plans and investments into wind-operated power plants.

Conoco Philips is an example of the company which tries to reduce its bad influence on biodiversity and beside biodiversity risk evaluation when estimating its investments, makes action plans and projects for areas of high-risk value.

The transition from use of energy produces with high percentage of carbon (coal and oil) to the ones with low percentage of carbon (gas) as well as encouraging innovations influencing lowering of carbon emission should be considered as sustainability.

However, the area is still divided into companies whose supervising committees are working on sustainability and those that show no evidence of engagement in this matter.

It is obvious that boosted exploitation of gas and oil has at the moment positive effect on economy recovery. However, no one is presenting information on extreme costs of water pollution near exploitation sites, climate change, endangering health of people *etc.*. The costs are still unknown.

If we compare the economic growth in this area, the growth of sustainability is more than modest. Although the financial means invested into lowering the greenhouse effect, saving the quality of water, employees safety, *etc.* reduce negative influences, it is still far from green industry.

The remaining part of the work is organized in four sections. In the second section, oil and gas sector circumstances are considered. In the third, the contribution of nanotechnology to the efficient management through new patent solutions is stated. In the fourth section, chronology of the events which explain up to a point what has happened and is still happening in this area are discussed. The last sections presents concluding remarks.

2. CURRENT CIRCUMSTANCES OF OIL AND GAS INDUSTRY

Oil is the most important commodity in the world trade exchange participating 15% and the most common load in marine transportation. High quality energy product and irreplaceable raw material in chemical industry. Possession of oil means power. Oil has often been the means of geopolitical conflict through history. Its history is the one full of price ups and downs. Recent events should be regarded accordingly. Since 1990 this has been the deepest fall. Figure 1 shows the average price flow from 2000 till today.
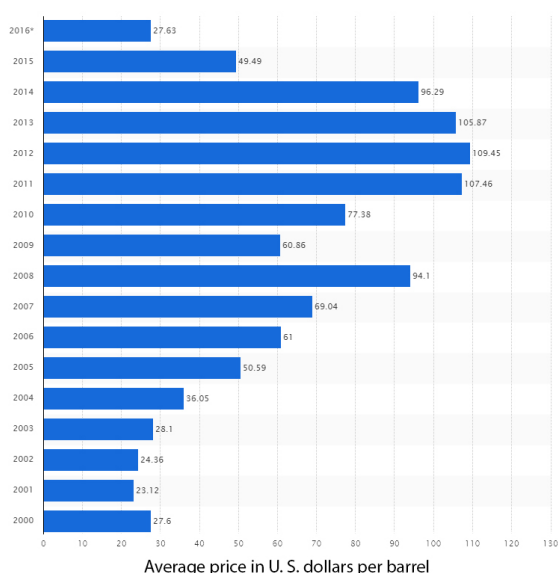
Figure 1. Average oil price on world market
Source: Statista, http//www.statista.com

Speculation on the reasons of raw oil price downfall during 2015 and continuing in 2016 as also vary from geopolitical conspiracy theories to simple explanations suggesting that long-term high oil price stimulated enormous investment influx in new technologies like freaking or drilling in deep water. These technologies, combined with real decrease of global oil supply led to extreme raw oil price downfall. The world expected OPEC to limit production, but that did not happen. Some analysts interpreted this as a calculated move aiming to bring energy (even political) blow to the USA competition (freaking) and Europe (renewable energy sources). On the other hand, it can be considered wider on relation USA-Russia-Saudi Arabia or USA-OPEC, *etc.* Is it really so, the time will show [6].

Acknowledging foreseen population growth trends, urbanization, economy and energy demand, companies for exploration and exploiting will have to find new sources of this energy product. New technologies will extend „life" of the existing drill holes through their enhanced recovery. This improvement will help, but it will not be enough.

New considerable oil findings must be made and the process is getting harder daily. The explorers will have to search over 3500 meters under the ground and make drill holes which will give less oil with higher recovery price then today. Some new sources will be from the onshore drill holes in the countries which are geographically, culturally and politically distant from the consumers' nations and thus will effect the transportation price.

The majority of new findings will be in deep waters off African, Brazilian, Canadian and Norwegian coast on depths over 2500 meters. The Arctic region will increase in importance as well as East and West coast of USA. The discovery and production process of such finds is extremely expensive because of the harmful materials and demanding eco standards, oil processing and refinement of this quality is long-lasting and requires highly sophisticated equipment which increases the costs. Operating costs in such expensive process directly influence the raw oil price and that shows the future raw oil price flow.

Water is the key component for research and production of upstream sector regardless of the technology used. For recovery of one barrel of oil, one to four barrels of water are polluted depending on the technology used.

For instance, revolutionary method of hydraulic fracturing pumps water and chemicals into shale sediments to extract gas. Procedure consists of placing drilling machinery, drilling vertical drill hole on depth from 2000-4000 meters and then drilling horizontally. Then, 5-30 million liters of freaking fluid (it consists of water, sand and chemicals) is pumped in under great pressure. This fluid penetrates into cracks of rocks, destroys them and suppresses gas trough the drill. However, it frees methane (the greenhouse effect gas), benzene and other carcinogenic substances which pollute the air as well as ground and underground water. It influences the erosion too.

Confrontation of short term profit and long term sustainability is most clearly expressed in oil and gas industry. Not only the competition, oil price downfall and huge increase of energy demand but fear of climate change and strong common effort to decrease emission of $CO2$ and minimize fossil fuel consumption are important factors which define business strategies of oil and gas companies. Facing numerous challenges companies relied on science and technology.

3. CONTRIBUTION OF NANOTECHNOLOGY TO OIL AND GAS INDUSTRY EFFICIENCY

It is common knowledge that technology has an important role in research, production, processing and transportation of raw oil. That is why the companies from that field have invested a lot in research and development of technologies which will enable them to enhance their business limits.

Nanotechnology has recently drawn public attention and become an interesting field of research. Companies worldwide have quickly reacted to the rise of nanotechnology by engaging considerable resources in order to provide convenience of this technology. Oil and gas companies are serious in their intention to take part in this international competition to ensure benefits from this technology use. The most obvious characteristic of nanotechnology is development of materials with better performances in wider sense. All materials have physic-chemical performances depending on the critical size of particles. Thus, geometric structure, chemical bonds, the ionization potential, electrical properties, optical properties, mechanical strength, melting point, magnetic properties, *etc.* are influenced by the particle size [7].

When material dimensions are reduced from macro to nano size, important changes are noticed in electric conductivity, optical absorption, chemical reactivity and mechanical features. Materials with range from 100nm to atomic level can have various or improved characteristics compared to the materials bigger in size.

Two main reasons for the change are relative surface and domination of quantum effects. The increase of the surface will result in adequate increase of corresponding chemical reactivity and creation of certain nano particles used as catalysts. As the site of materials is reduced on tenths of nanometers or less, quantum effects start acting, which can considerably change optic, magnetic or electrical performances of material.

Nanotechnology offers wide spectra of possibilities and adds new performances to tee wide range of materials used in oil and gas sector. The current aims of using nanomaterials are efficiency improvement in finds research, enlarging the recovery of oil finds, boosting the equipment reliability, enabling analysis of emulsion characteristics in real time, improvement of energy efficiency in production, reducing corrosion effects, remediation of formation damage, reducing the impact on the environment, *etc.*

Patents are one of the most important innovation indicators in evaluation of technological competitive-ness because they are one of the outcoming results in the development and research process. They can also be seen as potential factors of the future economic activity.

Statnano [8] conducted a study regarding the approved and registered oil and gas company patents related to nanotechnology. The research included 10 great companies from this sector, ExxonMobil, Chevron, Schlumberger, Baker Hughes, Halliburton, Royal Duch Shell, BP, Eni and Conoco Phillips (see Table 1). They have established 836 patents in this sector.

Company	No. Of Patents
Chevron	44
Schlumberger	91
Eni	18
ExxonMobil	142
Baker Hughes	217
Halliburton	96
Royal Dutch Shell	99
BP	42
Total	63
ConocoPhilips	24

Table 1. Nanotechnology related Patents
in the oil and gas industry
Source: Statnano

It is immediately noticed that Baker Hughes company is represented with 26%, ExxonMobil 17% and Royal Duch Shell with average 12%. The overview of patent chronology in the mentioned study shows that from 1970-1996, less than 10 patents have been submitted. From that year on it grows reaching its peak in 2011 with 107 patents. Another characteristic of the year 2011 is the beginning of the „Arab spring".

Despite the fact that economic crisis lasts for few years, great oil companies have expected a lot from research, development and application of nanotechnology. It can be stated that despite yearly decrease in the number of patents from 2011, nanotechnology is still the leading theme in this sector.

The importance that oil companies give to scientific research can be seen from the following data. ExxonMobil hired 1900 PhDs in year 2002 [9], Russian Rossneft employed over 650 PhDs in 2013 [10]. Arabic company Saudi Aramco had in its development sector 674 employees and 173 of them were PhDs ie.,26%. There were 1157 people in the development sector there years later, of which 434 are PhDs, *i.e.* 30% [11]. This company had

58 patents accepted by the, United States Patent and Trademark Office in 2012, in 2013 year 53 patents and in 2014 record 99 patents yearly [12]. Aramco has 24 patents related to nanotechnology.

Russia founded Rosnano in 2007 in order to boost research activity in this field [13]. Research is mainly focused on domestic economy and a small number of patents is registered abroad. It is estimated regarding the number of registered patents that this field is still not a priority [14]. It should be mentioned that there is a specialization agreement between the countries of BRICS (Brazil, Russia, India, China and South Africa) where India holds the leading role in the nanotechnology research [13].

4. DENOUEMENT TIME

The decision on shale mass production was influenced by the raw oil price as well as the power gained from this production. The US Ministry of Energy estimated in 2004 that shale can be competitive if the price of oil rises above 54$ per barrel for „above ground" technology or 35$ per barrel for „in situ" technology. Shale boom has started in 2007 with enhanced recovery program in the Appalachian (Devonian) Basin find. Output growth was enormous and is still rising. Although according to the report of the World Bank downfall of the production is expected [15]. New technology has enabled activation of technologically unavailable and economically unprofitable resources as well as relatively cheap energy product help lapsing American economy.

According to data from Energy Information Administration, the United States have even production of oil and gas. The US is the world leader in shale gas production. US have been relying on their cheap gas and are no longer great oil importers. This decision of the US resulted in the fact that Saudi Arabia lost part of that market.

Saudi Arabia, on the other hand, produces petroleum. For years now Saudi Arabia and Russia are altering on the first place of oil production. Russia is the greatest manufacturer and exporter of the natural gas. With introduction of sanctions Russia is constrained to search other markets, primarily in Asia (China and India). In these circumstances, Saudi Arabia tends to take over the European market. It is theoretized that Saudi Arabia is reducing prices of oil in order to push out America, which cannot export oil and gas from shale because their companies will operate with heavy losses.

Gas is much cheaper on the American than the European market because of the frocking technology. America completely satisfies its needs and with restrictive measures tries to keep cheap energy products on the market and thus support its economy recovery. At the current prices, the small number of shale drill holes in the US is economically viable. Some analysts say that their viable price is around 80$ per barrel. The costs of making export LNG terminal for intake, *i.e.* import for regasification, then transportation by LNG tankers to large distances as well as trading margins influence the fact that gas from shale would not be concurrent with the price on European market in comparison to Russian gas.

Simultaneously, great manufacturer and oil exporter Saudi Arabia, does not tend to reduce production, and the global economy keeps slowing down, so the management of oil companies and the investors expect market to stay in the upheaval till 2017.

According to writing of the New York Times, oil companies whose income had large boost in previous years are suffering income downfall now. Accordingly, they have stopped exploitation on the two thirds of their drill holes and considerably reduced investment into research and production. Numerous companies went bankrupt and it is estimated that approximately 250000 people from this sector lost their jobs.

The members of the OPEC and other significant manufacturers of oil and gas are prepared to „freeze" their production. The press quoted the words of Russian Minister of energy Alexandar Novak stating that the countries which produce 73% of oil in the world are ready to do so.

It is difficult to predict whether these are the signs of ending America's double confrontation with Russia and Saudi Arabia.

5. CONCLUSION

The question is: who gains and who losses in this geopolitical game? Downfall of oil prices on the world market has various consequences for different players. Small consumers in many countries spend less money on fuel, because retail prices are significantly reduced, while consequences for industry and economies dependant on oil production will be very negative. Those who gained on the industrial side will probably be refineries in Europe which the could make profit because of law raw oil price.

The greatest net losers are states – big producers and exporters of oil, especially those with large external debit and deficit. Low oil price has conditioned some projects not to be profitable. Many companies suffered fall of liquidity and reduction of income, which made insufficient funds for investment planning and led to releasing of employees.

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Undoubtfully, nanotechnology has already enabled and will keep enabling this sector to claim unreachable resources in the past and thus postpone the end of fossil fuel. Mankind is given a chance to use cleverly the time bought and find a new ecologically acceptable long-lasting energy solution, thus securing safe energy future for itself.

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GEOGRAPHIC INFORMATION SYSTEMS

OPEN SOURCE TECHNOLOGIES IN GEOGRAPHIC INFORMATION SYSTEMS

Marijana Petković[1],
Vladmir Bulatović[1],
Ivan Aleksić[2]

[1]University of Novi Sad,
Faculty of Technical Sciences,
Novi Sad, Serbia

[2]University of Belgrade,
Faculty of Civil Engineering,
Belgrade, Serbia

Abstract:

During the last decade, a growing number of Free and Open Source Software (FOSS) projects have been established to focus on development of several types of software for geographic data collection, storage, analysis and visualization. Because GIS technologies are increasingly present in different applications, it is necessary to divide the existing software projects into categories based on their functions. The goal of this paper is to present an overview of mature free and Open Source software GIS Desktop software projects with their characteristics.

Key words:

free software, Open Source, FOSS, GIS, desktop GIS.

1. INTRODUCTION

In the last ten years, several software projects that focus on development of Free and Open Source Geographic Information Systems (GIS) software have been realized due to: the increased technological progress in automated mapping and monitoring, on-line distribution and faster and easier access to georeferenced data, *etc*. This field has evolved from a highly specialized niche to a technology with broad impact on society and its interaction with nature (Mitasova, 2002).

The number of exiting projects has not changed significantly but the changes are visible in software user and developer communities. The Open Source GIS projects have been able to attract users and developers, which has subsequently influenced software functionality and support and as a consequence raised their attractiveness to new potential users.

It is important to emphasize the role of Open Source GIS projects in education on the geodesy and geomatics studies. Open software, open data, open standards and open education are the key components of the proposed open GIS framework (Sui, 2014). Open education concepts, such as accessible teaching materials and the usage of free and Open Source software are all accessible. This enables students to become active community participants and gain spatial, critical thinking and problem-solving skills.

Our goal is to present an overview of (major) GIS software projects that develop Free and Open Source Software (FOSS), the classification of different types of GIS software, and a list and characteristics of most commonly used Desktop GIS software.

Correspondence:

Marijana Petković

e-mail:

marijana.petkovic@uns.ac.rs

2. GEOGRAPHIC INFORMATION SYSTEM (GIS)

There are several definitions of Geographic Information system (Goodchild, 2009), (Sween, 2008), (Camara, 2004), but the simplest told GIS is a technological tool for comprehending geography and making intelligent decisions from simple tasks as navigation to extremely complex tasks, such as prediction and management of natural disasters (ESRI, 2006). GIS technology is used to describe and characterize spatially referenced geographic information for the purpose of mapping, querying, visualizing, modeling and analyzing spatial data maintained within a single database. GIS is present in almost every industry and benefits organizations of all sizes. There is a growing interest and awareness of the economic and strategic value of GIS and it has evolved to be used in a multitude of disciplines.

GIS software concept

For a representation of geographic object in GIS, data representation has to be established first. GIS data can be separated into two categories: spatially referenced data which is represented by vector and raster forms (including imagery) and attribute tables which are represented in tabular format (Tsou, 2011). Vector data is divided into three types: polygon, line (or arc) and point data where every object is represented by a (vector) geometry and value fields that describe the non-spatial object properties, the so-called 'attributes', in a table. Raster data (also known as grid data) represents the fourth type of feature, surfaces. Surfaces represent variables that are continuous over space, such as terrain elevations or land cover. Geographic objects with same geometric and attribute representation are usually grouped into layers.

Open Source and free GIS

Open Source and Free Software (FOSS) GIS plays an important role in adaptation of GIS technology by stimulating new experimental approaches and providing access to GIS for the users who cannot or do not want to use proprietary products (Mitasova, 2002). The terms Free and Open Source Software are redundant but both are in use today (Sween, 2008). Both terms have the similar meaning, however the main difference is that free software could not be modified, and Open Source could.

The trend of Free and Open Source Software development, especially in the field of Geospatial Information

Systems (GIS), has grown rapidly in recent years. Open Source software is a type of "free" software to be accessed, used or modified by their user groups and developers (Sween, 2008).

Free Software Foundation (FSF) presents the following definition for Free software: "Free software is a matter of the user's freedom to run, copy, distribute, study, change and improve the software." The concept of Free Software was first defined by Richard M. Stallman and it refers to four kinds of freedom for the users of the software:

0. Freedom The freedom to run the program, for any purpose.

1. Freedom The freedom to study how the program works, and adapt it to your needs. Access to the source code is a precondition for this.

2. Freedom The freedom to redistribute copies so you can help your neighbour.

3. Freedom The freedom to improve the program, and release your improvements to the public, so that the whole community benefits. Access to the source code is a precondition for this (Akbari, 2013).

The main reasons why a company should use Open Source and free software instead of proprietary software are:

- Easy access to (in many cases unique) functionality of high quality. Full access to the source code is particularly important for GIS because the underlying algorithms can be complex and can greatly influence the results of spatial analysis and modeling.
- No license costs reduce total development cost.
- Re-use of already tested components enhances the quality of the final product. (Sween, 2008)

3. CATEGORIES OF GIS SOFTWARE

GIS software is defined as software that is used to create, manage, analyze and visualize geographic data (Steiniger, 2009). First, the data need to be derived from field work, maps, satellite imagery, or acquired from data providers. Then, there are many tasks to be done to get the final product as:

- data visualization and exploration,
- data creation,
- data editing and data storage,
- data integration, data queries to select a subset of the data,

- data analysis,
- data transformation, creation of maps for visualization of analysis and query results (Steiniger, 2009).

Depending on the set of tools that software provides, GIS software can be divided into several categories. Related Open Source software can be categorized into five domains for GIS:

1. Basic desktop GIS,
2. Spatial Data Base Management Systems (SDBMS),
3. Web Map Server,
4. Server GIS,
5. Web GIS clients,
6. Mobile GIS, Libraries and Extensions (Steiniger, 2009).

Figure 1 and Table 1 provide a summary of used categories of GIS software. Usually, desktop GIS applications can be divided by function into three groups: GIS Viewer, GIS Editor, and GIS Analyst. Spatial Database Management Systems (DBMS) allows user to create, read, update and delete spatial data in a database. Spatial DBMS also provide limited analysis and data manipulation functionality. Most often encountered are PostGIS, SpatiaLite and TerraLib. WebMap Servers like GeoServer, Mapink, MapServer are used for distribution of maps and data over the Internet, using Open Geospatial Consortium (OGC) standards Web Map Service (WMS) and Web Feature Service (WFS).

Data display and analysis and query functionalities are possible through WebGIS Clients. Libraries and Extensions are used to provide additional functionality which is not part of the basic GIS software. Mobile GIS is used for field data collection.

Most commonly used Desktop GIS software and some of their applications shall be presented. Other categories have been only briefly explained.

GIS software category	viewing	creation	editing	storage	conflation	transformation	query	analysis	create maps
Desktop GIS									
Viewer	○		○				○		◊
Editor	○	○	○	○		◊	○		○
Analyst	○	○	○	○	○	○	○	○	○
Spatial DBMS				○		○	○	◊	
WebMap Server	○	◊	◊				○		○
Server GIS				○	○	○	○	○	○
WebGIS Client									
Thin Client	○						○		
Thick Client	○	○	○	○			○	○	○
Mobile GIS	○	○	○	○			○		
Libraries/ Extensions		○	○	○				○	○

Table 1. Funcionality of GIS tasks accomplished with different GIS software

○ standard functionality, ◊ optional functionality

In addition to these categories, there is remote sensing software whose focus is on modification and geometrical and spectral transformation of aerial and satellite image data as well as Lidar data. Desktop GIS usually do not possess all the functionality needed for working with this type of data. Photogrammetric tools and remote sensing analysis tools for image correction and filtering, georeferencing and orthorectification, mosaicking and vectorization image object extraction are needed. There is smaller number of software projects for remote sensing than for GIS Desktop. Ossimo Project has been proved to be the most prominent one.
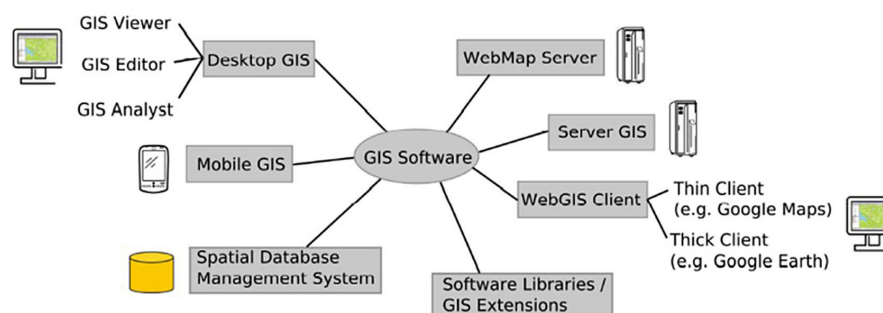
Figure 1. Different types of GIS software (Steiniger, 2009)

4. DESKTOP GIS

Desktop GIS can be defined as mapping software that is installed onto and runs on a personal computer and allows users to display, query, update and analyze data about geographic locations and the information linked to those locations (Tsou, 2011). Most Open Source desktop GIS software can be installed on multiple operating systems (Windows, MacOS, Linux). However, the lack of advanced cartographic functions and symbolization may be a problem in Open Source

GIS software which is expected to be resolved soon in the future. There are many excellent Open Source software packages in the category of basic Desktop GIS.

In the case of 3 desktop GIS categories (viewer, editor, analyst), so-called viewer applications offer functionality for viewing and exploring data, while editor applications provide, in addition to viewer capabilities, the ability to create and update spatial data.

Software such as Spring GIS, Spatial Commander, Google Earth, Google Maps, ArcExplorer or TNTlite were not considered since these software products are free for download but not Free and Open Source Software (FOSS). All presented projects have reached a mature stage over the last few decades and the software offers a multitude of functionalities.

Open Source GIS software can also be categorized into groups based on the implementation language in which they were written. The most common programming languages are C and JAVA. UMN MapServer, GRASS, OS-SIM, GEOS, PostGIS and QGIS were written in C while GeoTools, uDig, GeoServer, JUMP, and DeeGree were written in JAVA (Ramsey, 2007).

Many of these projects base their activities related to the development of software on the limited range of functionality, so the problem occurs that certain actions can been done with more than one desktop GIS software. Therefore, gvSIG Community Edition project was formed to bundles to a gvSIG, GRASS and SAGA in one distribution.

Geographic Resources Analysis Support System (GRASS)

Geographic Resources Analysis Support System (GRASS) is one of the biggest Open Source GIS projects realized under GNU GPL (General Public License). During the past 30 years, GRASS has formed a very large and active community of users and developers. The software combines different engines for raster, vectors and spatial

processing and provides a wide range of tools for spatial analysis, modeling, image/ recording processing and visualization. 2D raster/voxel display and analysis, 2D/3D vector editing, vector network analysis and image processing functions are supported. It has proven as a great choice for generating Digital Terrain Models (DMT) as shown in Figure 2. The functionality given in this software can be compared to that of commercial software ESRI's ArcGIS on the ArcInfo level (Steinger, 2009).
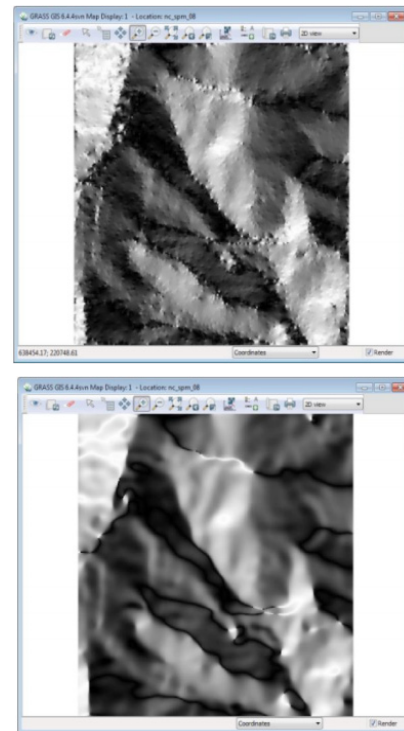
Figure 2. DTM in GRASS

GRASS can import a wide range of formats and has the ability to directly read attribute and spatial data from PostGIS. Quantum GIS can embed all GRASS functions via a graphic user interface (GUI) for easier public use. Multiple data input formats are available (Tsou, 2011). GRASS has been mostly used as an effective modeling tool which can carry out complex data analysis (Ramsey, 2007).

GRASS also provide modeling and simulations for hydrology, erosion, pollution and fire speed, which is why this software is being used in different applications related to risk management. Processing aerial survey data using GIS can also be done with GRASS.

Quantum GIS (QGIS)

Quantum GIS (QGIS) allows users to create maps with many layers using different map projections and it

represents a great tool for spatial data viewing, editing, and analysis.

QGIS is integrated with other open-source GIS packages, including PostGIS, GRASS and MapServer to give users extensive functionality. Plugins written in Python or C++ extend QGIS's capabilities and allow users customization or automatization of GIS functions (Tsou, 2011). Python is a widely used and supported Open Source programming language that is both powerful and easy to learn and it is also adopted by ESRI ArcGIS for their programming functions.

There are many different versions of QGIS available for download. Useful GIS tools are suitable for different spatial analysis, data management, geometry and geoprocessing. QGIS possesses an interface designed for GIS users and allows easy spatial data management. Adding layers to different types of data is done via the icons on the left side of the interface. Different models and simulations are supported.

The software provides the support of DWG file formats and the linkages to GRASS functionalities and to Web (WMS, WFS). ESRI shapefiles and coverage formats are supported. QGIS supports PostGIS and Shapefiles as vector data sources. QGIS supports DEM, ArcGrid, ERDAS, SDTS, and GeoTIFF raster formats (Ramsey, 2007).

User-friendly Desktop Internet GIS (uDIG)

uDig is a great Desktop GIS choice for access, editing and viewing software built on Java. Interface is user friendly, so uDig provide a familiar graphical environment for GIS users which facilitate manipulation with spatial data.

Therefore, uDig offers strong capabilities to integrate Web mapping technologies, standards, framework, printing support, standard GIS file format, coordinate projection support, database access support, cross-platform support, customizability, modularity and thematic mapping with advanced symbology (Ramsey, 2007).

Loading existing vector, raster and tabular data is done by simply adding these files into layers. A large number of data sources is supported, which can be seen in Figure 4. It is further possible to manipulate with attributes and formation of requested solutions.

JUMP, OPEN JUMP, KOSMO

JUMP represents a very useful user interface toolkit for visualization. JUMP has a specific position in the community as several forks (*i.e.* child products) emerged when the initial development stopped.
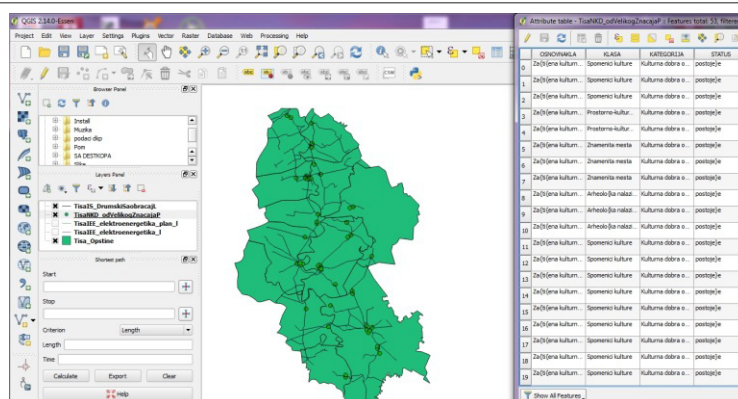
Figure 3. Vector data in QGIS
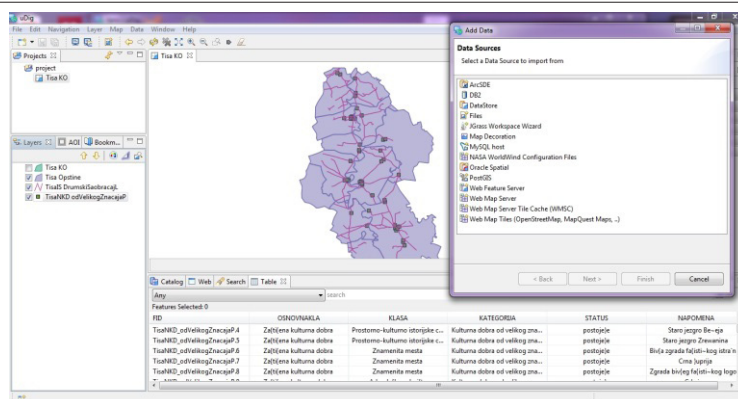
Figure 4. Vector data in uDig

KOSMO is one of the most popular Open Source desktop GIS with nice Graphic User Interface (GUI), GIS data editing tools, and spatial analysis functions (Tsou, 2011). KOSMO is one of the original JUMP GIS fork and was developed based upon OpenJUMP (Steinger, 2009). KOSMO has improved cartographic and spatial analysis functions, which provide a friendly and comprehensive GIS package for desktop computers. The major advantage is the capability for users to edit/modify vertices in vector-based layers. JUMP supports GML, Shape and RDBMS data sources.

gvSIG

gvSIG was developed by the European GIS community offering multiple language user interfaces (more than ten different languages) with flexible GIS data input format. Various GIS data formats (both vector and raster) and online resources can be used.

Today gvSIG is considered as a powerful Spatial Data Infrastructures (SDI) client that enables the connection to OGC Services like WMS, WFS, and WCS. Those standards allow users different functionalities for accessing data, overlapping it and combining it in gvSIG map views. gvSIG contains functions for good vector data editing (Alvaro, 2008).

Some GIS professionals believe that gvSIG is becoming close to replacing ESRI ArcMap software (Tsou, 2011). gvSIG, as a desktop environment, contains all the core functionality for styling, printing with layouts, data editing, raster and vector data support. The idea for gvSIG was to become "all-in" application for all GIS users at all levels. gvSIG offers integration of CAD and GIS worlds, vector and raster, local data with SDI and 2D with 3D and 4D.

A comparative analysis

Each of the listed software solutions has its own advantages and disadvantages. Table 2 gives an overview of the functionality they possess. The first partition of functionality column is concerned with data access (reading and writing) and refers to possibility to use the existing formats. Manipulation of vectors involves working with vector data, their creation, basic and advanced functions. The analysis grid is divided into working with 2D and 3D data and visualization *i.e.* display. Standard concerns OGC and ISO standards that are supported.

		GRASS	QGIS	uDig	JUMP/ OpenJUMP/ KOSMO	gvSIG
Data access (Read/Write)	Raster	√	√	√	√	√
	Vector	√	√	√	√	√
	Table	√	√	-	√	√
	Database	√	√	√	√	√
Vector manipulation	Create, Edit	√	√	√	√	√
	Basic tools	√	√	√	√	√
	Advance 2D analysis	√	√	√	√	√
	3D analysis	√	√	-	-	√
	Topology support	√	√	-	√	-
Raster analysis	2D	√	√	-	-	√
	3D	√	√	-	-	√
Visualization	2D	√	√	√	√	√
	3D	√	-	-	-	√
Appearance	Styling	√	√	√	√	√
	Labelling	√	√	√	√	√
Temporal analysis		√	√	-	-	-
Modular (Pluginable)		√	√	√	√	√
Standard		WMS,WFS,SFS,GML,KML	WMS,WFS,SFS,GML,KML	WMS,WFS,SFS,GML,KML,SLD,FE	WMS,WFS,SFS,GML,SFS	WMS,WFS,SFS,GML,KML,SLD,FE

Table 2. The result of comparing desktop gis software

5. CONCLUSION

Although private GIS software companies such as ESRI, Microsoft, Google and Intergraph had the biggest role in GIS development in the past, GIS Open Source Software Society has been providing good software solutions and is considered a strong competitor today. There is an increasing level of collaboration among Open Source projects today to ensure the creation of better quality GIS solutions.

Using Open Source GIS software proved to be very suitable at different levels (education, research and professional) due to their cost effectiveness and ease of use.

Certain common misconceptions exist today about the Open Source GIS software. Open Source GIS software solutions have robust capabilities for geospatial database creation, spatial analysis and geospatial web applications. They are compatible, substandard compared to proprietary software and they do have commercial support. Open Source software can be a replacement for or a compliment to commercial software.

For almost every geospatial software need and niche there is at least one mature Free and Open Source Software project with a well-documented record of successful application in diverse applications.

There are numerous Open Sources solutions at disposal depending on the needs of modern GIS clients. Open Source software projects are usually concentrated on one category, e. g. GIS desktop or WebMap Server while products by commercial vendors are for more than one category. Free desktop GIS projects, such as Quantum GIS and gvSIG, currently experience growing user communities. From data analysis view point GRASS has been proven as efficient software.

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USING GIS IN EMERGENCY MANAGEMENT

Miloš Milenković[1],
Dalibor Kekić[2]

[1]Ministry of Interior,
Sector for Emergency Situations,
Omladinskih brigada 31,
Belgrade, Serbia

[2]Academy of Criminalistic and Police Studies,
Cara Dušana 196, Zemun, Serbia

Abstract:

Complete, easy-to-use and timely information about geographic objects and factors and their influence is very important for making the right decisions. By the development and introduction of technologies as geographic information systems (GIS technology), this process should be much easier than before. Emergency management basically includes four phases, namely preparedness, mitigation, response and recovery. In all mentioned phases, GIS could be used because emergency management actions are based on the analysis of information. A considerable amount of information, which is used in emergency management, has spatial characteristics and can be shown on maps. Also, when some information is mapped and data is linked to the map, decision makers in all phases of emergency management have a powerful tool for making the appropriate decision. Emergency situations nowadays occur more often than before and emergency management personnel have critical tasks to protect people's lives, their property and environmental values. In solving these tasks, GIS will facilitate their work and raise public safety before, during and after some natural or other disasters. Institutions responsible for emergency management are aware of those facts and make considerable effort to implement GIS in their work.

Key words:

GIS, emergency management, preparedness, response, recovery.

1. INTRODUCTION

GIS stands for "Geographic Information System". GIS application is used to deal with spatial information on a computer. Most precisely it is the spatial representation, capture, storage, retrieval, analysis, display of information (attribute data) that is positioned to correspond to the same X, Y (and Z, if needed) coordinates throughout the various map layers (European emergency number association, 2015). At same time, GIS uses words, numbers and other data from database and makes correlation with locations with the aim to show that on maps. It is a tool for help to responsible people who have to take right decision. It is worth mentioning that GIS cannot make decision alone.

GIS is not only a program for representing maps. It is far beyond that because GIS adds useful information for parts of maps. By enhanced maps, decision makers have great possibilities to analyze locations, their relations, the fastest way to arrive at the particular location or similar. These possibilities are very important in many areas, especially in police, military jobs and other related to safety of citizens. Emergency management

Correspondence:

Miloš Milenković

e-mail:

milos10jul@gmail.com

is very important for safety and security and GIS is one very useful tool for headquarters, command units and others who decide about actions before, during and after some emergency situations. Few decades ago, GIS was the expensive technology because it was new on the market and with high price inaccessible to many. Also, there was limitation from producer that only scientific institutions and military institutes could use GIS. Many years later, it was clear that GIS should be used in many areas and this technology has become accessible to all. Today, GIS technology makes a very huge turnover which can be counted with many billions of euros. This information system is part of lessons at many famous and important schools and colleges. Today, all the institutions and companies that work with space data and management and exploitation of spatial objects, use GIS. The examples of previous sentence are urbanism, construction land, road and rail networks, water supply, sewerage, electricity, gas distribution, telecommunications, heating, ecology, green, agriculture and forestry, *etc*. As noted areas, responsible institutions for emergency management recognize GIS and use it in all phases.

2. PREPAREDNESS FOR EMERGENCY SITUATIONS AND GIS

As mentioned in the previous part of this paper, emergency management has four phases in the function cycle. Preparedness is the first one. During this period, responsible institutions have a task to prepare citizens, schools, companies, and all protected values for possible emergency situations. This phase compared with others, consumes a lot of time and money. Usually, many forget about the importance of implemented actions in order of prevention and preparedness. Only one dollar invested in prevention can save up to seven dollars of economic loss (UNDP, 2012).

Emergency management programs begin with identifying potential emergency risks. Using a GIS, officials can pinpoint hazards and begin to evaluate the consequences of potential emergencies or disasters. When hazards, such as earthquake faults, fire hazard areas, flood zones, shoreline exposure and others are viewed with other map data (streets, pipelines, buildings, residential areas, power lines, storage facilities, *etc*.), emergency management officials can begin to formulate mitigation, response, and possible recovery needs (Johnson, 2000). An appropriate plan is very important for mitigation, response and recovery. The process of emergency planning during the phase of preparedness is not so easy. GIS facilitates this

process by providing planners opportunity to view the spatial data generated at computer maps

During the phase of preparedness emergency management bodies at all levels, from local to national, have to make some documents which are very important. Risk assessment and emergency plan are two of them. By risk assessment, all institutions included in emergency management cycle provide necessary analyzes about potential risk form natural and other disasters. This document should prevent potential hazards that threaten citizens and other protected values. GIS is the useful tool for making adequate risk assessment. Maps can show the critical points and development of some emergency. For example, space which will be flooded on GIS platforms can be connected with information about density of population, number of objects in that area, number of children, and all necessary data important for somebody who will make decision when flood occur. On the other side, emergency planning and plan, as a final result of this process, are very important parts of the first phase for emergency management. In this document, based on the previous-risk assessment, emergency management representatives have to elaborate on what will be done in other phases. This is not a simple job and without serious approach it will not give the desired result. So, GIS should be used for planning to show all actions which define plan. Emergency management planning requires acquiring, integrating, and analyzing vast amounts of information and data in a variety of disparate formats to develop a comprehensive risk-based emergency management program. First, GIS optimizes the planning process because by it we can identify and map natural and technological hazards, identify and map critical values at risk or identify values at risk that reside within the impacted areas of natural or technological hazards (ESRI, 2008). GIS is used for modeling of different scenario which have possibility to become real. Loses can also be projected. Priorities for emergency response are mentioned through the use of GIS.

Education is also an the important part of preparedness for emergency situations. Today, everybody needs basic knowledge on how to react in eventually dangerous situation, caused by natural or other disasters. Modern information technologies give huge offer how to create education programs and materials. On the other side, sentence that "A picture is worth a thousand words" (Bouch, 2009) is very popular and for sure will justify use of GIS maps in new education materials. Printed lectures, brochures or similar, should have GIS outputs. People who will use these materials will make the picture in their heads about "circle of dangerous", after chemical accident in some

factory or after floods. So, they will learn more effectively than before, when is used only the lectures based on text.

3. MITIGATION OF EMERGENCY SITUATION AND GIS

Before emergency situation starts, emergency management bodies need to take the appropriate action to mitigate the effects that will happen. So, the next phase immediately before emergency situations is called mitigation. In the this phase, governments, organizations, and individuals develop plans to save lives and minimize disaster damage (for example, compiling state resource inventories, mounting training exercises, installing early warning systems, and preparing predetermined emergency response forces) (Johnson, 2000). By mitigation measures, we want to enhance future disaster response actions. For example, this means checking stock of vital food and medical supplies, training exercises and by mobilizing special emergency units on standby.

GIS is the powerful tool for this phase. This technology can provide answers to the following questions, such as:

- How many paramedic units are required and where should they be located?
- What evacuation routes should be selected if a toxic cloud or plume is accidentally released from a plant or storage facility based on different wind patterns?
- How will people be notified?
- Will the road networks handle the traffic?
- What facilities will provide evacuation shelters?
- What quantity of supplies, bed space, and so forth, will be required at each shelter based on the number of expected evacuees? (Johnson, 2000)

In this phase, we can use GIS also to show on maps all inputs received from institutions responsible to monitor environment situations such as hidro-meteorogical agency, seismological agency or similar. The mentioned institutions provide necessary information for local or national emergency management bodies, which later make warnings important in mitigation phase. This warning is usually public and should be viewed via the Internet or television. GIS can display real-time monitoring for emergency early warning. Earth movements (earthquake), reservoir level at dam sights, radiation monitors, and so forth, can all be monitored and displayed by location in GIS (Johnson, 2000). The use of GIS enables it to deliver this type of information and geographic display over the Internet for public information.

4. USING GIS IN RESPONSE TO EMERGENCY SITUATIONS

Probably the most important and complex phase of emergency management is response. During this phase, responsible emergency institutions have a wide range of tasks to save and rescue people, and protect environmental and heritage values. This phase consist of unified answer of different subjects as fire and rescue units, hospitals and other medical institutions, Red Cross, army and similar. So, coordination is very important as it provides instructions on how to use resources in the most effective way.

To achieve goals of this phase, it is necessary to use information technologies, such as GIS. The name for centers, where information about emergencies is gathered, processed and dispatched, should be different. We can call them with one name which shows their main function. This name is Emergency Operations Center which is responsible for supporting incident management operation needs and maintaining continuity of operations for the community. Acquiring, managing, and maintaining status of resources from various locations is an important function (ESRI, 2008). To centers is coming information from court. People who work in these centers are responsible for their analysis, making priorities for rescue operations and making of reports for different users. More important is one report with maps, showing the affected areas, the nearest shelters and firefighter units. This reports are a helpful tool for decision makers and they would enable the to make the appropriate decisions in a timely manner. There are also few functions which GIS can provide in the response missions such as:

- Provide warnings and notifications to the public based on the location or areas to be impacted by the incident,
- Maintain shelter location continuity of operations: supply inventories, external power requirements, shelter population capacities,
- Support incident management operations and personnel, provide required resources, and exchange internal and external information,
- Prepare maps, briefs, and status reports for the executive leadership (elected officials) of the jurisdiction (ESRI, 2008).

Natural and other disasters which affect a lot of people and make big damages require a huge number of different resources. For example, floods which occurred on the territory of the Republic of Serbia in mid-May 2014 affected a large area and Serbia suffered great damage with human

casualties. Response phase was very complex, because it was big catastrophe. A lot of people and material resources were necessary to provide an answer. Also, this emergency situation was characterized by scattered flooded places. This requires adequate resource dispatching. In situation as this, especially when resources are limited, GIS is the powerful tool for proper schedule of resources. GIS can provide one of the primary components for computer-aided dispatch systems. Emergency response units based at fixed locations can be selected and routed for emergency response. The closest (quickest) response units can be selected, routed, and dispatched to an emergency once the location is known (Johnson, 2000). So, institutions responsible for emergency response will have the opportunity to avoid mistake and not to overload one place with recourses, and on the other not to have enough. GIS maps give the chance to consider where and which recourses should be dispatched. Also, the evacuation is one task which is usually realized during the response phase. On GIS platforms we can see and after decide which route is most safety for evacuation of people, animals or cultural values. In case of earthquake, floods and other risks, it is not easy to decide where is safety to conduct evacuation. For example, earthquakes may have repeated shock and that consequence can affect evacuation direction.

Modern GIS technologies provide more opportunities that can contribute to better emergency response. One example for this is the advanced vehicle locating which can be incorporated to track (in real time) the location of incoming emergency units. This locating can also assist in determining the closest mobile units to be dispatched to an emergency, as they are located on the map through global positioning system transponders (Johnson, 2000). So, on one map can be shown all dispatched units, their movement and change of location to another affected territory.

Situational awareness for emergency management personnel is very important to provide the right answer. Situational awareness means to be aware of what is happening around and possible consequences of natural or other disasters. This is especially important where situation is very serious and threatens to make much greater damage. GIS provides situational awareness through high operating maps. Maps can display relevant GIS data as critical infrastructure or hazards integrated with dynamic event data collected from sensors, cameras, traffic escorts to represent the current situation. Only by comprehensive situational awareness, emergency management personnel will have an opportunity to make better decisions that after can be shared, and understood by units which have to take actions. In order to enhance situational awareness during the response phase to maps can also be added the response plans or contingency plans, and other documents.

Based on the previous text, it can be concluded that GIS plays a great importance during the response phase. With this technology is much easier to make the right answer, save people's lives and protect material and cultural assets.

5. RECOVERY FROM EMERGENCY SITUATION AND GIS

Recovery efforts begin when the emergency is over (immediate threat to life, property, and the environment). Recovery efforts are often in two phases, short term and long term (Johnson, 2000). The short term recovery is focused on the essential needs of citizens who were affected by emergency situations. That primarily means water purification, energy supplying, telecommunications, healthy institutions and similar. On the other side, actions which
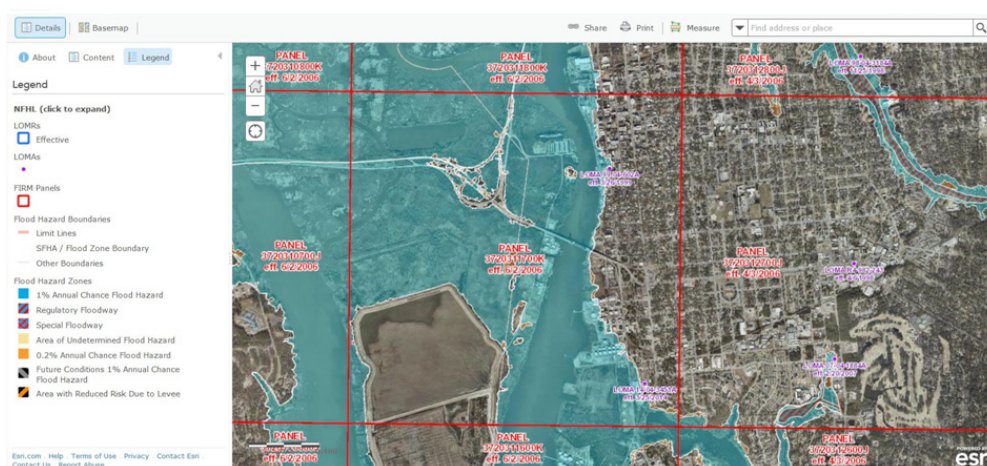
Figure 1. Example of GIS map in case of flood response *(FEMA,2015)*

are taken during long term recovery are focused on business entities, educational institutions and similar. In both phases, we can use GIS, as a the helpful tool to bring all living conditions into normal state.

After emergency situations, people's basic needs have to be satisfied as soon as possible. Priorities must be made and responsible institutions start to work on mentioned tasks in short recovery phase. It is not simply job because of many problems that occur immediately after the end of emergency situations. One very important task is to make the appropriate assessment, determine what happened and where to start with recovery. Using GIS, decision makers will have the precise picture of the source of problem. GIS can locate each damaged property, identify the amount of consequences, and begin to establish the first places for immediately actions. Also, when emergency situations start, GIS use one database. In recovery phase the situation is probably completely different. So, especially in short term recovery phase, this database has to be updated. Also, after most of natural or other disasters people should be in shelters, temporarily or permanently. They have to be there until the conditions in their houses are not same as before the emergency situation. With adequate database, GIS will show the location of shelters, number of people in them and their essential needs (food, water…).

After short term recovery phase starts long term recovery phase. As stated in the previous text, during this period is important to think how to employ people who lost job because of emergency situation. The part of this phase is also critical infrastructure, such as roads, bridges, *etc*. Everything has to be in normal or better conditions. Long term recovery is characterized by huge investments. For recovering of one bridge, the responsible institution has to pay a lot of money, probably in millions of euro. GIS provides the opportunity to show on one place the progress of investments. The investors, who are usually country governments or donors from abroad, want to check at any moment this progress. They can see on GIS maps which task is finished and where are bottlenecks.

6. EXAMPLES OF GOOD PRACTICE OF USING GIS

Institutions, responsible for emergency management, in many countries use GIS in all the mentioned phases. They have recognized all values of GIS in practical activities.

United States Army Corps of Engineers has the mission to deliver vital public and military engineering services, partnering in peace and war to strengthen their nation's security, energize the economy and reduce risks from disasters (US Army Corps of Engineers, 2001). Besides the main orientation to investigation in the area of military activities, this organization tries to pay more attention to develop and use modern technologies for emergency management. One example of this is the GIS. They use GIS for different tasks, such as gap analysis, capability assessments and public affairs. Gap analysis, which is realized with the GIS, can facilitate data collection and acquisition prioritization. When emergency situation occur, this organization use GIS to work on capability assessments. They use geospatial data as a tool to determine organizational strengths and weaknesses. This is especially important for subjects that are involved in national search and rescue system. In the area of public affairs, United States Army Corps of Engineers use GIS to
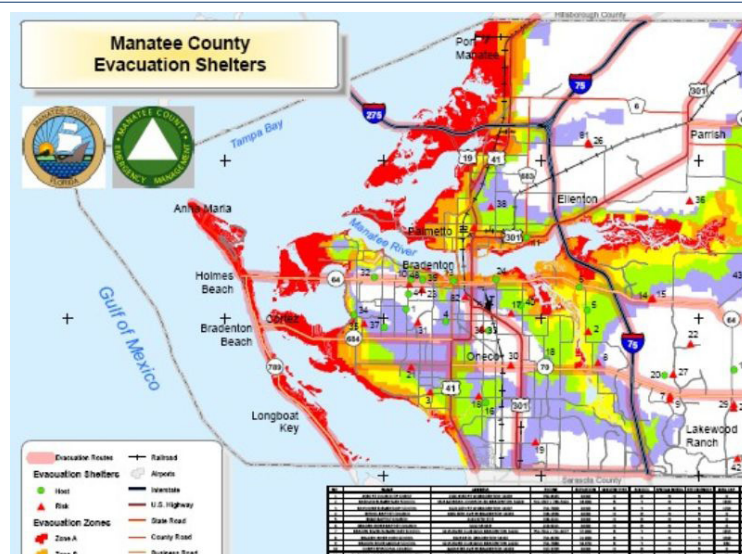
Figure 2. A sample of the evacuation shelter map *(from https://www.mymanate.org, Retrieved March 27, 2016)*

disseminate geospatial information, such as static maps and prepared data for web viewers and social media.

In mid-May 2014, the Republic of Serbia experienced the worst flood in over 100 years. The extreme floods had been caused by heavy rainfall during three days. National capacities were not enough to answer on this situation. Many teams came from abroad to help Serbian's authorities. United Nations Disaster Assessment and Coordination (UNDAC) Team was deployed to Serbia. Two mapping and GIS experts from MapAction were attached to the UNDAC Team (OCHA, 2014). Use of GIS during floods was very significant. GIS maps, prepared by Serbian's Sector for Emergency Management and international team, were used for different tasks. Flooded areas and forecasts of the movement of the flood wave were presented on maps. This was the useful tool for decision makers, who were responsible to decide about the evacuation routes, care places for evacuated people, *etc.*

7. CONCLUSION

GIS, as a system, is a very powerful tool for emergency management decision makers during all four phases. Regardless of preparedness, mitigation, response or recovery, GIS will find its place. Responsible institutions must have this in their operating centers. If they do not have, they must start to think about that.

Also, because GIS primarily depends on information, this information system is good provided that information is adequate. So, decision makers in the area of emergency management should be cautious. GIS will not provide the appropriate maps and other products if database is not correct. Also, for all phases, it is characteristic that they are very dynamic and unpredictable. For example, during preparedness phase, some buildings or bridges are built and new forests are planted. Everything has to be included in GIS platforms in order for the final GIS product to be adequate for users. It is not an easy process, especially during the response phase. Coordination between somebody who is in charge for GIS and other stakeholders who are obliged to give data is very important. Without this, we will have incorrect data and final maps will show false picture. Consequences may be catastrophic, especially because in this case attention is placed on people's lives, animals and cultural and other heritage.

On the other side, GIS invest constant efforts to make innovations. Today, the most of people use mobile phones. This technology has found its role in emergency management. Communication between citizens, operating centers and first responders goes through mobile phones. Also, the first responders use other technolo-

gies, such as TETRA for example. But, citizens who are in danger from natural or other disasters probably will call the operating center by mobile phone. GIS producers now try to make option for this information system to automatically show the caller's location and display on GIS maps. As the calls come in, the system automatically displays caller's location on a map, and dispatchers who use the same map will see which emergency units are in the best position to respond. Dispatchers can also see which fire stations are nearby, enabling them to send units equipped to deal with hazmat situations. The maps, enriched with several layers of GIS data, also show the nearest hospitals from which to dispatch emergency units (European emergency number association, 2015).

With new options, GIS will undoubtedly be an information tool necessary in any emergency management institution.

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GIS IN LITHUANIAN FOREST INVENTORY – 20 YEARS' EXPERIENCE

Ina Bikuvienė[1],
Daiva Tiškutė-Memgaudienė[2]

[1]Kauno Kolegija - University of Applied Sciences,
Pramonės pr. 20, Kaunas, Lithuania

[2]Aleksandras Stulginskis University,
Kaunas dist., Lithuania

Abstract:

It has been almost 20 years since the start of using GIS based stand-wise forest inventory and management in Lithuania. The first cycle of the stand-wise forest inventory by using GIS was finished in 2006. Lithuanian Institute for Forest Management Planning introduced the technologically new solution in 1999 in development of forest inventory by presenting the geographic information system (GIS). It started to work with PC/ArcInfo for data collection and storage as well as for cartographic works analysis. Later on, GIS system has evolved into a big and multifunctional digital information system, based on the ArcGIS, ArcSDE platforms and MS SQL Server. Technology was based on the integration of all cartographical material using GIS and on-screen vectorization of orthophoto maps. That has affected the foresters to change their approach to the benefits of using GIS technology in forest resources processing.

Key words:

forest management, Geographic Information System (GIS), geo-reference background.

1. INTRODUCTION

The planning and management of forest resources in Lihuania is known for a long time. The first references about forest conditions reach the 16th century. Regular forest inventories started in 1801-1820 and until 1914 all state's owned forests were inventoried at least once. (Mozgeris *et al.* 2008). During the period from 1922 to 1940, considerable attention was devoted to the forest measurement works and their accuracy. Forest plans were drawn by hand in scale 1:10000 or 1:5000. After 1950's for delineation of forest compartments started to use panchromatic ortophotomaps (Bikuviene, 2012). Usually, the forest inventory cycle in the state-owned forests in Lithuania is ten years. Forest management plans and cartographic material are prepared for the same period. Aerial photography is used for preparing cartographical material or orthophotomaps. Until 1990's, almost 85% of forests was covered with aerial phothography (Mozgeris *et al.* 2008).

In Lithuania, there are more than 2 millions ha of forests and every year about 10% of them (200-230 thousands of hectares) are inventoried. In 1984, digital data base for storing and processing of inventoried data was created. All data are analyzed, processed and then used for printing of reports. Data is updated according to the performed economic tools and the use of stand growth table. In a database more than 1,4 million

Correspondence:

Ina Bikuvienė

e-mail:

ina.bikuviene@gmail.com

records about forest compartments are stored, which are indicated with almost 100 parameters. This data base is used for statistic of ownerships, forest's cadastre, for forest planning and strategical development, for prediction of forest's condition, *etc*. (Mozgeris *et al.*, 2008).

All forest inventory works are carried out by the Lithuanian Institute for Forest Management Planning by surveying and measuring every single individual stand. GIS database was developed for the first GIS-inventoried Biržai forest enterprise in the year 1995 by using manual digitizing from the paper topographic map with stand boundaries, transferred onto the maps from aerial photographs by using photo-mechanical projectors. Since 1996, orthophotographic maps have been used as a mapbase, while the manual digitizers were used to capture the geographic forest inventory data. Orthophotos based on special color infrared aerial photography have been used since 2002. These orthophotos are created specially for forest inventory and management planning purposes. Lithuanian Forest Inventory and Management Planning institute introduced technologically new solution in 1999 in development of forest inventory GIS databases. This technology is based on the integration of all cartographical material using GIS and on-screen vectorization of orthophoto maps. The main points of this technology are (Kuliešis *et al.*,2000; Kuliešis, 2002; Palicinas, 2007):

1. Collection of all available information to be used for possibly objective singling-out of the forest inventory units – forest stands (old forest maps, remote sensing data, general GIS databases and maps, measurements, *etc.*).
2. Automatization and integration of all collected information (scanning and geo-referencing of paper maps).
3. On-screen interpretation of new forest's compartment boundaries carried-out by forest's inventory's engineers. The same person will implement the field work and finalization of the compartment level GIS database later.
4. Development of initial version of forest compartment GIS database and printing-out of sk*etc*h maps for field surveys.
5. Conventional field survey.
6. Finalization of forest compartment GIS database, development of cartographic elements, calculation of some specific attributes (area), mapping, *etc*. using conventional techniques.

The first cycle of the stand-wise forest inventory using GIS was finished in 2006 in Lithuania. The technologies used for forest inventories were redesigned essentially during the first decade. The last of them was on-screen vectorization of colour infrared orthophotos, assisted with numerous auxiliary information, including maps from previous forests' inventories and georeference GIS databases.

2. THE INFLUENCE OF DIFFERENT INVENTORY TECHNIQUES ON THE GEOMETRICAL ACCURACY OF FOREST GEOGRAPHIC DATA

It was expected that innovation was enabled to obtain more accurate data than using manual digitizing. However, this has been tested only few times. Moreover, there is practically no information on the geometrical accuracy of geographic data, collected during stand-wise forest inventories. Some publications are about the quality of orthophotos used for inventory (Mozgeris and Dumbrauskas, 2006), but only theoretic accuracy assumptions are done in the technological descriptions of works. The instruction of forest inventory and management planning activities provides just the requirements for GIS data basis accuracy that is expected. According to the instructions, the geographic accuracy by clearly identifying objects in the area and in the GIS database or cartographic plans (such as section line, hydrographic network elements and others crossings, road junctions, *etc.*) positional accuracy root mean square error (RMSE) cannot by greater than 5 m (http://www3.lrs.lt/...).

The positional accuracy of forest GIS base was tested by comparing different technological solutions. Identical object on two GIS databases – forest compartment GIS database at a scale of 1:10000, was developed within the frames of stand-wise forest inventories and Lithuanian georeference background data base GDB10LT. Approximately, 2500 of control points were located on both databases (Figure 1). Clearly identifiable objects on both databases, such as road, dike intersections, sharp corners of forest tracts, *etc.*, have been digitized (Figure 2).

Euclidean distances between points were calculated, as well as the distances at X and Y directions. GDB10LT was considered as the standard. Conventional accuracy estimates, such as bias, location root mean square error, including the ones in X and Y directions, standard deviations were calculated. Standard ArcGIS software was used for capturing the control points and calculating the accuracy estimates.

The results have shown, that the biggest and not acceptable errors at a scale of 1:10000 were achieved in the

Figure 1. Locations of control points on the Lithuanian forest directorate

Forest compart-
ment GIS data-
base at a scale of
1:10000

GDB10LT
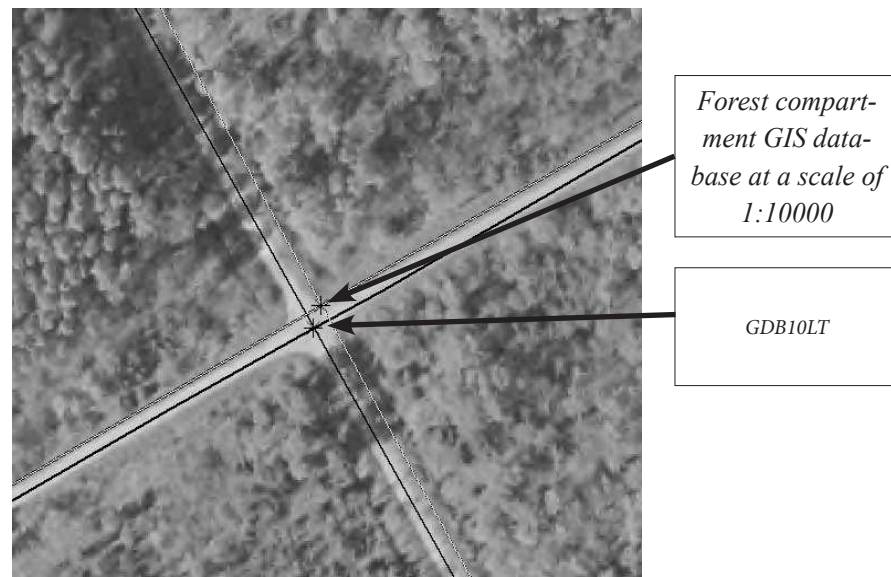
Figure 2. Locations of control points on the Lithuanian forest directorate

first steps of using GIS. The largest root meaning square errors (12.37 m and 10.87 m, for X and Y coordinates respectively) was found on a version of forest compart-ment GIS database, which was developed by using manual digitizing of topographic maps. The overall root meaning square error here was 16.47 and the bias – 13.2 m. The geometric accuracy of forest compartment GIS database seems to improve steadily with the introduction of more advance techniques. Introduction of coloured infrared orthophotos instead of panchromatic ones has resulted in slightly decreased geometrical accuracy of clearly iden-tifiable forest objects. It should be noted that coloured infrared orthophotos are focused on improving forest's stand delineation but not for detecting of topographic

objects, such as rods and dikes. The geometrical accuracy of forest inventory oriented colour infrared orthophotos is somewhat less than the one of panchromatic ortho-photos (Mozgeris and Dumbrauskas, 2003).

The results achieved lead to the conclusion that for-est compartments GIS databases, created two decade ago, failed to meet the requirements of mapping at a scale 1:10000. Nevertheless, all technological innovations in development of forest inventory GIS databases have had positive influence on the geometrical accuracy of well-defined geographic objects. The best results were achieved with an introduction of on-screen vectorization techniques. Errors have reduced below the level required for mapping at a scale of 1:10000 (Bikuvienė, 2008).

3. INTEGRATION OF GIS IN ALL FOREST INVENTORY, MANAGEMENT AND CONTROL STAGES

All of these innovations have been used for creation of GIS based system for forest cadastre and management. Lithuanian Institute for Forest Management Planning established department for GIS and cartography. GIS evaluation has taken all the stages from a simple system, based on ArcView, then to ArcGIS ArcInfo, and finally to ArcSDE platforms and MS SQL Server's. For the purpose of improving the quality of forest inventory and management data, GIS is used in almost all stages of works. Inside the company, all departments can use the GIS database as clients of centralized server with different levels of management. Outside users can connect to the centralized server for a browsing for different types of forest information. GIS system is created like an integrated and flexible system and can work with different types of data, not only collected with devices, using an ArcGIS platform.

Lithuanian State Forest Service has created an MGIS system based on ArcGIS Viewer for Flex, which provides information about forests managements plans in private and state forests, forest's conditions after natural events (windstorms, fires), land utilities, forests compartments, etc. (http://www.amvmt.lt:81/mgis/). Every single user can browse this information for free (Figure 3).
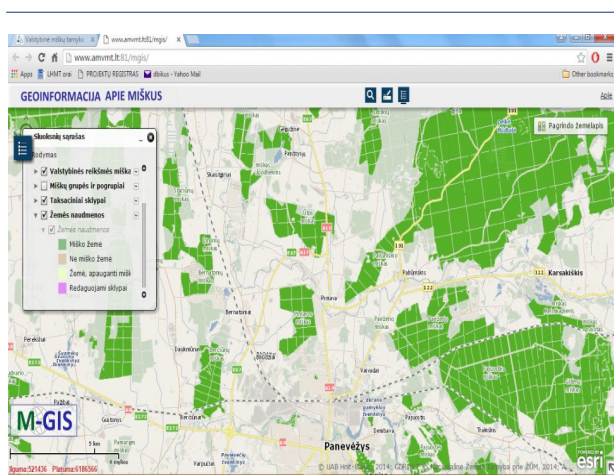
Figure 3. Example of MGIS

One more GIS database was created for employees working in the territorial divisions, with the possibility of editing data from their workplaces all around the Lithuania (http://www.amvmt.lt:81/vmtgis). Authorised users can edit, browse, print and analyse data. For both databases mentioned above, Lithuanian georeference

background database GDB10LT and orthophotomaps of different years, are used as background.

The introduction of more accurate positional devices, such as GPS receivers (Trimble Juno series) or field computers, improved the accuracy of collected data. After the field surveying, it is possible to move collected data directly to the database. For field works all devices are prepared with digital forests compartment maps. There are a lot of different layers, with important data for forests inventory purposes: forests classes, ownerships of forests, cadastral parcels borders, protected areas, etc. The field surveyors can create a preliminary version of GIS and transfer it later directly to the database. For field works papermaps are prepared, on which old borders are given of forest's compartments and forest's borders itself, protected areas, cadastral information, etc. All corrections are performed on them, and later vectorized on a screen by GIS specialist (Figure 4).
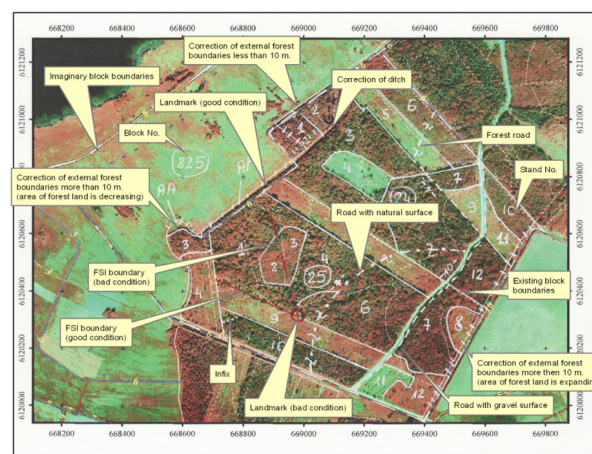
Figure 4. Example of a papermap, used by field surveyors

In a GIS database, created after field works, are stored not only the vector data, but the descriptive information too. After field works, a preliminary version of GIS databases are updated and supplemented with exhaustive descriptive data (Mozgeris et al., 2008). Different kinds of thematics maps for forest inventory are created in a digital form, which can later be printed or submitted to the recipients in digital form.

4. GIS SIGNIFICANCE FOR THE LITHUANIAN FOREST SYSTEM

After the first decade of using GIS in forest inventory works, the users - forest enterprises or private foresters – were asked about their opinion or expierence with GIS.

An interview was made with more than 100 foresters (Mozgeris *et al.*, 2008). None of them was a GIS specialist. The use of GIS in the forestry was rated on the scale from 4 to 10 (10- excellent, 4 - unsatisfactory) and the results was 5,5. The question, „What is your opinion about the benefits of innovation by using GIS, digital maps, orthomaps for forest inventory?", was answered not only by the users of end production- different kind of maps, plans, *etc.* - but the field surveyors too. None of them have answered like „4". This gave a hope, that innovation will be used and integrated to all works in the forest.

This interview was repeated this year by asking the state forest enterprises to determine the situation related to the current use of GIS. Of 42 forests' enterprises, the answers were obtained from 25. In 2004, only three enterprises were using GIS software, 14 were planning to buy it. Today, 20 forest enterprises are using GIS software, while 2 are planning to buy it. The number of people with experience in working with GIS has reached almost 200. Number of GIS personal desktops is around 130. All of respondents have answered that they use GIS in fieldworks. This leads to the conclusion that GIS has become more important for the foresters and in the future all works will be performed by using GIS software.

5. CONCLUSIONS

Technological innovations in development of forest inventory GIS databases have had positive influence on the geometrical accuracy of well-defined geographic objects.

GIS has evolved to an integrated and flexible system, used in all stages of forest inventory, management and control.

More than a half of forest enterprises are using GIS software or will use it in the nearest future.

GIS has become very important for foresters and in the future, all works will be performed by using GIS software.

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http://www.amvmt.lt:81/vmtgis

http://www.amvmt.lt:81/mgis

ADVANCED ENGINEERING SYSTEMS

RISK ASSESSMENT OF MOBILE PHONES USING FAILURE MODE AND EFFECTS ANALYSIS

Ana Bašić,
Predrag Popović

Singidunum University,

32 Danijelova Street, Belgrade, Serbia

Abstract:

The use of mobile phones implies the existence of a risk to users of this kind of equipment. An additional problem is that for the radio equipment there is still no general standard which defines principles for the design of this type of equipment with the emphasis on assessment and risk reduction. Failure in hardware and software in mobile phones is one of possible risks. The effects of failure cause problems in mobile phones, customer dissatisfaction, cost ineffectiveness, poor marketing for manufacturers, *etc.* The causes and effects of failure analysis will help the user and manufacturer to understand the system more effectively and also to avoid the failures as much as possible. This paper presents the failure mode and effect analysis of the mobile phone. The aim of the research is to analyze the whole mobile phone system with its components and their potential failure modes. Based on the proposed analysis, the paper shows calculation of Risk Priority Numbers for various mobile phone components. The results of this research represent attachment to the general methodology of assessment and risk reduction of mobile phones.

Key words:

mobile phone, risk assessment, Failure Mode and Effect Analysis (FMEA), Risk Priority Number (RPN).

1. INTRODUCTION

Advances in science and technology have enabled people the access to many means that facilitate their lives. In addition to mobile phones, lap tops, payment cards, navigation devices and Internet, there are many more useful products of the present day scientific-technological revolution. However, many of the technical products which make the everyday life easier, more interesting and economical have got negative consequences to health and safety of users, as well as to the environment. Unfortunately, these negative effects are very often put into the rear plan with respect to the usefulness, usability and technological power of new technical products.

Risk assessment and management in technical systems constitute very important economic and general social issue. Risk is an economic category in the sense that it has its price, its market and its buyers. Technical systems risk management is possible only if there is knowledge of the phenomena by which it is managed, as well as of the management methods.

If risk is expressed as the product of an unwanted effect occurrence probability and consequences of that event, the risk is then represented as

Correspondence:

Ana Bašić

e-mail:
ana.basic@ratel.rs

the product of one real and one imaginary component. Nevertheless, practice has shown that this definition is very practical and that it enables risk management to be executed in adequate ways. Consequences of an unwanted event can relate not only to economic and financial losses, but also to health issues and the environment, to market prestige and competition, to social and political factors, customer dissatisfaction, *etc.* This means that consequences of unwanted events can be expressed in different ways, depending on the system analyzed and the nature of the damage. Assessment of unwanted event consequences is very simple if financial losses are assessed, while it is much more difficult in cases of unwanted events' effects on health and environment, *i.e.* when it is difficult to measure the consequences. When considering probability of an unwanted event occurrence, the risk there is related to technical systems' reliability performances. In such cases, reliability of a technical system represents capability of the system to operate without failure, under the same conditions and in the given period of time.

The conformity assessment procedure for technical products implies that safety requests have been integrated into the design project. In the course of designing technical products, risk levels are analyzed and quantified with the goal of determining the necessary safety systems. The New Approach Directives, as well as some harmonized standards, explicitly state the risk assessment procedure. When risk assessment isn't stated in the Directive, it may be required by the standard related to that Directive (Đapić *et al.*, 2012).

In the new Radio Equipment Directive 2014/53/EU, which comes into force in June 2016, it is noticeable that it covers the activities which deal with risk assessment of this type of equipment. However, there still is not a general standard which would define the principles for designing such equipment pointing out risk assessment and risk reduction (Bašić and Popović, 2014). The ADCO R&TTE Group has worked intensively on the project of devising the radio equipment risk assessment procedure for several years now.

The object of this research is application of technical systems' failure analysis in the context of radio equipment risk assessment. The Failure Mode and Effects Analysis have been performed on the mobile phone as the typical representative of radio equipment. Special attention has been paid to analyzing failures that may occur in mobile phone hardware, as well as in software. Ten most frequent failure modes have been identified for which the complete FMEA has been performed and the Risk Priority Number (RPN) value calculated.

The object of research was approached by applying the basic risk management principles. The results of this paper, achieved by simultaneous implementation of engineering principles and basic risk management principles, represent a contribution to designing efficient technical systems and at the same time they represent a contribution to the project of devising the radio equipment risk assessment methodology. At the end of the paper, the use of FMEA method is justified and the advantages and shortcoming of its use are stated. Problems encountered in using the FMEA method are pointed out and the obtained results are explained in detail and guidelines are added for their further implementation.

2. RADIO EQUIPMENT RISK ASSESSMENT

The European Commission has initiated development of several generic harmonized standards to enable systematic approach and provide guidelines for identifying hazards, risk assessment of these hazards and acceptability assessment of the selected safety measures. At the moment, there are numerous standards for risk assessment and reduction in technical products, defined in the New Approach Directives. The risk assessment and reduction standards are very well developed in the areas of machines (Directive MD 2006/42/EC), lifts (Directive 2014/33/EU) as well as in the equipment and safety systems used in potentially explosive atmospheres (Directive ATEX 2014/34/EU).

In recent years an extensive research has been ongoing related to the development and implementation of radio equipment risk assessment methodology. In these research bases for adequate methodology development are the standards for technical products' risk assessment defined in the New Approach Directives. Potential hazards that may occur in radio equipment use should be regarded through several aspects. Only when the research issues are approached from multiple sides it is possible to obtain complete data.

The constant issue is whether there are risks in radio equipment usage, and what level they are, primarily in the use of mobile phones. There are many different opinions based on numerous studies and research works. The risks that exist in mobile phone use are not just the risks related to the device's failure effects, electromagnetic radiation effects, occurrence of interference, *etc.* The risks of mobile phone use should be considered from the health, ethical, social and environmental stand point (Bašić and Popović, 2015).

Developing the methodology for radio equipment risk assessment is an extremely complex issue. This issue should not be approached only from the engineering point of view. The desirable approach is the one from the management point of view as it will point out not only to the engineering but to other issues as well, giving proposals for resolving these issues. Within this paper, the issue of radio equipment, *i.e.* mobile phone risk assessment, has been approached by way of one of the basic tools used in the engineering management. Different failure modes and effects have been analyzed by FMEA in the context of radio equipment risk assessment.

Occurrence of any kind of failure brings about problems in mobile phone regular operation which simultaneously render very bad marketing for manufacturer of the device. FMEA analysis results can be of significant assistance to both manufacturers and users of the equipment, enabling them to gain better knowledge of the system's operation and to avoid failure occurrence whenever it is possible.

Square Trade Company has conducted a very interesting research on smart phones' failure rates. The research lasted for 12 months and covered more than 50 thousand mobile devices from different manufacturers. Figure 1 depicts the results achieved by Square Trade relating to failure rates in the period of 12 months in different types of smart devices.
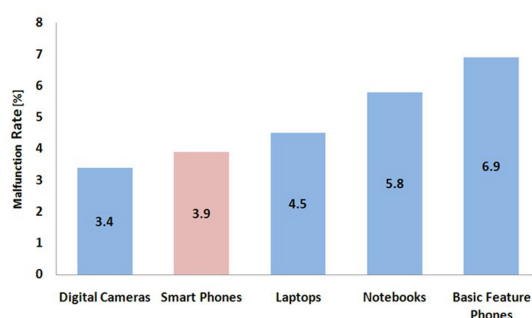
Figure 1. Malfunction rate in various types of radio equipment as per (Square Trade Research brief, 2010).

Manufacturing of smart phones commenced in 2006. In ten years' time of their manufacturing, reliability of these devices has improved significantly. The results of this analysis depicted in Figure 1 shows that smart phones take the second place with the failure rate of 3.9%, *i.e.* it shows that devices such as lap tops, notebooks and basic feature phones are less reliable in respect to smart phones (Square Trade Research brief, 2010).

If the analysis of smart phone failures is simplified, it is possible to define two basic types. To put it more precisely, failures can occur due to an accident or due to the mobile phone hardware or software failure/malfunction. According to the data acquired by Square Trade, two most frequent accidents leading to mobile phone malfunction/failure are falling and soaking of the device. Fig. 2 depicts very interesting results of the ratio of failure rate due to malfunction and failure rate due to accidents in mobile phones of various manufacturers. The results of the analysis show that failure rate due to software or hardware malfunction is less compared to failure/malfunction rate due to accident occurring in mobile phone usage (Square Trade Research brief, 2010).
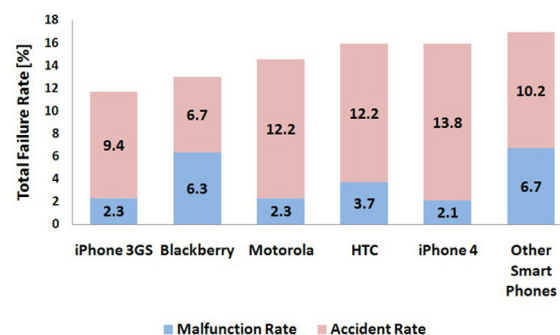
Figure 2. Overall Failure Rate due to accident and malfunction as per (Square Trade Research brief, 2010).

2. FAILURE MODE AND EFFECT ANALYSIS

General characteristics of the FMEA method

FMEA method is one of the basic system tools used in the engineering management. This method is widely applied and can be used for both equipment and objects, as well as for the manufacturing operations analysis and their effects on the product or on the entire process. FMEA can be used in all phases of the system's life, from the initial system specification, system implementation and further to its management and maintenance. The use of FMEA in analyzing technical systems failures enables identification of all potential failure modes of the technical system elements and failure occurrence causes, as well as for assessing failure effects.

The basic advantages in applying the FMEA method are:

- ◆ Early identification of errors in the technical system, thus avoiding subsequent expensive modifications of the system;

- Identification of failures which have unacceptable effects on the system's operation and/or which can severely jeopardize users' safety;
- The possibility to determine whether there is the need for increasing system reliability (redundancy, components selection, *etc.*);
- The possibility to form a logical model for assessing probability of irregular working conditions occurrence with the aim of preparing the technical system for the criticality analysis;
- Efficient detection of the problems related to technical system safety, as well as to the system conformity with normative requirements;
- Assistance in determining key issues towards which quality control and manufacturing process control should be directed;
- Assistance in determining the strategy of technical system preventive maintenance;
- Assistance in isolating failures and planning of alternative modes of operation and in planning the system configuration improvements;
- Assistance to designers in understanding the factors that affect technical system reliability.

The procedure for FMEA method realization

The FMEA method represents the system analysis and logical technique which enables performing the system reliability assessment on the basis of consideration of potential, individual failures. The objective of FMEA method application is to define the answers to the following questions:

- What are the possible causes of identified system failures?
- What are the effects of identified failures at the level of elements/subsystems?
- What are the most efficient means for detection of failures?
- What is the failure frequency in the observed system?

Figure 3 is a graphic depiction of the basic FMEA method phases.
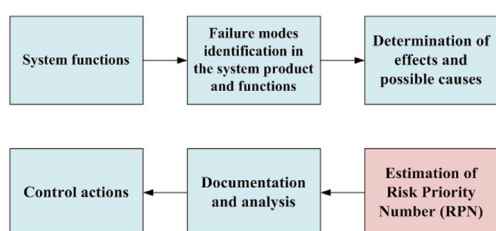
Figure 3. The basic FMEA method phases

The procedure of implementing the FMEA method always begins with identifying the purpose and all functions of the observed system. It is necessary to gather basic data on the system, such as: structure and limits of the system, the system level which is analyzed, description of functioning of all system parts, environment conditions, *etc.*

The next step is identification of all possible failure modes. It is very important to collect as many data on the system failures, on failure causes and effects, ways of failure detection, procedures for failure compensation, classification of criticality and probability of occurrence. It has been proved in practice that implementing of the *brainstorming* method enables very good results in identifying failure modes.

The next phase encompasses determining causes and effects of the defined failure modes. In determining the failure effect severity (*Severity*), failure occurrence probability (*Occurrence*) and estimation of the possibility to detect failure before it jeopardizes operation of the system (*Detection*), the values are used as given in Table 1, Table 2 and Table 3, respectively (Marques, 2010).

Index	Severity	Criteria
1	Very low	Failure occurrence almost unnoticed by the client
2 3	Low	Slight decline in the quality of the observed system performances and occurrence of marginal customer's dissatisfaction
4 5 6	Moderate	Significant decline of the system performances quality and dissatisfaction of the customer
7 8	High	The system stops working; high customer dissatisfaction
9 10	Very high	The system stops working; very high customer dissatisfaction; safety problems

Table 1. Determining failure effect severity (Severity)

Index	Occurrence	Proportion
1	Very low	1:1000000
2 3	Low	1:20000 1:4000
4 5 6	Moderate	1:1000 1:400 1:80
7 8	High	1:40 1:20
9 10	Very high	1:8 1:2

Table 2. Determining failure occurrence probability (Occurrence)

Index	Detection	Criteria
1 2	Very high	Failure will be detected before it jeopardizes system operation/ the customer
3 4	High	There is high probability for the failure to be detected before it jeopardizes system operation/ the customer
5 6	Moderate	Failure will probably be detected before it jeopardizes system operation/ the customer
7 8	Low	Failure will probably not be detected before it jeopardizes system operation/ the customer
9 10	Very low	Failure will not be detected on time; regular system operation and customer's safety are jeopardized

Table 3. Assessment of the possibility to detect failure before it jeopardises system operation/the user (Detection)

The next step in the procedure of FMEA implementation is calculation of the RPN value, which represents failure criticality degree assessment and also risk priority assessment. All failures in the system can be ranked with respect to RPN, where high RPN value denotes high priority in problem solving. The RPN value is calculated by the next equation:

$$RPN = S \times O \times D \qquad (1)$$

- ◆ S (*Severity*) – failure effect severity, *i.e.* assessment of how much the detected effect affects and jeopardizes system operation/the customer;
- ◆ O (*Occurrence*) – failure occurrence probability;
- ◆ D (*Detection*) – estimation of possibility for the failure to be detected before it jeopardizes system operation and/or the user.

In the obtained RPN value is less than 50, the failure criticality degree is low. For the RPN values from 50 to 100, the failure criticality degree is considered to be moderate, or from 100 to 200, the failure criticality degree is considered to be high. For all RPN values over 200, the failure criticality degree is considered to be very high, *i.e.* these are the failures which have priority in problem solving. The last step in the procedure of FMEA application is documenting of the implemented procedure and taking of actions with the aim of risk reduction for the identified failure modes.

Application of FMEA method to technical systems hardware and software

Application of the FMEA method with the goal of failure analysis implies implementing of the method to both hardware and software of the technical system. In

cases when there is a reduced rate of failure occurrence in the system, reliability in the system is increased. However, there is a significant difference between hardware failure rate and software failure rate, which is depicted in Figure 4 by the reliability curves (Vijayalakshmi, 2014).

If observing the technical system's hardware reliability curve, it is evident that after manufacturing of a certain component, the number of failures becomes high.
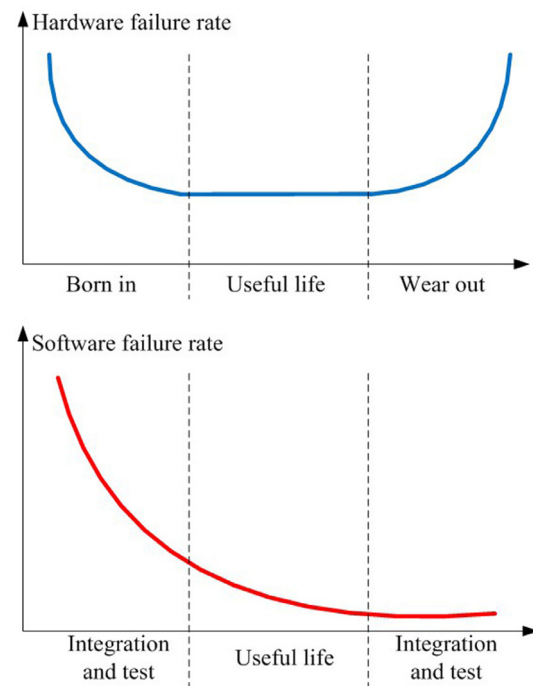
Figure 4. Technical system's software and hardware reliability curves as per (Vijayalakshmi, 2014)

The number of failures decreases over time because the components where failure occurred have been identified and replaced by new components or their operation has been stabilized. For a certain period of time, the system is in stable state in which there is a minimum number of failures. In time, in the course of usage, the system components wear out and age and the rate of their failures/malfunctions increases.

If the technical system software reliability curve is analyzed, it can be seen that the rate of failures/errors is greatest at the moment of software integration and during initial tests. After the initial software testing, the observed errors are eliminated, and the procedure of the system improvement is continually reiterated with the assumtion that new errors do not occur in neither of the new cycles. At one moment of the system operation, failure degree reaches the lowest level. Unlike the hard-

No.	Failure mode	Functions / Conditions	Failure causes	Failure effests	Effects on systens	Process control	Recommended actions
			HARDWARE				
1	Keyboard failure	Allows the user to perform/execute operations on the mobile phone	Due to accidental falls, water infiltration, wrong utilization by user, manufacturing error.	Incapability to execute actions	No operation or wrong data	Tests; inspection	Change keyboard material to a stronger and reliable one; more supervision
2	Battery failure	Provides energy and sustainability to the mobile phone	Due to inappropriate use of battery; inappropriate type of battery; overcharging and aging; negligent utilization by custumer	No power on; dissatisfaction by the costumer; risk of explosion; need frequent charging	Constant shut down; durability of the battery too insufficient for a correct utilization of mobile phone	Tests; inspection	Utilization of appropriate batteries; more supervision
3	Mobile phone shell failure	Covering and protecting the internal components	Low material quality; manufacturing desigh errors	Unappealing esthetics; uncomfortable utilization by users; low resistance to physical contact	Broken frequency; more external scratches; less anti stress factor, low withstanding power in falls and less water resistant	Tests; inspection	Selection of appropriate material for the shell; more supervision
4	Mobile phone screen/display failure	To interact with the user; protection for internal display	Low material quality and manufacturer error; wrong utilization by user	Incapability to interact with other function	Incapability to interact with other functions	Tests; inspection	Black screen; color change; low image quality; external scratches; poor resolution and low thermal withstanding
5	Power supply unit failure	To supply DC power to all components	Manufacturing errors	Incapable of supply of electricity to the internal circuits	Low resolution image; short circuit and poor international connectivity	Tests; inspection	More reliable materials; careful manufacturing; more supervision
			SOFTWARE				
6	Freeze	Sudden software hanging	Due to more operation; poor memory capacity; less software quality	Malfunction and hanging	Not able to operate the required function; improper output	Tests; inspection	Selection of appropriate and reliable software; more supervision
7	Shelf-shut down	Sudden shut down accidently	Poor battery or software problem or memory access violation error	Create problems for various hardware and malfunctions of software	Frequent shut down; improper output	Tests; inspection	Utilization of appropriate batteries; more supervision
8	Unstable behavior	There is no stable output in apps	Due to operating system or poor apps software quality	Malfunction or hanging of system	Improper output	Tests; inspection	Selection of appropriate and reliable software; more supervision
9	Output failure	No output for the given input	Input hardware problem (touch screen, button, *etc.*); software problem	Malfunction	Improper output	Tests; inspection	Careful manufacturing; more supervision
10	Failure data logger	Error output for the given input	Internal hardware problem or software problem	No data	No output; improper output	Tests; inspection	Careful manufacturing ;more supervision

Table 4. Application of FMEA on hardware and software components of mobile phones

ware system portion, the software cannot be physically worn. Nonetheless, it becomes obsolete after some time and useless due to arrival of a new software.

3. MOBILE PHONE ANALYSIS BY USING FMEA METHOD

The objective of conducted research is to perform the analyses of various failure modes and effects for both hardware and software of the mobile phone.

A standardized form used in practice in the course of conducting FMEA analysis is not appropriate for this paper for technical reasons. The contents of the FMEA form is divided into two parts and represented in Table 4 and Table 5.

For each of the defined failure modes, the RPN value is calculated on the basis of which assessment is made of failure criticality degree. On the basis of the obtained RPN value, ranking of the defined failure modes is made, as depicted in Table 5.

By applying the *brainstorming* technique, ten most frequent mobile phone failure modes have been determined. The analysis conducted for five most frequent hardware failure modes and five most frequent software failure modes. Values of three parameters have been estimated: failure severity, failure occurrence probability and failure detection measures. The causes of failure occurrence for each failure mode and failure effect have been defined in the sense of their influence on the component and on the whole system. For each of the defined failures, proposal of actions has been given aimed at eliminating the causes of failure occurrence.

Failure severity represents maybe the most influential parameter on certain RPN values and it is formed on the basis of the data on injury level, property damage and system damage. Failure severity assessment has been made by way of the data stated in Table 1. The failure occurrence probability has been determined by way of the classification given in Table 2. Detection represents the probability that the failure will be identified even before it affects the system operation. The values for failure severity, probability and detection have been ranked from 1 to 10, 10 being the rate for the most hazardous effect. On the basis of estimated values of these three parameters, the RPN has been calculated and the risks have been ranked.

Failure modes	Sev.	Occ.	Det.	RPN	Rank Number
HARDWARE					
1	8	5	4	160	4
2	8	7	4	224	2
3	4	8	8	256	1
4	8	6	2	96	5
5	8	5	5	200	3
SOFTWARE					
6	7	7	6	294	2
7	8	7	6	336	1
8	8	4	3	96	5
9	9	5	3	135	3
10	9	3	4	108	4

Table 5. Calculation of RPN for hardware/software components

4. DISCUSSION OF OBTAINED RESULTS

In the conducted FMEA analysis, from the results depicted in Table V, only the "major" failures in the system have been considered. Minor failures that may occur were not taken into consideration in the course of the FMEA analysis. After ranking the risks, the obtained results show that malfunction in the mobile phone housing has got the highest RPN value. Therefore, in case of problems with the mobile phone housing, the risk is increased for the mobile phone user during use of the mobile phone. If the whole system is observed from the software point of view, the highest RPN value is attributed to the failure mode of self-switching off of the device. Such failure mode is very risky as it causes loss of data and/or malfunction of the mobile phone operating system. Regarding smart phones, special attention should be paid to proper and safe access to the phone memory. The results of the analysis have shown that errors/failures in mobile phone hardware occur much more frequently than in software.

If the obtained results are compared with the results of the Vijayalakshmi (2014) and Marques (2010) analyses results, it is evident that the RPN is not identical even for the same failure modes. However, the sequence according to which the failure modes have been ranked is identical. That means that mobile phone housing malfunction, as well as self-switching off of the device are treated as the highest priority risks.

But nevertheless, are the obtained results completely true? If solely the failure criticality degree values are considered, it is then obvious that the malfunction occurring in the mobile phone housing has got the highest RPN value (256). In that case, the value of failure effect severity is very low (4), on the basis of which it can be concluded that mobile phone housing failure certainly is not the failure which deserves the highest priority. On the other hand, there are components of the system for which in the conducted analysis a high RPN value has not been obtained, but they should certainly be treated as high priority failures because the values of the failure effect severity and/or failure occurrence probability are very high.

The obtained results point to the fact that the procedure of applying FMEA is not simple and clear-cut. For the purpose of obtaining the final results on risk priorities, it is desirable to obtain more additional data on the system, or to apply some additional analysis measure. As by the tabular arrangement of data on system failures are obtained applying the FMEA method, there is the possibility of graphical linking of the data, *i.e.* of the failure tree construction. In that respect, good results are obtained by joint application of the FMEA and FTA methods, since these two methods are complementary. Proper application of the FMEA method implies the failure mode independence. This fact makes the analysis more difficult, *e.g.* in cases when mutual hardware and software effects occur in the system, *i.e.* in case when the assumption of failure mode independence is not valid. When such problems exist, the use of the FTA method is recommended.

5. FINAL CONSIDERATIONS

Mobile phones offer a wide scope of possibilities to their users. However, failures that may occur in the course of mobile phone use can significantly jeopardize operation of the device which requires additional costs for servicing of the equipment. Mobile phone malfunctioning can also endanger health and safety of the users. The FMEA is very often used in designing technical systems. FMEA results can prevent reoccurrence of the problems that existed in the system. The analysis of the obtained results provides good guidelines for improving the entire technical system and contributes to accomplishment of the radio equipment safety concept.

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ADVANCED ENGINEERING SYSTEMS

TEACHING ELECTRICAL ENGINEERING USING WOLFRAM LANGUAGE

Miroslav Lutovac[1],
Vladimir Mladenović[2]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]University of Kragujevac,
Faculty of Technical Sciences,
Čačak, Serbia

Abstract:

The undergraduate engineering degree programs usually require good mathematical knowledge because the electrical courses, such as Electrical engineering and Electronics, heavily rely on school and advanced mathematics. On the other hand, in order to start with exercises and experiments, as soon as possible, the appropriate tools and support will benefit for success. This paper presents a new approach that describes the usage of Wolfram language. It is shown that basic expressions and circuit analysis procedures can be transformed into the program code for immediate visualization of basic formulas and properties, and expand the logical functions into the form that can be realized with appropriate logic circuits.

Key words:

software tools, algorithms, electronics.

1. INTRODUCTION

Some teachers with excellent mathematical knowledge consider electrical engineering nothing more than applied mathematics. Therefore, in the traditional education, the first-year university students, sometimes called freshers or freshman, are usually focused on the mathematics and the basic electrical engineering with numerous mathematical derivations and mathematical proofs of theorems. Nowadays, many students are not willing to work hard before starting with the application of that knowledge (such as the electrical courses), especially if software engineering is in the center of attention. On the other hand, it is important to avoid teaching in the form *Electrical engineers for dummies*.

The purpose of this paper is to motivate students to attend electrical engineering courses and to use the appropriate software environments for overcoming weak knowledge of mathematics. Nowadays, we will not use slide rules (slipstick) or analog computer to perform mathematical computations, although they were very popular before appearance of pocket digital calculator. Following the same philosophy, modern engineers are not less good engineers if they are using computer algebra systems for deriving properties or proving mathematical theorems.

Correspondence:

Miroslav Lutovac

e-mail:
mlutovac@singidunum.ac.rs

In order to provide thorough understanding of fundamental concepts in electrical engineering, a great number of computer distance assisted learning programs have been released. They can be used on personal computers or tablets and smart phones.

For advanced simulations and complex packages, workstations and cloud solutions can be used. Usually, the course materials are organized in modular syllabus structures. The interactivity, real-time calculations and self-assessment are required features for delivery units (Froyd *et al.*, 2012). For pedagogical reasons, the students of the same group can teach other less successful students, and this way preparing them for team working. Some students will have better mathematical knowledge, while other students will have better understanding of electrical principles and devices. As a team, they will encourage some students to solve problems that are unfamiliar for the rest of the team.

The most-favored pedagogical model for teaching electrical engineering is the project-based learning; as fundamental methods of solving problems using trial and error, generate and test, or guess and check, which are based on the software tools and appropriate applications (Guzdial & DiSalvo, 2013), students can learn without damaging measurement devices and electrical components.

During the process of designing some meaningful systems, students of electrical engineering will enhance design thinking skills. Some students will still have problems with their understanding of mathematics, and the purpose of this approach is to overcome frustration and disappointment.

We expect that some students with such unsatisfactory knowledge will concern about their interpretation of mathematics in learning electrical engineering. Our assumption is that students will worry how to transform the textbook mathematical expressions into the real world electronic systems and practical exercises. This means that we should focused on transformations from the real world into the mathematical representations, derive properties in the mathematical space, and finally, transform the mathematical expressions into the real word meaningful engineering context. To do that, we will explain the role of symbols that represent some physical quantities, the conventions for interpreting the symbols in a proper domain, and finally present how the equations can be interpreted. Experience with teaching electronics was presented in several papers (Lutovac & Mladenović, 2015a, 2015b; Lutovac *et al.*, 2015).

2. CALCULATION AND VISUALIZATION OF ELECTRICAL QUANTITIES

Calculation and Visualization of Electric Field

As the first example, let us consider Coulomb's law that describes force interacting between two static electrically charged particles, Q_1 and Q_2. The vector form of the electrostatic force $\vec{F}_{12}$ on the charge Q_2 in the vicinity of the charge Q_1 is as follows (assuming that $\vec{r}_{012}$ is the unit vector and k is the constant):

$$\vec{F}_{12} = k \frac{Q_1 Q_2}{r^2} \frac{\vec{r}_{12}}{r_{12}} = k \frac{Q_1 Q_2}{r^2} \vec{r}_{012} \qquad (1)$$

By using the law of superposition, the force $\vec{F}_p$ on the charge Q_p, due to a system of n discrete charges $\{Q_1, Q_2, Q_3,..., Q_n\}$ is:

$$\vec{F}_p = \vec{F}_{1p} + \vec{F}_{2p} + \vec{F}_{3p} + ... + \vec{F}_{np} \qquad (2)$$

The electric field $\vec{E}$ is also a vector that exist in space at the point where is a small stationary test particle of unit charge Q_p:

$$\vec{E} = \frac{\vec{F}_p}{Q_p} \qquad (3)$$

When two discrete charges are considered, the visualization of forces and electric field is also very simple. Whit more charges with different values, such as illustrated in Figure 1, plotting can be a serious problem.
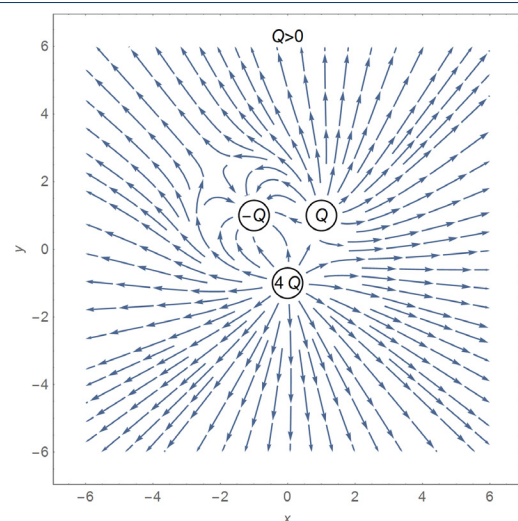
Figure 1. Illustration of the electric field surrounding three charges $\{Q_1=Q, Q_2=-Q, Q_3=4Q\}$, where $Q>0$.

The Wolfram language (Wolfram, 2015) can be used for defining the electric field in terms of electric charge and the position of that charge in the space (in this case it is a function of x and y as Cartesian coordinate system in the plain). To enter the knowledge into our environment, the first step is to define a function that will return some values for some known input quantities. We can use := to assigns some procedure described at the right side of = so the result will not be evaluated at the moment of writing the code. That is, the procedure at the right side will remain unevaluated, this is just a knowledge of something. In this example, knowledge is the expression describing electric field. On the left side of := we define the name of the function (Ee) and list of expected arguments (q, x, y, x0, y0). The symbol with associated underscore (q_) means that it is a pattern object that can stand for any Wolfram Language expression that will be used as local variable on the right side (q). This knowledge of the electric field at the point {x, y} in a plain is a pair of two values that is a function of charge q that exists at the position {x0, y0}, see Figure 2:

```
Ee[q_, x_, y_, x0_, y0_] :=
 {
     q
  ────────────────────────────────────────────────
  4 π ε₀ ((Abs[x - x0] + εₓ)² + (Abs[y - y0] + ε_y)²)

  (          x - x0                                    ),
   ──────────────────────────────────────────────
   √((Abs[x - x0] + εₓ)² + (Abs[y - y0] + ε_y)²)

     q
  ────────────────────────────────────────────────
  4 π ε₀ ((Abs[x - x0] + εₓ)² + (Abs[y - y0] + ε_y)²)

  (          y - y0                                    )}
   ──────────────────────────────────────────────
   √((Abs[x - x0] + εₓ)² + (Abs[y - y0] + ε_y)²)
```

Figure 2. Deffining the electric field produced by single charge.

Some values on the right side of := are global variables and constants, such as ε_0, ε_x, and ε_y, that we can define before or after entering the knowledge, as shown in Figure 3:

```
qₑ = 1.602 × 10⁻¹⁹; (* C *)
ε₀ = 8.8542 × 10⁻¹²; (* F/m *)
εₓ = 1 × 10⁻¹²; ε_y = 1 × 10⁻¹²;
nₑ = 10⁷;
q = qₑ nₑ;
```

Figure 3. Definning the constants.

In the next part we define other specific variables, such as elementary charge, and three charges with their positions in the plain, see Figure 4. Finally, we calculate electric filed at still unknown position {x, y}:

```
Q₁ = 1; x₁ = 1; y₁ = 1;
Q₂ = -1; x₂ = -1; y₂ = 1;
Q₃ = 4 ; x₃ = 0; y₃ = -1;
E₁ = Ee[Q₁ q, x, y, x₁, y₁];
E₂ = Ee[Q₂ q, x, y, x₂, y₂];
E₃ = Ee[Q₃ q, x, y, x₃, y₃];
```

Figure 4. Setting the particular values and commputing the electric field of each charge.

By using the superposition, we are calculating electric field in Cartesian coordinate system.

```
StreamPlot[{Re[E₁ + E₂ + E₃], Im[E₁ + E₂ + E₃]},
```

Figure 5. Command Streamplot for plotting the electric field.

The reason for specifying ε_x and ε_y is that to avoid infinitive values of the field in the center of charges. The command StreamPlot generates a stream plot of the vector field, Figure 5.

Computation of Electrostatic Equipotentials Between Three Electrically Charged Spheres

All variables, already used for plotting electrical field, can be used for illustrating other characteristics. We do not need the vector presentation; therefore, the required knowledge can be as in Figure 6.

```
E_norm = 1000;
Ed[q_, x_, y_, x0_, y0_] :=
              q
  ──────────────────────────────────────────────── E_norm
  4 π ε₀ ((Abs[x - x0] + εₓ)² + (Abs[y - y0] + ε_y)²)

Ed1 = Ed[Q₁ q, x, y, x₁, y₁];
Ed2 = Ed[Q₂ q, x, y, x₂, y₂];
Ed3 = Ed[Q₃ q, x, y, x₃, y₃];
```

Figure 6. Defining the electric field of single charged spheres for plotting electrostatic equipotentials.

By using the superposition, we are calculating electrostatic equipotentials in Cartesian coordinate system, as in Figure 7.

```
ContourPlot[{E_d1 + E_d2 + E_d3}, {x, -4.5, 5}, {y, -5, 4.5},
```

Fig. 7. Command ContourPlot for plotting the electrostatic equipotentials.

The command ContourPlot generates a contour plot, Figure 8.
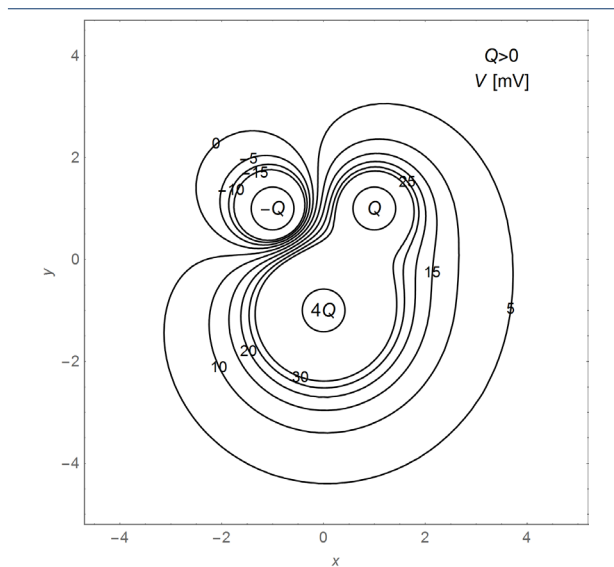
Figure 8. Illustration of electrostatic equipotentials of three charges $\{Q_1=Q, Q_2=-Q, Q_3=4Q\}$, where $Q>0$.

3. DESIGN OF DIGITAL INTEGRATED CIRCUITS

Digital circuits are designed using logic gates. Logic gate are used for performing boolean logic for creating combinational logic.

Integrated circuits consist of a great number of logic gates of just a few different logic types, so that the designer has a task to interconnect logic gates. Integrated circuits are designed using automation software to perform specific type of functions. Instead of relying on a single software solution, sometimes designers would prefer to take a full control on the design process, especially if some specific conditions are considered for embedded hardware.

Wolfram language can be efficiently used for performing this job. Suppose that we have on disposal a specific type of logic circuits, all of them in available forms. For logic optimization, specific commands can be used. LogicalExpand puts logical expressions into a

standard disjunctive normal form (DNF), consisting of an OR of ANDs. Other forms are as follows:

"DNF","SOP"	disjunctive normal form, sum of products,
"CNF","POS"	conjunctive normal form, product of sums,
"ANF"	algebraic normal form
"NOR"	two-level NOR
"NAND"	two-level NAND
"AND"	two-level AND or Not
"OR"	two-level OR and Not

Two-level NOR and NAND logic circuits can be used as Not when both logic inputs are connected to the same signal.

Example of Optimisation

As an example, we will consider the logic function x

$$x = (a \wedge b \wedge \neg c) \vee (a \wedge \neg b \wedge c) \vee (a \wedge \neg c \wedge d) \vee (\neg a \wedge b \wedge c) \vee (b \wedge c \wedge \neg d) \vee (b \wedge \neg c \wedge d) \vee (\neg b \wedge c \wedge d)$$

One possible solution for implementation can be by using two-input NOR gates. The command **BooleanConvert** will perform that transformation:

```
y = BooleanConvert[x, "NOR"]
y // TraditionalForm
```

The results of using the Wolfram language notation is:

$(!a\bar{\triangledown}!b\bar{\triangledown}!c\bar{\triangledown}!d)\bar{\triangledown}(a\bar{\triangledown}b\bar{\triangledown}c)\bar{\triangledown}(a\bar{\triangledown}b\bar{\triangledown}d)\bar{\triangledown}(a\bar{\triangledown}c\bar{\triangledown}d)\bar{\triangledown}(b\bar{\triangledown}c\bar{\triangledown}d)$

Traditional format for the mathematical representation is:

$$(\neg a\bar{\triangledown}\neg b\bar{\triangledown}\neg c\bar{\triangledown}\neg d)\bar{\triangledown}(a\bar{\triangledown}b\bar{\triangledown}c)\bar{\triangledown}(a\bar{\triangledown}b\bar{\triangledown}d)\bar{\triangledown}(a\bar{\triangledown}c\bar{\triangledown}d)\bar{\triangledown}(b\bar{\triangledown}c\bar{\triangledown}d)$$

We can use two-input NAND logic circuits:

```
y = BooleanConvert[x, "NAND"]
y // TraditionalForm
```

The result of using Wolfram language notation is:

$(a\bar{\wedge}b\bar{\wedge}!c)\bar{\wedge}(a\bar{\wedge}!b\bar{\wedge}c)\bar{\wedge}(a\bar{\wedge}!c\bar{\wedge}d)\bar{\wedge}(!a\bar{\wedge}b\bar{\wedge}c)\bar{\wedge}(b\bar{\wedge}c\bar{\wedge}!d)\bar{\wedge}(b\bar{\wedge}!c\bar{\wedge}d)\bar{\wedge}(!b\bar{\wedge}c\bar{\wedge}d)$

Traditional format for the mathematical representation is:

$(a\bar{\wedge}b\bar{\wedge}\neg c)\bar{\wedge}(a\bar{\wedge}\neg b\bar{\wedge}c)\bar{\wedge}(a\bar{\wedge}\neg c\bar{\wedge}d)\bar{\wedge}(\neg a\bar{\wedge}b\bar{\wedge}c)\bar{\wedge}(b\bar{\wedge}c\bar{\wedge}\neg d)\bar{\wedge}(b\bar{\wedge}\neg c\bar{\wedge}d)\bar{\wedge}(\neg b\bar{\wedge}c\bar{\wedge}d)$

We can use two-input AND and OR logic circuits, and not gates for the realization of disjunctive normal form:

```
y = BooleanConvert[x, " DNF"]
y // TraditionalForm
```

Result using Wolfram language notation is:

$(a\bar{\wedge}b\bar{\wedge}!c)||(a\bar{\wedge}!b\bar{\wedge}c)||(a\bar{\wedge}!c\bar{\wedge}d)||(!a\bar{\wedge}b\bar{\wedge}c)||(b\bar{\wedge}c\bar{\wedge}!d)||(b\bar{\wedge}!c\bar{\wedge}d)||(!b\bar{\wedge}c\bar{\wedge}d)$

Traditional format for the mathematical representation is:

$$(a \wedge b \wedge \neg c) \vee (a \wedge \neg b \wedge c) \vee (a \wedge \neg c \wedge d) \vee (\neg a \wedge b \wedge c) \vee (b \wedge c \wedge \neg d)$$
$$\vee (b \wedge \neg c \wedge d) \vee (\neg b \wedge c \wedge d)$$

We can use two-input AND and OR logic circuits, and not gates for the realization of conjunctive normal form:

```
y = BooleanConvert[x, " CNF"]
y // TraditionalForm
```

The result of using Wolfram language notation is:

$$(!a||!b||!c||!d)\&\&(a||b||c)\&\&(a||b||d)\&\&(a||c||d)\&$$
$$\&(b||c||d)$$

Traditional format for the mathematical representation is:

$$(\neg a \vee \neg b \vee \neg c \vee \neg d) \wedge (a \vee b \vee c) \wedge (a \vee b \vee d) \wedge (a \vee c \vee d) \wedge (b \vee c \vee d)$$

We can use two-input AND logic circuits and not gates:

```
y = BooleanConvert[x, "AND"]
y // TraditionalForm
```

The result of using Wolfram language notation is:

$$!(a\&\&b\&\&c\&\&d)\&\&!(!a\&\&!b\&\&!c)\&\&!(!a\&\&!b\&\&!d)\&\&!(!a\&\&!c\&\&!d)\&\&!(!b\&\&!c\&\&!d)$$

Traditional format for the mathematical representation is:

$$\neg(a \wedge b \wedge c \wedge d) \wedge \neg(\neg a \wedge \neg b \wedge \neg c) \wedge \neg(\neg a \wedge \neg b \wedge \neg d) \wedge \neg(\neg a \wedge \neg c \wedge \neg d) \wedge \neg(\neg b \wedge \neg c \wedge \neg d)$$

We can use two-input OR and Not gates:

```
y = BooleanConvert[x, "OR"]
y // TraditionalForm
```

The result of using Wolfram language notation is:

$$!(!a||!b||c)||!(!a||b||!c)||!(!a||c||!d)||!(a||!b||!c)||!(!b||!c||d)||!(!b||c||!d)||!(b||!c||!d)$$

Traditional format for the mathematical representation is:

$$\neg(\neg a \vee \neg b \vee c) \vee \neg(\neg a \vee b \vee \neg c) \vee \neg(\neg a \vee c \vee \neg d) \vee \neg(a \vee \neg b \vee \neg c) \vee \neg(\neg b \vee \neg c \vee d) \vee \neg(\neg b \vee c \vee \neg d) \vee \neg(b \vee \neg c \vee \neg d)$$

Form	ANF	DNF	CNF	AND	OR	NAND	NOR
#circuits	27	27	19	32	21	27	19

Table I. Required two-input logic circuits and Not gates

Calculating the count of the number of two-input logic circuits and one-input Not logic gates the most efficient realization can be selected, as it is shown in Table I.

Design and analysis of electric circuits using computer algebra systems (CAS) is presented in (Lutovac *et al.* 2001; Lutovac, 2015), where the same environment is used for drawing schematics and deriving properties of circuits.

For simplifying the design and analysis using CAS, software is released for analog and digital systems (Lutovac & Tosic, 2015).

4. SUMMARY

A new approach to teaching electrical engineering at Singidunum University is based on software tools for knowledge presentation and visualization and students homework. The main issue is to understand the theory and to avoid complex mathematical proving and derivations. The students are encouraged to use free open source software environments and vendor canned software. Computer algebra systems, such as that based on Wolfram language, is used for preparing all figures in the main textbook, and all examples are solved using symbolic processing.

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THE EFFECTS OF COMPOSITION OF SHIELDING GAS MIXTURE ON THE MICROSTRUCTURE AND TOUGHNESS OF MICROALLOYED STEEL WELD METAL

Olivera Popović[1],
Radica Prokić Cvetković[1],
Nenad Milošević[1],
Dragan Cvetković[2]

[1]University of Belgrade,
Faculty of Mechnical Engineering,
Kraljice Marije 16, Belgrade, Serbia

[2]Singidunum University,
Faculty of Informatics and Computing,
32 Danijelova Street, Belgrade, Serbia

Abstract:

It has been established that the ferrite structure occurring in different morphologic forms dominates in weld metal of microalloyed steel. Acicular ferrite is the most desirable morphology of ferrite, so this paper analyses influence of the composition of gas mixture on the ferrite modification in the weld metal, specially on the morphology of acicular ferrite. At the same time, this morphological form of ferrite is very significant, because it has great influence on the mechanical properties, especially toughness. Five different gas mixtures (Ar, CO_2, O_2) were used to determine the optimal gas shielded metal arc process. For investigated microalloyed steel, the optimum gas mixture has been established (5% CO_2, 0.91% O_2, balance Ar), providing maximum impact energy due to microstructure, consisting predominately of acicular ferrite.

Key words:

microstructure, toughness, microalloyed steel, mixture of shielded gases, acicular ferrite.

1. INTRODUCTION

Welding by metal arc process with mixture of shielded gases has been increasingly popular in recent years. Gaseous mixtures are physical mixtures of various gasses. Theoretically, these mixtures can be produced in any rate unless mixing is limited by physical or chemical component properties, as also by valid safety specification[1]. Mixtures of argon (Ar), carbon-dioxide (CO_2), and/or oxygen (O_2) are often used for welding of microalloyed steels. Gas shielded arc welding in shielding atmosphere of argon usually does not provide stable arc that results in different defects forming, such as undercut, porosity and insufficient penetration and their effects on decreasing strength and ductility. Welding in protective gas mixtures Ar+CO_2 or Ar+CO_2+O_2 provides better weld forming and less spattering than those obtained by welding in pure CO_2, and comparing with welding in protective atmosphere of pure argon provides better penetration. Composition of gas mixture significantly affects weldment properties, especially weld metal toughness. Mechanical properties and toughness of weldment depend on microstructure of weld metal and HAZ. Many factors affect the structural changes [2, 3, 4, 5, 6]. Acicular ferrite is the most desirable morphology of ferrite, so this paper analyses influence

Correspondence:

Olivera Popović

e-mail:

opopovic@mas.bg.ac.rs

of the composition of gas mixture on the ferrite modification in the weld metal, especially on the morphology of acicular ferrite [7]. This morphological form of ferrite is very significant, because it has great influence on the mechanical properties, particularly toughness. Namely, increased presence of oxide inclusions in weld metal, at least to a certain limit, promotes nucleation of acicular ferrite, which is well-known for its beneficial effect to both weld metal toughness and strength [8].

Therefore, the influence of gas mixture on weld metal microstructure and toughness has been investigated for hot-rolled microalloyed steels, welded by metal arc process with five different mixtures of shielded gases, comprising Ar, CO_2 and O_2.

2. EXPERIMENTAL PROCEDURE

Hot rolled plates of microalloyed steel alloyed with Nb, V and Ti were used for welding. The filler material was commercially available wire VAC 60 Ni Ø1,2 mm made by "Jesenice" - Slovenia (which has classification G3Ni1 according EN 440, SG-2 according DIN 8559 and ER 80 S-Ni1 according ASME/AWS 5.28). Their chemical composition and mechanical properties are given in Table 1 and Table 2.

Welding was performed by metal arc process with five different shielded gas mixtures, as shown in Table 3.

The input energy was kept in narrow range 7-9 kJ/cm to exclude its influence since the weld metal toughness has been proved to be sensitive to input energy [8].

element	C	Si	Mn	P	S	Cu	Al	Nb	Ti	Ni	V
Base m.	0.056	0.32	1.28	0.012	0.005	0.031	0.049	0.045	0.02	-	0.054
VAC 60 Ni	0.08-0.1	-	1.4-1.6	P+S<0,025		-	-	-	-	1-1.2	-

Table 1. Composition of base and filler materials

material	Re, [N/mm²]	Rm, [N/mm²]	A_5, [%]	KV(20°C), [J]
Base metal	510-537	571-595	37-42	152-197
VAC 60 Ni	440-510	560-630	22-30	80-125, 30-35 (at -40°C)

Table 2. Mechanical properties of base and filler materials

No. of mixture	volume content (vol %)		
	CO_2	O_2	Ar
1	5.24	-	balance
2	5.00	0.91	balance
3	4.70	2.30	balance
4	10.30	-	balance
5	14.80	-	balance

Table 3. Chemical compound of gas mixture

From all plates V notched specimens for weld metal toughness testing were produced, size according to the available material: 55x10x6 mm. Obtained toughness values were transferred for comparison by regular procedure to standard specimen values. Toughness was determined on the Charpy pendulum with oscilloscope [9]. Tests were performed at room temperature (20°C) and at -55°C.

3. RESULTS AND DISCUSSION

The microstructure of microalloyed steel, tested here, consists of acicular ferrite (AF), proeutectoid ferrite (PF) and ferrite with the secondary phase (FS), whose contents highly depend on gas mixture compound [10]. Figure 1 presents microstructures of the cover pass for different mixtures.
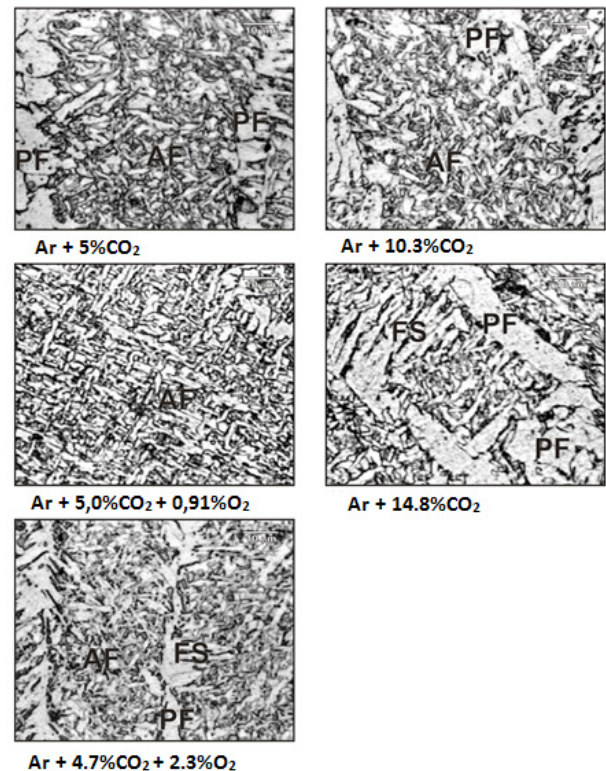
Figure 1. Microstructures of the cover pass for different mixtures

The highest content of AF corresponds to the gas mixture 2, being in accordance with the highest toughness, also obtained with gas mixture 2 [10]. The increase of oxygen content in a gas mixture increases number of inclusion sites and thus, the number of acicular ferrite nucleation sites, but only up to a certain limit. Above that limit, the opposite effect is noticeable, namely AF content is reduced due to increased content of other ferrite

morphologies, like ferrite with the secondary phase and proeutectoid ferrite [5,10]. For higher oxygen contents, the latter one has typical course microstructure, appearing in blocks (Fig. 1e). These observation are consistent with fact that increased oxygen equivalent effects on moving CCT diagram to shorter times [2].

Figure 2 shows the dependence between the change of volume content of AF in the cover pass and composition of gas mixture.

Volume content of AF in the cover pass of weld metal for all gas mixtures (78-83.3% AF) is much higher than literature data [6] (50-60% AF). Literature data are given for MIG weldments (process without oxygen), while this paper is giving data for weldments in shielding gases mixtures, with different active gases mixtures.
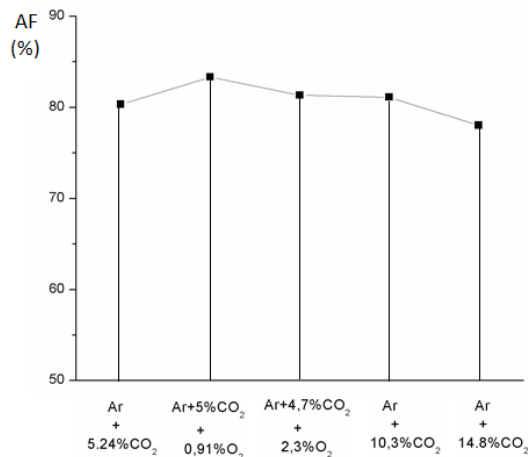
Figure 2. Dependence between change of volume content of AF in the cover pass and composition of gas mixture

Besides the noticed influence of composition of protective gasses on the microstructure, it is important to emphasize that the type of protective gas also affects metal weld toughness. Figure 3 presents the values of weld metal toughness (E_u) at +20^{0}C and -55^{0}C for all compositions of gas mixtures.

Figure 3 shows the weld metal toughness changes as a function of composition of shielded gas. The highest toughness is achieved by welding in protective atmosphere 2 (energy 208 J at 20^{0}C), and the lowest toughness is achieved by welding in protective atmosphere 5 (166 J at 20^{0}C). The same dependence is characteristic for lower temperatures (93 J for protective atmosphere 2 and 58 J for protective atmosphere 5). With the oxygen content increase, toughness, firstly, increases but later decreases, which is directly connected to the metal weld

microstructure. The oxygen content increase affects the content increase of acicular ferrite in weld metal until the certain limit, and after that limit effects on the content decrease. The highest volume content of acicular ferrite (AF) in the cover pass corresponds to the gas mixture 2 (83,3%). On the contrary, the lowest volume content of AF is obtained with gas mixture 5 (78%). The change of AF volume content in cover pass is in accordance with dependency between toughness and composition of gas mixtures.
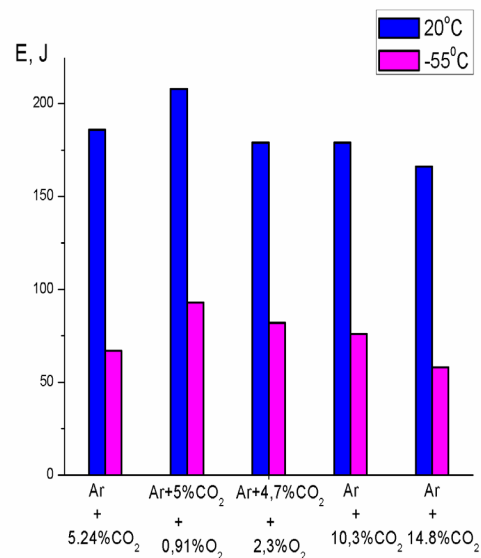
Figure 3. Values of weld metal toughness (E) at +20°C and -55°C for all compositions of gas mixtures

4. CONCLUSIONS

Based on the analysis of experimental results, the following conclusions can be derived:

1. The composition of gas mixture, *i.e.* oxygen content in shielding gas significantly affects weld metals properties, especially toughness and microstructure. This paper describes its effect to appearance of different ferrite morphologies and their content in weld metal microstructure, and effect on weld metal toughness.

2. In the weld metal microstructure, high volume content of AF has been noticed, but less contents of PF and FS. Dependency composition of shielding gas and volume content of AF in cover pass is between 78-83%. The highest volume content of AF in cover pass of weld metals is obtained by welding with mixture 2 (5.0%CO_2 + 0.91%O_2 + Ar), and that value could be taken as optimum.

3. The type of protective gas affects metal weld toughness. The highest toughness is achieved by welding in protective atmosphere 2 (5.0%CO_2 + 0.91%O_2 + Ar) and the lowest toughness is achieved by welding in protective atmosphere 5 (14.8%CO_2 + Ar). The same dependance is observed at lower temperature (-55°C).

4. The change of AF volume content in cover pass is in accordance with dependency between toughness and composition of gas mixtures.

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Advanced engineering systems

APPLICATION OF THE MODIFIED MATERIAL POINT METHOD IN CALCULATING FLIGHT PARAMETERS

Dušan Regodić[1],
Damir Jerković[2],
Aleksandar Jevremović[1],
Radomir Regodić[1]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]University of Defense,
Military Academy,
Pavla Jurišića Šturma 33,
Belgrade, Serbia

Abstract:

The aim of this study was to analyze the effects of structural characteristics and initial conditions on foreign ballistic missile features. The problem is interesting because it extends the resolution of physical models of classical projectile motion that describes a translational movement. Applying software solutions proposed by the authors to save resources and reduce time numerical calculations as designing modern technical systems requires the use of simple physical and mathematical models and software that provide the required accuracy. The use of this software solution is in line with trends in development of modern solutions in the external ballistics. This model allows the numerical integration of equations for a shorter time than the model with six degrees of freedom.

Key words:

modified material point, force, torque, coefficients, rotate, body.

1. INTRODUCTION

In the classic artillery, projectile axis does not coincide with the velocity direction on the trajectory, but with it making an offensive angle σ.

Aerodynamic force $\vec{R}$ makes a certain angle with projectile axis and operates from the center of pressure (CP).

The effect of this force out of the center of mass can be replaced by force in the center of mass and moment of force according to the center of mass. This moment is called the main aerodynamic moment $\vec{M}^R$. Size, direction and position of attack points (center of pressure) of the total aerodynamic force depends on the size and shape of the projectile, orientation relative to the axis, velocity and angular velocity projectiles and characteristics of air.

To improve the Euler's model, we will adopt that the total aerodynamic force $\vec{R}$ consists of two dominant components, resistance $\vec{D}$ and lift $\vec{L}$, neglecting Magnusovu force (which is by intensity over 100 times smaller than the lift) and other secondary forces with unsteady character.

If we adopt the assumption that the Earth is immovable, by flight of rapid-rotary artillery projectiles, it is not necessary to take into account the influence of inertial forces, so it can be adopted $\vec{a}_p = \vec{a}_{cor} = 0$ and that the velocity $\vec{V}_k$ relative to Earth is absolute.

With the previous assumption, the vector equations of motion of mass center is reduced to

Correspondence:

Dušan Regodić

e-mail:

dregodic@singidunum.ac.rs

$$m\frac{d\vec{V_k}}{dt} = \sum_{i=1}^{n}\vec{F_i} = m\vec{g} + \vec{R}, \qquad (1)$$

where the total aerodynamic force is [9,10]:

$$\vec{R} = \vec{D} + \vec{L}, \qquad (2)$$

so:

$$m\frac{d\vec{V_k}}{dt} = m\vec{g} + \vec{D} + \vec{L}. \qquad (3)$$
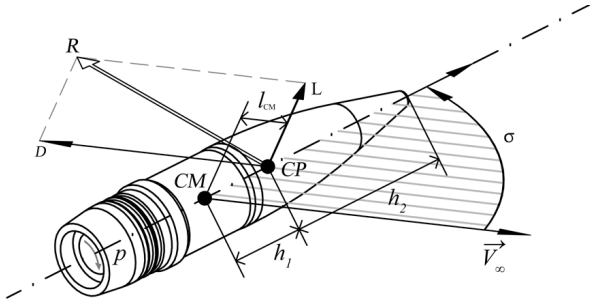
Figure 1. Air resistance and lift forces

Artillery projectile is a solid body with rotating shape. Unit vector $\vec{x_0}$ is the axis of rotational symmetry with the positive direction from the center of mass to the top of the projectile.

The total moment of projectile motion amount can be expressed as the sum of two vectors in a coordinate system related to the Earth:

- ◆ moment of motion amount around vectors $\vec{x_0}$ $I_x p$,
- ◆ moment of motion amount around the axis normal to the vector.

Angular velocity of projectile around the axis normal to $\vec{x_0}$ is given by vector $\vec{\Omega} = (\vec{x_0} \times \dot{\vec{x_0}})$. Since the projectile has a rotational symmetry, each axis that passes through the center of mass, and normal on $\vec{x_0}$, it is the main axis of inertia. If we check the moment of projectile inertia around some transversal axis that passes through the center of mass with I_y, the total moment of motion amount around the axis normal to $\vec{x_0}$ is represented by vector $I_y(\vec{x_0} \times \dot{\vec{x_0}})$. The total moment of motion amount is [1,9]:

$$\vec{K} = I_x p \vec{x_0} + I_y(\vec{x_0} \times \dot{\vec{x_0}}). \qquad (4)$$

The sum of all external moments affecting the projectile is:

$$\frac{d\vec{K}}{dt} = I_x \frac{dp}{dt}\vec{x_0} + I_x p\dot{\vec{x_0}} + I_y(\vec{x_0} \times \ddot{\vec{x_0}}) = \sum\vec{M}. \qquad (5)$$

2. AERODYNAMIC FORCES AND MOMENTS

The resistance force of air $\vec{D}$ represented by vector is:

$$\vec{D} = \frac{\rho V^2}{2}SC_D\vec{V} \qquad (6)$$

Because of the occurrence of angle of attack σ in the obstruction plane between $\vec{V}$ and $\vec{x_0}$ increases the resistance force of air due to the occurrence of induced resistance. Coefficient of induced resistance is indicated as $C_D\sigma^2$, and increase of resistance coefficient due to asymmetrical obstruction with $C_{D\sigma^2}\sigma^2$. Effective resistance coefficient is:

$$C_D = C_{D0} + C_{D\sigma^2}\sigma^2. \qquad (7)$$

The resistance force of air is the direction $-\vec{V}$ and after the introduction of the reference surface $S = \frac{\pi d^2}{4}$ is:

$$\vec{D} = -\rho\frac{\pi d^2}{8}(C_{D0} + C_{D\sigma^2}\sigma^2)V\vec{V}. \qquad (8)$$

Lift force $\vec{L}$ occurs in the plane comprising the projectiles axis and aerodynamic velocity due to asymmetrical obstruction under the offensive angle. The direction is perpendicular to the wind velocity and proportional to the offensive corner.

$$\vec{L} = \rho\frac{\pi d^2}{8}C_{L\sigma}V^2\sin\sigma = \rho\frac{\pi d^2}{8}C_{L\sigma}\sigma\left[\vec{V} \times (\vec{x_0} \times \vec{V})\right]. \qquad (9)$$

Vector $\left[\vec{V} \times (\vec{x_0} \times \vec{V})\right]$ has the intensity $V^2\sin\sigma$ and it is normal on $\vec{V}$, and it flies in a plane that contains $\vec{V}$ and $\vec{x_0}$. If the vector of total aerodynamic force $\vec{R}$ is projected parallel and normal to $\vec{x_0}$, instead of $\vec{V}$, than we will get the components of axial force $\vec{X}$ and normal force $\vec{Y}$.

Figure 2 shows decomposition of the total aerodynamic force $\vec{R}$ on the components $\vec{X}$ and $\vec{Y}$.
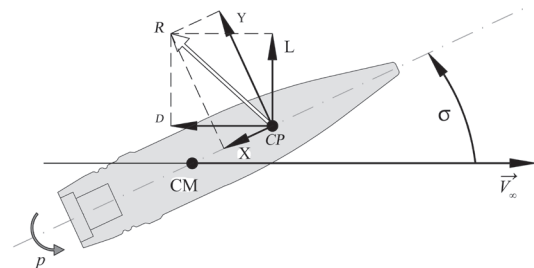
Figure 2. Dissolution of the total aerodynamic force

The values of these forces can be written in the following form

$$\vec{X} = \frac{\rho V^2}{2} S C_x = \rho \frac{\pi d^2}{8} V^2 C_x,$$
$$\vec{Y} = \frac{\rho V^2}{2} S C_y = \rho \frac{\pi d^2}{8} V^2 C_y. \tag{10}$$

Longitudinal damping moment M_x occurs as a result of longitudinal friction over the surface of the rotating projectile and has a tendency to reduce (stop) axial rotation. The intensity of this moment is defined as:

$$M_x = \frac{\rho V^2}{2} s C_{\ell p} p V = -\rho \frac{\pi d^4}{16} C_{\ell p} p V \vec{x}_0, \tag{11}$$

Where is:

$C_{\ell p}$ - dimension less gradient coefficient of suppressive longitudinal moment for reference angular velocity $p^* = \dfrac{pd}{2V}$.

3. FORMATION OF THE FINAL SYSTEM OF EQUATIONS

To resolve the lift force, it is necessary offensive angle σ and unit vector of lift force $\vec{i}_L$:

$$L = \rho \frac{\pi d^2}{8} C_{L\sigma} \sigma \vec{i}_L. \tag{12}$$

If we introduce velocity coordinate system (V) with the origin of coordinates at the center of projectile mass, axis x_V in the direction of aerodynamic velocity, and z_V in the vertical plane on the aerodynamic velocity pointing downward.

Separation of aerodynamic velocity on two components along the projectile axis and normal to aerodynamic velocity. The second component is $V\sigma\vec{i}_L$. Its components that coordinate the system along the axis of velocity are:

$$\begin{bmatrix} 0 - \tilde{\beta}V - \tilde{\alpha}V \end{bmatrix}^T. \tag{13}$$

Projection of the lift force of axis of velocity coordinate system:

$$L^V = \frac{\rho V}{2} C_{L\sigma} \begin{bmatrix} 0 - \tilde{\beta}V - \tilde{\alpha}V \end{bmatrix}^T. \tag{14}$$
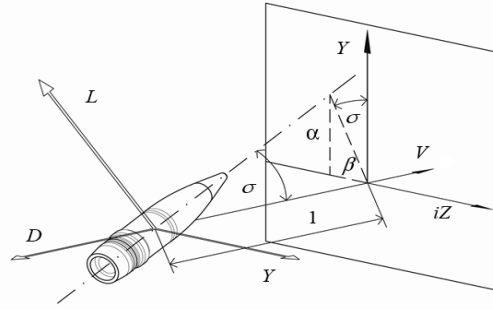
Figure 3. Projection of attack angle in space [1,10]

To determine the components along the local (L) coordinate system, it is necessary to determine the matrix of transformation from velocity system in the nosen system. The axes of nosen coordinate system are parallel to the axes of local coordinate system. By rotation for angle χ_a around the axis z and for angle γ_a around the axis y we come from the tractive to the velocity coordinate system. That matrix of transformation is [1,2,10]:

$$L_{V0} = L_y(\gamma_a) L_z(\chi_a). \tag{15}$$

According as:

$$L_Z(\chi_a) = \begin{bmatrix} \cos\chi_a & \sin\chi_a & 0 \\ -\sin\chi_a & \cos\chi_a & 0 \\ 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} \dfrac{u}{\sqrt{V^2-v^2}} & \dfrac{w}{\sqrt{V^2-v^2}} & 0 \\ -\dfrac{w}{\sqrt{V^2-v^2}} & \dfrac{u}{\sqrt{V^2-v^2}} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$L_y(\gamma_a) = \begin{bmatrix} \cos\gamma_a & 0 & -\sin\gamma_a \\ 0 & 1 & 0 \\ \sin\gamma_a & 0 & \cos\gamma_a \end{bmatrix} = \begin{bmatrix} \dfrac{\sqrt{V^2-v^2}}{V} & 0 & -\dfrac{v}{V} \\ 0 & 1 & 0 \\ \dfrac{v}{V} & 0 & \dfrac{\sqrt{V^2-v^2}}{V} \end{bmatrix}$$

multiplying these matrices we obtain the required matrix of transformation.

Projections of vector $\sigma\vec{i}_L$ on axes of transmission coordinate system are:

$$L_{OV}\begin{bmatrix} 0 \\ -\tilde{\beta} \\ -\tilde{\alpha} \end{bmatrix} = \begin{bmatrix} \dfrac{u}{V} & -\dfrac{w}{\sqrt{V^2-v^2}} & \dfrac{uv}{V\sqrt{V^2-v^2}} \\ \dfrac{w}{V} & \dfrac{u}{\sqrt{V^2-v^2}} & \dfrac{vw}{V\sqrt{V^2-v^2}} \\ -\dfrac{v}{V} & 0 & \dfrac{\sqrt{V^2-v^2}}{V} \end{bmatrix} \begin{bmatrix} 0 \\ -\tilde{\beta} \\ -\tilde{\alpha} \end{bmatrix} \tag{16}$$

$$\tilde{\alpha} = \tilde{\alpha}_h + \tilde{\alpha}_p$$
$$\tilde{\beta} = \tilde{\beta}_h + \tilde{\beta}_p$$

where the homogeneous integral [4,10]:

$$\tilde{\beta}_h + i\tilde{\alpha}_h = C_1 e^{r_1 \overline{s}} + C_2 e^{r_2 \overline{s}}$$

and particular:

$$\tilde{\beta}_p + i\tilde{\alpha}_p = -\frac{G_\xi}{M_\xi + iPT_\xi}.$$

The solutions of these two parts are different. Homogeneous integral is random and particular deterministic size. By initial conditions $\tilde{\beta}_0 + i\tilde{\alpha}_0 = 0$ of the complex constants are equal and with opposite sign $C_1 = -C_2$ depending on the transversal angular velocity:

$$C_1 = \frac{\tilde{\xi}_0{}'}{r_1 - r_2} = \frac{\sigma_0{}' e^{i(\varphi_0 - \phi_0)}}{r_1 - r_2}.$$

Initial angular velocity has a Rayleigh distribution, and the angle that determines the position of the plane in which is that angular velocity $(\varphi_0 - \phi_0)$ relative to the vertical plane, has an equal distribution from 0 to 2π. Based on stated, we conclude that the influence is random size which is probable for all directions around velocity. Therefore, the influence of homogeneous integrals $\tilde{\xi}_h = \tilde{\beta}_h + i\tilde{\alpha}_h$ in the model modified material point does not take into consideration by calculating the trajectory, but it is thought to lead to distribution over trajectory for which the homogeneous integral is equal to zero.

$$G_\xi = \frac{gd\cos\gamma}{V^2}\left[P - i\left(\frac{V'}{V} + \frac{C^*_{\overline{m}q}}{\overline{r}_y^2}\right)\right] \approx \frac{gd\cos\gamma}{V^2}P$$

$$M_\xi + ipT_\xi \approx M_\xi \approx M = \frac{C^*_{\overline{m}\sigma} - C^*_{\overline{m}\dot{\sigma}}\frac{V'}{V} - C^*_{\overline{m}q}C^*_{\overline{z}\sigma}}{\overline{r}_y^2} \approx \frac{C^*_{\overline{m}\sigma}}{\overline{r}_y^2}$$

For that case is:

$$\tilde{\beta}_p + i\tilde{\alpha}_p = -\frac{G_\xi}{M_\xi} = -\frac{\dfrac{gd\cos\gamma}{V^2}\dfrac{I_x}{I_y}\dfrac{pd}{V}}{\dfrac{\rho Sd}{2m}\dfrac{C_{\overline{m}\sigma}}{r_y^2}d^2},$$

where is:

$$\tilde{\alpha}_p = 0$$

$$\tilde{\beta}_p = -\frac{2I_x}{\rho Sd}\frac{g\cos\gamma}{V^3}\frac{p}{C_{\overline{m}\sigma}}$$

For the calculation of particular integrals β_p it is required, angular velocity p for each point of the trajectory is requiried. We can determine it based on the equation of rolling aircraft.

$$I_x\frac{dp}{dt} = \frac{\rho V^2}{2}SdC_{\mathrm{l}p}p^*.$$

Required projection of vector $\sigma\vec{i}_L$ on the axes of tractive coordinate system:

$$L_{OV}\begin{bmatrix} 0 \\ -\tilde{\beta} \\ -\tilde{\alpha} \end{bmatrix} = \begin{bmatrix} \tilde{\beta}_p \dfrac{w}{\sqrt{V^2 - v^2}} \\ -\tilde{\beta}_p \dfrac{u}{\sqrt{V^2 - v^2}} \\ 0 \end{bmatrix}$$

Components of lift force on the axis of local coordinate system are:

$$\begin{bmatrix} Lx \\ Ly \\ Lz \end{bmatrix} = \frac{\rho V^2}{2}SC_{L\sigma}\tilde{\beta}_p \begin{bmatrix} \dfrac{w}{\sqrt{V^2 - v^2}} \\ 0 \\ -\tilde{\beta}_p \dfrac{u}{\sqrt{V^2 - v^2}} \end{bmatrix} \qquad (17)$$

Therefore, we have the system of equations modified model of material point (without Coriolis acceleration):

$$\frac{du_k}{dt} = -E\left(C_D\frac{u_k - u_w}{V} + C_{L\sigma}\tilde{\beta}_p\frac{w_k - w_w}{\sqrt{V^2 - v^2}}\right)$$

$$\frac{dv_k}{dt} = -E\left(C_D\frac{v_k}{V}\right) - g$$

$$\frac{dw_k}{dt} = -E\left(C_D\frac{w_k - w_w}{V} - C_{L\sigma}\tilde{\beta}_p\frac{u_k - u_w}{\sqrt{V^2 - v^2}}\right)$$

$$\frac{dp}{dt} = \frac{Sd^2}{4I_x}\rho VC_{\ell p}p \qquad (18)$$

$$\frac{dx}{dt} = u_k$$

$$\frac{dy}{dt} = v_k$$

$$\frac{dz}{dt} = w_k,$$

where are:

$$E = \frac{\rho V^2}{2}\frac{S}{m} = \rho\frac{\pi d^2 V^2}{8m},$$

$$V = \sqrt{(u_k - u_w)^2 + v_k^2 + (w_k - w_w)^2},$$

$$\tilde{\beta}_p = -\frac{2I_x}{\rho Sd}\frac{g\cos\gamma}{V^3}\frac{p}{C_{\overline{m}\sigma}}.$$

We must add the following to the equations:

- aerodynamic functions $C_D(Ma)$, $C_{L\sigma}(Ma)$, $C_{\overline{m}\sigma}(Ma)$, and $C_{\ell p}(Ma)$,
- constants d, m i I_X,
- data on the state of the atmosphere $\rho(y)$, $a(y)$ and data on wind $u_w(y)$, $w_w(y)$,
- Initial conditions y_0 (always take $x_0 = z_0 = 0$), V_{k0}, γ_{k0}, χ_{k0}, and p_0.

Based on the stated we can add Coriolis force in the model of the modified material point:

$$\frac{dV_k}{dt} = \frac{\rho V^2}{2}\frac{S}{m}C_D\frac{\vec{V}_k - \vec{V}_w}{V} + m\vec{g} + \frac{\rho V^2}{2}\frac{S}{m}C_{L\sigma}\sigma\vec{i}_L - \vec{a}_K \qquad (19)$$

Components on the axes of local coordinate system give the system of differential equations models MMMT [1,2,4,5,9]:

$$\frac{du_k}{dt} = -E\left(C_D\frac{u_k - u_w}{V} + C_{L\sigma}\tilde{\beta}_p\frac{w_k - w_w}{\sqrt{V^2 - v^2}}\right) - 2(-\Omega_{EZ}v_k + \Omega_{EY}w_k)$$

$$\frac{dv_k}{dt} = -E\left(C_D\frac{v_k}{V}\right) - g - 2(\Omega_{EZ}u_k - \Omega_{EX}w_k)$$

$$\frac{dw_k}{dt} = -E\left(C_D\frac{w_k - w_w}{V} - C_{L\sigma}\tilde{\beta}_p\frac{u_k - u_w}{\sqrt{V^2 - v^2}}\right) - 2(-\Omega_{EY}u_k + \Omega_{EX}v_k) \qquad (21)$$

$$\frac{dp}{dt} = \frac{Sd^2}{4I_x}\rho V C_{\ell p}p$$

$$\frac{dx}{dt} = u_k$$

$$\frac{dy}{dt} = v_k$$

$$\frac{dz}{dt} = w_k,$$

where are:

$$E = \frac{\rho V^2}{2}\frac{S}{m} = \rho\frac{\pi d^2}{8m}V^2,$$

$$V = \sqrt{(u_k - u_w)^2 + v_k^2 + (w_k - w_w)^2},$$

$$\tilde{\beta}_p = -\frac{2I_x}{\rho Sd}\frac{g\cos\gamma}{V^3}\frac{p}{C_{\bar{m}\sigma}}.$$

- aerodynamic functions $C_D(Ma)$, $C_{L\sigma}(Ma)$, $C_{\bar{m}\sigma}(Ma)$ and $C_{\ell p}(Ma)$.

- constants d, m and I_X,

- data on the state of the atmosphere $\rho(y)$, $a(y)$ and data on wind $u_w(y)$, $w_w(y)$,

- initial conditions y_0 (always take $x_0 = z_0 = 0$), V_{k0}, γ_{k0}, χ_{k0}, and p_0.

- angular speed of rotation of the Earth

$$\begin{bmatrix}\Omega_{EX} \\ \Omega_{EY} \\ \Omega_{EZ}\end{bmatrix} = \begin{bmatrix}\Omega_E\cos A_0\cos\varphi_0 \\ \Omega_E\sin\varphi_0 \\ -\Omega_E\sin A_0\cos\varphi_0\end{bmatrix}. \qquad (20)$$

4. FILE CALCULATION RESULTS „OJLMMT.IZL"

TESMMT software solution is designed for testing and testing OJLMMT subroutine to calculate the path of classical stabilized projectile by the method of modified material point. Software solution is made in the programming language FORTRAN on a personal computer. It consists of three parts [9,10]:

1. Program TESMMT.FOR - the main program,

2. File OJLMMT.DAT - input data,

3. File OJLMMT.IZL - calculation results.

Baseline data files „ OJLMMT.DAT"

.153,43.56,.0584,.169,.1558,1.,1,2
1000.,288.9,.0,.0
.0,.0,.0,.0,.0
.826,810.,.01,.0,.0

Figure 4 shows changes in the Y-axis vertices trajectories of projectiles at different distances X.
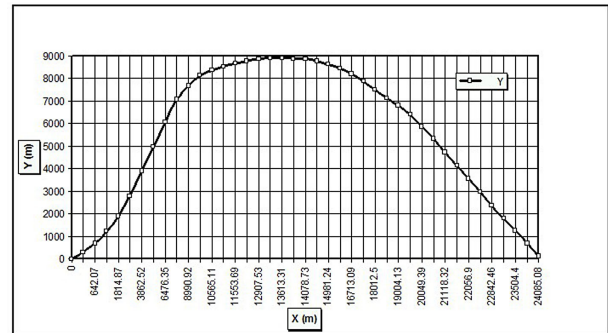
Figure 4. Change ordinate the vertices of Y for different distance X.

Figure 5 shows the change in the trajectories Z direction (X).
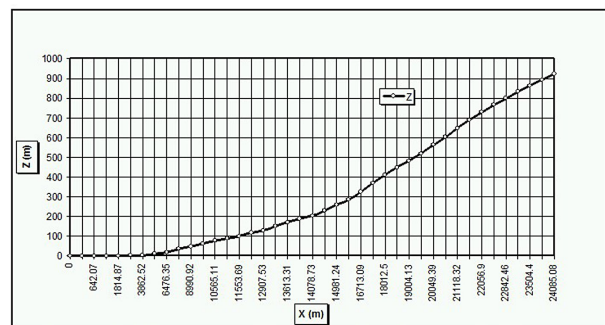
Figure 5. Change the direction Z (X) in the path of the projectile.

Figure 6 shows the change of the angular velocity for different distance shooting missiles X.
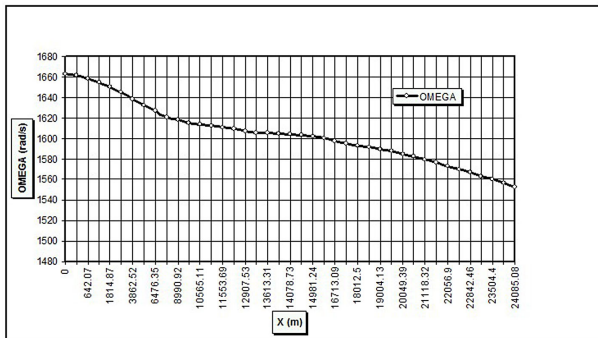
Figure 6. Change the angular velocity at different ranges of missiles.

Figure 7 shows the change in speed V of the trajectories of projectiles X.
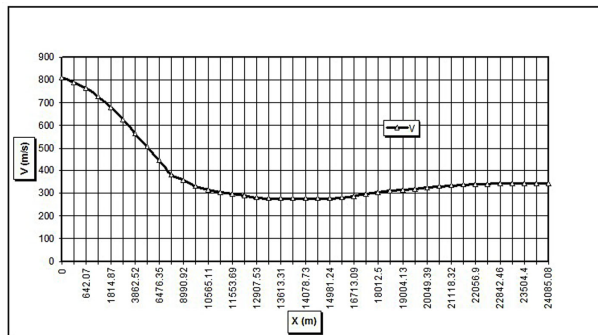
Figure 7. Change the speed V (X) at different distances

Figure 8 shows the change of angles α (X) and β (X) at various distance learning shooting.
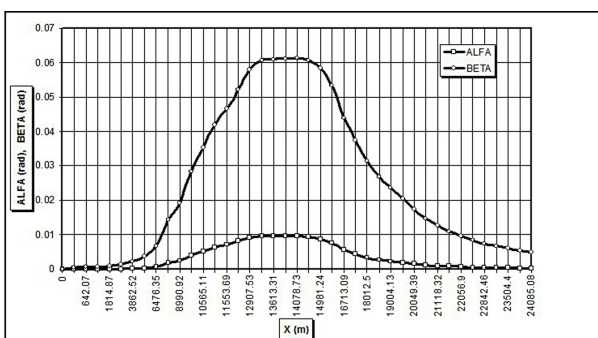
Figure 8. Changing the angle α(X) and β(X) at different shooting distances.

Figure 9 shows the change of angles α (β) in the path of the projectile.
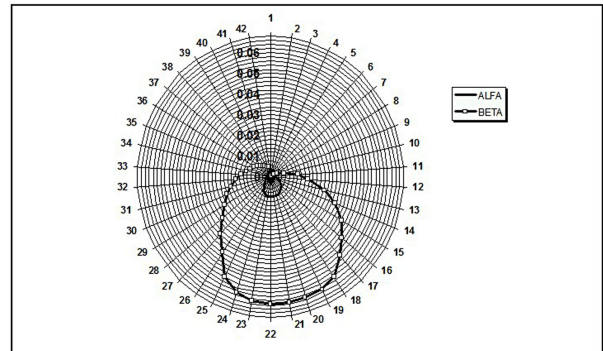
Figure 9. Changing the angle α (β) in the path of the projectile

5. CONCLUSION

When defining a physical model, it is necessary to first set the mathematical model and determine the missile. The six-degrees of freedom equations are the starting point for the modified point mass equations of motion. During the definition of a physical model neglected the effects of certain aerodynamic forces and moments to simplify calculations. Calculation of path elements is done by integrating the differential equations of motion modified material point method of Runge-Kutta fourth order. Such a composed software solution is universal and can be used for all tools that use defined projectile. For external ballistics calculation of the new, desired projectile is necessary to modify the input file or create a new defined-aerodynamic coefficients in subroutine AERO and baseline data of the selected missile. The output file is created during program executionand and the information obtained via WRITE command execution program is stored in it. These are external ballistics calculations. The program is organized so that the calculation stops at a given range of x and y axis. For standard atmosphere is carried out calculations of airspeed and Mach number of missiles in the current weather conditions at different altitudes projectile flight. Subroutine AERO define the aerodynamic coefficients depending on the current airspeed and Mach number. Special subroutine to solve systems of linear equations of the type Ax = b. The calculation results show that the largest angle at the vertex orbit is around 0.062 radians. The fact that it satisfies the condition of stability for the most unfavorable situation means that the projectile is stable throughout the trajectory.

The proposed solution providing accurate calculations of the characteristics of the missile, the elements of stability and the conditions under which it is exercised.

Applying software solutions proposed by the authors to save resources and reduce time numerical calculations as designing modern technical systems requires the use of simple physical and mathematical models and software that provide the required accuracy. The use of this software solution is in line with trends in the development of modern solutions in the external ballistics. This model allows the numerical integration of the equations for a shorter time than the model with six degrees of freedom.

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DIRECT-TO-HOME TELEVISION SERVICES IN EUROPE

Branimir Jakšić[1],
Mile Petrović[1],
Petar Spalević[1],
Bojana Milosavljević[2],
Marko Smilić[3]

[1] University of Pristina,
Faculty of Technical Sciences,
Kosovska Mitrovica, Serbia

[2] Singidunum University,
Faculty of Informatics and Computing,
Belgrade, Serbia

[3] University of Pristina,
Faculty of Natural Sciences and Mathematics,
Kosovska Mitrovica, Serbia

Abstract:

The paper describes the main characteristics and the principle of distribution of signals Direct-to-Home service. The most important characteristics of DTH providers in Europe: satellite, satellite positions, the number of multiplexes, the DVB standard, compression, standard and coding system are presented. Also, the change in the number of SDTV and HDTV DTH providers for five years since 2000 is given. The characteristics that provide DTH services in former Yugoslavia are presented, as well as the structure of the TV channels that are distributed as part of the DTH services in the states of former Yugoslavia.

Key words:

Direct-to-Home (DTH), satelit, satellite positions, SDTV, HDTV.

1. INTRODUCTION

Direct-to-Home (DTH) technology refers to the process of broadcasting the satellite TV signal and other services designed exclusively for home reception with personal antennas. This technology was previously signed as a Direct Broadcast Satellite (DBS) technology (Pattan, 1993; Valenti, 2011; Chaplin, 1992). DTH technology has been developed to compete with tv services cable operators, broadcasting high-quality satellite signals with a large number of TV channels. The use of satellites has significant advantages for broadcasting and distribution of television programs, which are primarily reflected in the service area of a large territory, the construction of unnecessary infrastructure and the ability to transfer more channels with the same satellite (Valenti, 2011). On the other hand, due to a much greater technical capacity than other forms of transmission, satellite transmission is ideal for development of HDTV.

Thanks to the rapid development of digital technology, DTH operators all over the world, beside the permanent increase of number of TV channels in SD (Sdandard Definition) and HD (High Definition) format, introduce new services along with the interactive applications, video on demand, satellite internet and others. DTH services are broadcasted from high power satellites so that the reception is available directly into homes by using smaller antenna diameter of 60 to 90 cm. The most suitable

Correspondence:

Branimir Jakšić

e-mail:
branimir.jaksic@pr.ac.rs

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and the most present transfer of DTH services is in Ku band, although there are services in C and Ka band. TV channels that are broadcasted via DTH in digital format are generally encrypted so that the receiver/decoder of protected channels is required to access them (Tirro, 1993). DTH transmission excludes local cable operators completely, because the user is directly connected with the service provider.

2. TRANSMISSION OF SIGNALS WITH DTH TECHNOLOGY

There are five major components in DTH systems: the signal source, the emission center (uplink antenna), satellite, downlink antenna and receiver (Figure 1).
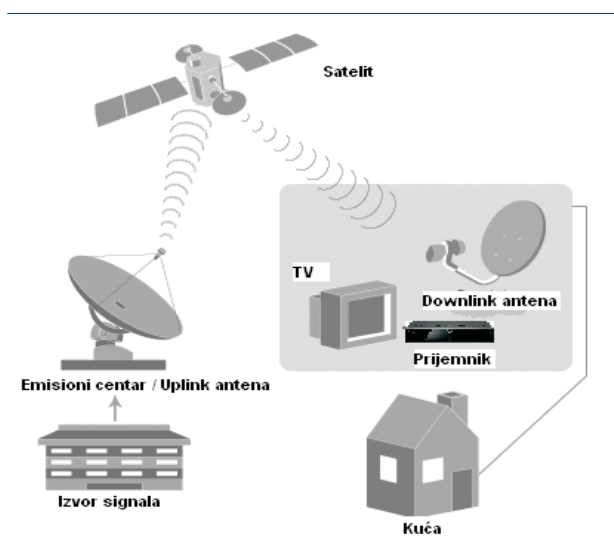
Figure 1. DTH system.

Signals are sent from the ground station to a satellite uplink antenna via the emission of the object whose dimensions are a diameter of 9 to 12 meters. On one satellite exists a large number of transponders whose task is to receive high-frequency modulated signals that are broadcasted fromterrestrial broadcasting station, and also to amplify them at another frequency and broadcast them towards the Earth (Petrović, 2007). Table 1 shows the frequency bands for uplink and downlink (Valenti, 2011).

Frequency band	Downlink	Uplink
C	3.7 - 4.2 GHz	5.925 - 6.425 GHz
Ku	11.7 - 12.2 GHz	14.0 - 14.5 GHz
Ka	17.7 - 21.2 GHz	27.5 - 31.0 GHz

Table 1. Frequency band for uplink i downlink

Downlink signals, attenuated after propagation through long sections, are collected with downlink parabolic satellite antenna.Dimensions of receiving antennas depend on the strength of the satellite transponder and satellite coverage area. In DTH services, receiving antennas have a diameter of 60 to 90 cm. Receiving antenna reflects signals into a single point that low-noise block converter - LNB enhances (about 50dB, 100,000 times) and converts it from C and Ku band to the frequency range of the receiver.This converted and amplified signal is led by using coaxial cable, which should have little attenuation in the satellite receiver for further processing (Petrović, 2007; Mirabito and Morgenstern, 2004).

The first satellite television transmission was in the analogous format. The main characteristic of analogous distribution is that one TV channel was using a single frequency, or a satellite transponder. This method of distribution resulted in the high cost of leasing transponders, and thus a smaller number of broadcast TV channels in relation to digital transmission. Because of the stated characteristics, DTH services in analogous technics were very poor and with very small number of TV channels. Unlike analogous reception, higher quality digital signal transmission enables that from one transponder is broadcasted a larger number of programs that form a multiplex.The result had a direct impact on the development of DTH services all over the world, especially as the price of a digital broadcasting signal significantly diminished and therefore the number of television and radio channels, as well as other services, increased significantly.

The development of digital telecommunications enabled, besides the Standard Definition Television (SDTV), also the use of high-definition television - HDTV. HDTV is a technology that offers picture and sound quality significantly higher than the traditional technology of visual and sound display (analogous PAL, NTSC, SECAM, and digital SDTV) (Pechard et al., 2006). In recent years, in addition to HDTV, the first Ultra High Definition Television has appeared (UHDTV) which included 4K UHDTV and 8K UHDTV with two times larger, or four times larger number of pixels in regard to Full HDTV (Marcotte, 2012).

The transfer of television video signal in its uncompressed formats requires a very large throughput flow that is outside the flow supported by modern technology. Therefore, different algorithms are used to compress video signals. The two most popular compression standards for digital TV signals are MPEG-2 and MPEG-4 AVC (H.264) (Haykin). Lately, higher quality MPEG-4

standard is more and more in use compared to the previous MPEG-2 standard. For UHDTV, HEVC compression standardwas adopted by the ITU (International Telecommunication Union).

DVB-S (Digital Video Broadcasting - Satellite) is the oldest DVB standard, which was adopted in 1994 by the European Telecommunications Standards Institute (ETSI). It is a satellite transmission of digitized audio and video content by a system of geostationary satellites and adequate receivers.The second generation of this standard - DVB-S2 has a larger capacity, it uses more efficient modulation and MPEG-4 / H.264 compression. DVB-S2 delivers 30% better performance compared to DVB-S, which in combination with the MPEG-4 / H.264 compression provides the ability that HDTV program broadcasts with the same flow that was formerly required for SDTV (Mignone *et al.*, 2011).

3. DTH PLATFORM DEVELOPMENT IN EUROPE

Satellite television services in Europe started to use the Ku band in late 1980s. In 1988, Luxembourg company SES Astra has launched the first satellite medium power Astra 1A, which was designed for reception of signals by individual antennas of a smaller diameter (90 cm). Before DTH service in digital format, in the mid-1990s, the signals from the satellites were broadcasted analogously. In analogous format, the most famous DTH platform was British Sky Analogue (1990-2001) which broadcasted over 30 encrypted TV channels from Astra satellites at 19.2 ° East. In addition to Sky Analogue, two significant analogous DTH platforms in Europe were the Scandinavian Canal + and Viasat. The other analogous DTH services were comprised of one or several encrypted TV channels for France, Germany, Spain, the Netherlands, Turkey and Russia.

The first digital DTH platform in Europe began distributing TV channels in the second half of the 1990s in France, Germany, Netherlands, Italy, Spain and the UK. Table 2 provides the main characteristics of the DTH platform which are broadcasted in Europe (KingOfSat, 2015; LingSat, 2015). Table 2 shows that all countries in Europe have DTH services. In some countries there are several DTH providers (Romania, Hungary, France, Bulgaria, Serbia, Croatia ...). In previous years, there has been a joint of several DTH platforms into one, as is the case with Sky Italia, which was formed in 2003. The joint of the Italian DTH platform Tele + and Stream TV,

Movistar + 2003 was created by joining the Spanish DTH platform via Digital and CanalSatelite Digital, NC + was created by joining N Poland i Cyfra+.

Some DTH providers offer services from multiple satellites, such as Canal Digitaal, TV Vlaandern, Orange France and Bis TV. The most popular coding systems are Nagravision, Viaccess, Conax and VideoGuard. DTH providers such as Canal Digtiaal, Vlaandern TV, Canal Sat France, NC +, Bis TV, Sky Link, UPC Direct and KabelKiosk use two or three coding systems. DTH platforms to the greatest extent use DVB-S2 stanndard and MPEG-4 compression for broadcasting TV channels. Some operators continue to use the DVB-S standard and MPEG-2 compression with a tendency of switching to DVB-S2 / MPEG-4. For HDTV are exclusively used DVB-S2 / MPEG-4. The largest number of DTH platforms is broadcasted from the two most popular satellite positions in Europe (13 ° East and 19.2 ° East). A large number of providers that are located on the same satellite positions perform mutual ''exchange'' of TV by including a channel codingin a number of systems. This leads to saving in the capacity of transponders or multiplexes.

Table 2 presents the number of multiplexes and satellite transponders, which are owned by European DTH providers. DTH providers beside from their multiplex, also broadcast TV channels from multiplexes of other DTH providers with whom they exchange TV channels, or with a certain compensation. Orange Polska DTH platform with 13° East does not have its own multiplex,but provides its services from the trasnponder of other DTH operators. The largest number of multiplexes has Sky UK (61), then Canal Digital (30) and Viasat (29).

Table 3 shows the number of SDTV and HDTV channels for DTH operators in Europe at the end of (31 of December) 2000, 2005, 2010 and 2015.

The number of TV channels increases from year to year, but since 2005 appear the first HDTV channels (Jakšić *et al.*, 2014). At the end of 2015, the highest number of SDTV channels is offered by Sky Sports provider (495), followed by NTV Plus (227) Digi TV (217) Viasat (210), Sky Italia (196) ... The largest number of TV channels is offered by Canalsat France (144), Sky Sports (95) Sky Deutschland (85). Besides its own SDTV and HDTV channels, DTH providers in its offer include the so-called free (free-to-air) SDTV and HDTV channels that are distributed from the same satellite. Such is the case with satellite position 28.2° E, 19.2° E and 13° E from which broadcasts a large number of unencrypted SDTV and HDTV channels.

DTH provider	Country	Start	Pozition	Satellite	No. MUX	Standard / Compression	Type Coding
Vivacom	Bulgaria	2010	45.0°E	Intelsat 12	6	DVB-S2, MPEG-4	VideoGurad
D-Smart	Turkey	2007	42.0°E	Turksat 2A/3A/4A	8	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	VideoGurad
Bulsatcom	Bulgaria	2004	39.0°E	Hellas Sat 2	5	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	BulCrypt
Polaris Media	Serbia	2010	39.0°E	Hellas Sat 2	1	DVB-S, MPEG-2 DVB-S2, MPEG-4	BulCrypt
Dolce TV	Romania	2006	39.0°E	Hellas Sat 2	9	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	VideoGurad
NTV Plus	Russia	1999	36.0°E	Eutelsat 36A/36B	22	DVB-S, MPEG-2 DVB-S2, MPEG-4	Viaccess
Tricolor TV	Russia	2005	36.0°E	Eutelsat 36A/36B	18	DVB-S, MPEG-2 DVB-S2, MPEG-4	DRE-Crypt
MagtiSat	Georgia	2012	31.5°E	Astra 5B	4	DVB-S2, MPEG-4	BulCrypt
Orange Romnaia	Romania	2013	31.5°E	Astra 5B	7	DVB-S2, MPEG-4	Viaccess
Sky UK	UK	1998	28.2°E	Astra 2E/2F /2G	61	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	VideoGurad
SkyLink	Czech R., Slovakia	2007	23.5°E	Astra 3B	6	DVB-S, MPEG-2 DVB-S2, MPEG-4	Cryptoworks, Irdeto
Canal Digitaal (23.5E)	Netherlands	1996	23.5°E	Astra 3B	7	DVB-S2, MPEG-4	Mediaguard, Nagravision, Viaccess
Canal Digitaal (19.2E)	Netherlands	1996	19.2°E	Astra 1KR/1L/1M/1N	2	DVB-S, MPEG-2 DVB-S2, MPEG-4	Mediaguard, Nagravision, Viaccess
TV Vlaanderen (23.5E)	Belgium	2006	23.5°E	Astra 3B	7	DVB-S2, MPEG-4	Mediaguard, Nagravision, Viaccess
TV Vlaanderen (19.2E)	Belgium	2006	19.2°E	Astra 1KR/1L/1M/1N	2	DVB-S, MPEG-2 DVB-S2, MPEG-4	Mediaguard, Nagravision, Viaccess
Sky Deutschland	Germany	1996	19.2°E	Astra 1KR/1L/1M/1N	12	DVB-S, MPEG-2 DVB-S2, MPEG-4	VideoGurad
Movistar+ Astra	Spain	1997	19.2°E	Astra 1KR/1L/1M/1N	17	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Mediaguard, Nagravision
Canal Sat France	France	1996	19.2°E	Astra 1KR/1L/1M/1N	22	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Mediaguard, Nagravision, Viaccess
Orange France (19.2E)	France	2008	19.2°E	Astra 1KR/1L/1M/1N	1	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Viaccess
AustriaSat	Austria	2010	19.2°E	Astra 1KR/1L/1M/1N	1	DVB-S, MPEG-2 DVB-S2, MPEG-4	Irdeto
Total TV	Serb., Croatia, Slovenia, B&H, Maced., Mont.	2006	16°E	Eutelsat 16A	11	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	VideoGurad
Max TV	Croatia	2010	16°E	Eutelsat 16A	3	DVB-S2, MPEG-4	Nagravision
Vip Sat	Croatia	2013	16°E	Eutelsat 16A	2	DVB-S2, MPEG-4	Conax
DigitAlb	Albania	2004	16°E	Eutelsat 16A	4	DVB-S2, MPEG-4	Conax
Tring Digital	Albania	2008	16°E	Eutelsat 16A	2	DVB-S2, MPEG-4	Conax
Mtel	Bulgaria	2014	16°E	Eutelsat 16A	3	DVB-S2, MPEG-4	Conax

Antik Sat	Slovakia	2015	16°E	Eutelsat 16A	3	DVB-S2, MPEG-4	Conax
Sky Italia	Italy	1997	13°E	Hot Bird 13B/13C/13D	25	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	VideoGurad
Nova	Greece, Cyprus	1999	13°E	Hot Bird 13B/13C/13D	4	DVB-S, MPEG-2 DVB-S2, MPEG-4	Irdeto
Cifrowy Polsat	Poland	1999	13°E	Hot Bird 13B/13C/13D	6	DVB-S2, MPEG-4	Nagravision
NC+	Poland	1998	13°E	Hot Bird 13B/13C/13D	10	DVB-S, MPEG-2 DVB-S2, MPEG-4	Conax, Mediaguard
Orange Polska	Poland	2008	13°E	Hot Bird 13B/13C/13D	0	DVB-S, MPEG-2 DVB-S2, MPEG-4	Viaccess
Orange France (13E)	France	2008	13°E	Hot Bird 13B/13C/13D	3	DVB-S2, MPEG-4	Viaccess
Bis TV (13E)	France	2007	13°E	Hot Bird 13B/13C/13D	2	DVB-S2, MPEG-4	Viaccess, Mediaguard
KabelKiosk	Germany	2009	9°E	Eutelsat 9A	10	DVB-S2, MPEG-2, MPEG-4	Conax, VideoGuard
AustriaSat Magyay	Hungary	2008	9°E	Eutelsat 9A	2	DVB-S2, MPEG-4	Conax, Irdeto
OTE TV	Greece	2012	9°E	Eutelsat 9A	6	DVB-S2, MPEG-4	VideoGurad
DigiTurk	Turkey	2000	7°E	Eutelsat 7A	21	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Cryptoworks, Irdeto
Viasat	Swed., Norw., Finla., Denm., Lithuania, Latvia, Eston.	1999	4.8°E	Astra 4A, SES 5	29	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	VideoGurad
Viasat Ukraine	Ukraine	2008	4.8°E	Astra 4A, SES 5	2	DVB-S2, MPEG-4	VideoGurad
Canal Digital	Swed., Norw., Finland, Denmark	1998	0.8°W	Thor 5/6, Intelsat 10-02	30	DVB-S, MPEG-2 DVB-S2, MPEG-4	Conax
UPC Direkt	Hungary, Czech R., Slovakia	2000	0.8°W	Thor 5/6, Intelsat 10-02	9	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Conax, Cryptoworks, Irdeto, Nagravision
Focus Sat	Romania	2004	0.8°W	Thor 5/6, Intelsat 10-02	5	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Conax
Digi TV	Roma., Hung., Slovak, Czech R., Serbia	2004	0.8°W	Thor 5/6, Intelsat 10-02	16	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Nagravision
T-Home	Hungary	2008	4°W	Amos 2/3	6	DVB-S2, MPEG-4	Conax
Orange France (5W)	France	2008	5°W	Eutelsat 5 West A	1	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Viaccess
Bis TV (5W)	France	2007	5°W	Eutelsat 5 West A	2	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Viaccess
Fransat	France	2009	5°W	Eutelsat 5 West A	8	DVB-S, MPEG-2 za SD DVB-S2, MPEG-4 za HD	Viaccess
Movistar+ Hispasat	Spain	1997	30°W	Hispasat 1D/1E	10	DVB-S, MPEG-2	Nagravision
NOS	Portugal	2000	30°W	Hispasat 1D/1E	5	DVB-S, MPEG-2 DVB-S2, MPEG-4	Nagravision
MEO	Portugal	2008	30°W	Hispasat 1D/1E	4	DVB-S2, MPEG-4	Mediaguard, Nagravis.

Table 2. Characteristic DTH platforms in Evrope

DTH provider	2000.		2005.		2010.		2015.	
	SD	HD	SD	HD	SD	HD	SD	HD
Vivacom	-	-	-	-	80	-	97	14
D-Smart	-	-	-	-	75	9	81	51
Bulsatcom	-		31	-	66	6	89	10
Polaris Media	-	-	-	-	43	2	63	4
Dolce TV	-	-	-	-	85	6	106	16
NTV Plus	36	-	62	-	168	9	227	34
Tricolor TV	-	-	12	-	77	-	186	39
MagtiSat	-	-	-	-	-	-	106	2
Orange Romnaia	-	-	-	-	-	-	76	40
Sky UK	268	-	474	-	523	50	495	95
SkyLink	-	-	-	-	60	12	92	41
Canal Digitaal 23.5E	-	-	-	-	31	21	52	33
Canal Digitaal 19.2E	21	-	36	1	47	1	24	2
TV Vlaanderen23.5E	-	-	-	-	-	-	39	24
TV Vlaanderen19.2E	-	-	-	-	47	2	23	5
Sky Deutschland	46	-	50	-	74	13	75	85
Movistar+ Astra	50	-	91	-	87	21	107	44
Canal Sat France	77	-	124	1	171	21	68	144
Orange France (19.2E)	-	-	-	-	-	-	57	19
AustriaSat	-	-	-	-	-	-	14	15
Total TV	-	-	-	-	100	3	123	35
Max TV	-	-	-	-	50	-	73	9
Vip Sat	-	-	-	-	-	-	65	13
DigitAlb	-	-	19	-	56	6	55	24
Tring Digital	-	-	-	-	24	-	45	7
Mtel	-	-	-	-	-	-	57	27
Antik Sat	-	-	-	-	-	-	37	10
Sky Italia	64	-	152	-	204	40	196	69
Nova	24	-	44	-	49	4	51	14
Cifrowy Polsat	17	-	38	-	70	14	93	60
NC+	19	-	57	-	101	14	98	78
Orange Polska	-	-	-	-	61	7	67	52
Orange France (13E)	-	-	-	-	49	2	69	8
Bis TV (13E)	-	-	-	-	35	-	34	6
KabelKiosk	-	-	-	-	91	11	54	35
AustriaSat Magyarország	-	-	-	-	31	7	45	13
OTE TV	-	-	-	-	-	-	66	31
DigiTurk	61	-	83	-	118	14	131	48
Viasat	24	-	92	-	196	17	210	48
Viasat Ukraine	-	-	-	-	40	-	37	7
Canal Digital	78	-	116	1	190	26	166	69
UPC Direkt	36	-	58	-	101	11	137	24
Focus Sat	-	-	34	-	62	-	74	7
Digi TV	-	-	58	-	167	-	217	22
T-Home	-	-	-	-	82	4	104	23
Orange France (5W)	-	-	-	-	66	2	71	12
Bis TV (5W)	-	-	-	-	31	-	31	7
Fransat	-	-	-	-	48	4	76	29
Movistar+ Hispasat	78	-	86	-	90	-	115	-
NOS	18	-	81	-	88	11	61	16
MEO	-	-	-	-	88	8	91	15

Table 3. SD and HD TV channels number.

4. DTH PLATFORM IN FORMER YUGOSLAVIA

Thefirst DTH platform for the countries of the former Yugoslavia was a package of TV channels called SeeMe. The platform began with its work in January 2005, with a dozen TV channels. In the first half of 2006, DTH platform Total TV began its work, and initially it was intended only for Serbia, but later expanded the business to Montenegro, Bosnia and Herzegovina, Croatia, Slovenia and Macedonia. At the end of 2006, the Romanian DTH platform took users of Seemore package and launched its services in Serbia and Croatia (DigiTV, 2015). Since 2013, Digi TV provided services only to users in Serbia,and users from Croatia were assumed by newly formed Vip Sat DTH platform (VipSat, 2015). In 2010, two more DTH platforms started - Polaris Media in Serbia and Max TV in Croatia (KingOfSat, 2015).

Characteristics of DTH providers in the former Yugoslavia can be seen in Table 2. Even three DTH platforms: Total TV, Max TV and Vip Sat are distributed from the satellite position 16 degrees East, a Polaris Media from 39 ° East and Digi TV from 1 ° West. Platforms Vip Sat and Max TV exclusively use DVB-S2/MPEG-4 standard for the transmission of TV channels, while Total TV uses DVB-S2/MPEG-4 for TV, and for SDTV, it uses DVB-S/MPEG-2 (Petrović *et al.*, 2014).

Table 4 gives the number of SDTV and HDTV channels at the end of year for DTH platforms that provide services in countries of former Yugoslavia. For DTH platform Digi TV were taken into account only TV channels that were broadcasted in Serbia and Croatia, not counting the TV channels for other markets.The number of TV channels increased from year to year, except for Digi TV, where the number of TV channels decreased after leaving the business in Croatia. At the end of 2015, the highest number of TV channels were located in the platform Total TV. Since 2010, they were distributed within DTH and first HDTV channels. During 2015 there was a higher growth of HDTV services, so that at the end of 2015 the number of HDTV channels in the platform Total TV were 23 hour Vip 13, Max TV 9, Polaris Media 4. Digi TV to subscribers in Serbia does not offer HDTV services.
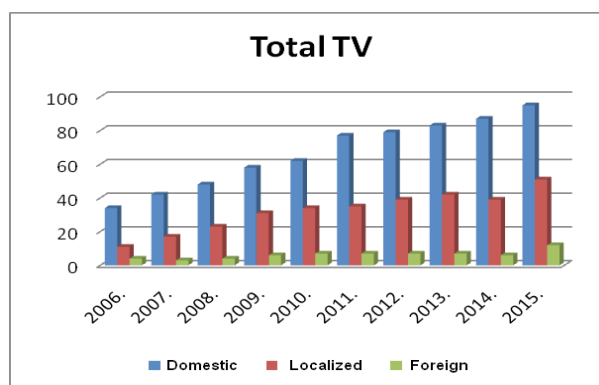
Figure 2. TV channels in DTH platform Total TV.

DTH provider		2006.	2007.	2008.	2009.	2010.	2011.	2012.	2013.	2014.	2015.
Total TV	SD	48	62	75	95	100	116	118	125	125	135
	HD	-	-	-	-	3	3	7	7	7	23
Digi TV	SD	32	39	44	45	45	43	39	31	29	28
	HD	-	-	-	-	-	-	-	-	-	-
Max TV	SD	-	-	-	-	50	73	74	72	73	73
	HD	-	-	-	-	-	1	4	5	5	9
Polaris Media	SD	-	-	-	-	43	49	58	62	63	63
	HD	-	-	-	-	2	2	2	3	3	4
Vip Sat	SD	-	-	-	-	-	-	-	60	61	65
	HD	-	-	-	-	-	-	-	6	6	13

Table 4. SDTV and HDTV channels number of DTH providers in countries of Former Yugoslavia
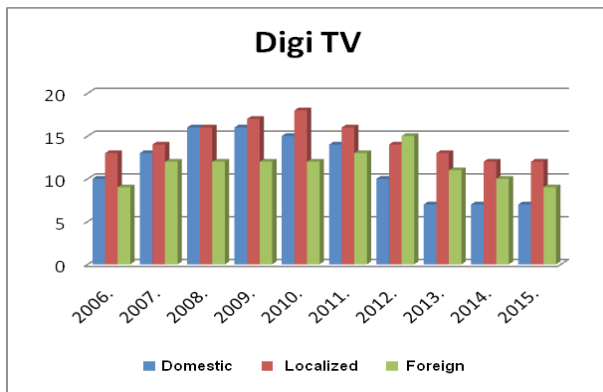
Figure 3. TV channels in DTH platform Digi TV.
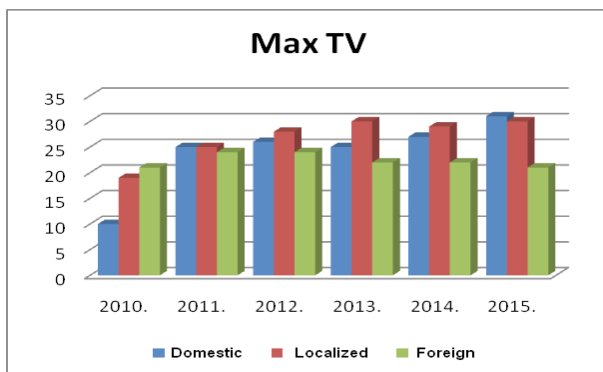
Figure 4. TV channels in DTH platform Max TV.
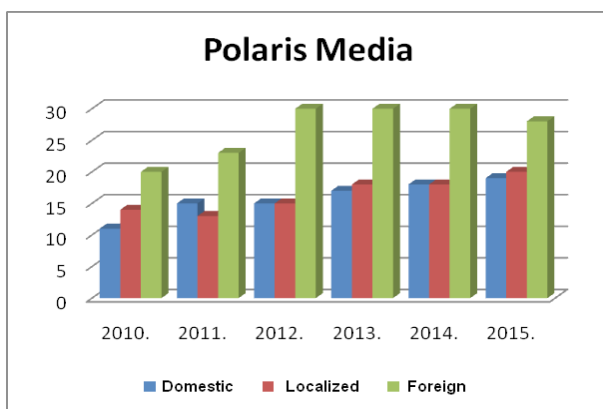
Figure 5. TV channels in DTH platform Polaris Media.
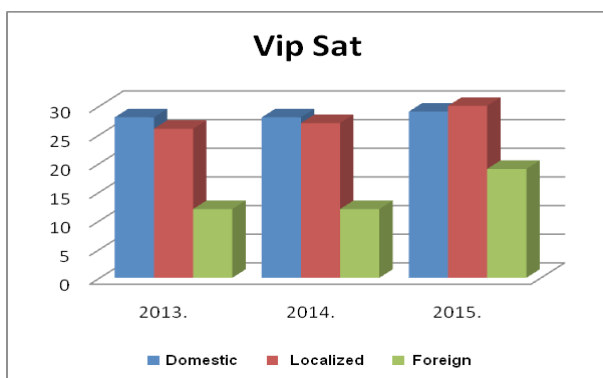
Figure 6. TV channels in DTH platform Vip Sat.

The structure of TV channels that broadcast in regional DTH platform can be classified into three categories: domestic, localized and foreign. Under localized TV channels are considered foreign TV channels (pan-European) that are localized in local languages by DVB subtitles or audio. TV channels that include program broadcast in foreign languages, mainly English, are considered foreign TV channels. The structure of TV channels in DTH platform Total TV, Digi TV, Max TV, Polaris Media and Vip Sat are respectively given in Figure 3, Figure 4, Figure 5 and Figure 6. In Total TV prevails domestic over localized TV channels, and at the minimum are represented foreign TV channels without localization. In Polaris Media, the most represented are foreign TV channels. In other DTH providers, domestic and localized TV channels are equally represented, followed by foreign TV channels.

5. CONCLUSION

Direct-to-Home (DTH) refers to the broadcasting of TV programs and related services in which the subscribers, or the final users, receive signals directly from satellite from the geostationary orbit. The signals are broadcasted in digital format and in the Ku band (in Europe). Companies that provide DTH services, provide other services besides TV channels, such as radio, video on demand and satellite internet. DTH services are popular in rural areas where conventional cable services are not available. DTH services are also used by the urban and suburban users, who are not satisfied with the quality and quantity of TV services available by cable operators. In Europe, in the second half of the 1990s, the first DTH services began to operate in digital format, reaching their rapid extension during the 2000s. However, in recent years, rapid expansion of HDTV channels has occurred, which will be replaced by SDTV in the upcoming years. In 2015, the distribution of the first UHD TV channels also occurs, for which the satellite is an ideal way of distribution because of the required large-capacity for transmission (Jakšić *et al.*, 2015).

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USING ICT TO ENRICH TEACHING METHODS

Dragana Stanojević[1],
Željko Stanković[2],
Dragan Cvetković[3]

[1] Institute for Education Quality and Evaluation, Belgrade, Serbia

[2] Institute for Improvement of Education Belgrade, Serbia

[3] Singidunum University, 32 Danijelova Street, Belgrade, Serbia

Abstract:

Modern society imposes that it is necessary to search for a variety of teaching methods that actively engage all students in the educational process. To include each student is one of the biggest challenges of the modern teacher. Bearing in mind the results of the Association of Serbian IT professors, which indicate that 77% of students use the Internet every day for more than 4 hours, it is necessary to find a method that will help teachers to manage this challenge.

On the other hand, the same study shows that there is an insufficient number of computers in schools that students could use in every class consistently, and only a small number of schools have just one lab with computers for each student. The paper presents the results of research in which teachers, after completing the training, had the opportunity to use the mathematical knowledge quiz. They also had the opportunity to use the quizzes in other subjects.

Key words:

quiz, teaching methods, educational standards, student achievement.

1. INTRODUCTION

In every teaching method, information technology is used as a basis for involving students and engaging their thinking processes in order to improve their competence. The teaching method is the essence of the teaching process. The use of information technology in modern society is considered essential because information technologies are an integral part of the extracurricular life of every student. A computer application in the teaching process ensures that all students are involved, which is not always the case with classical teaching methods. Application programs are taken from information technologies that users with minimal computer knowledge can use in the field of teaching.

Frequent testing is a necessary element in the monitoring of student achievement, and in most cases, it also represents evaluation of achievements. Due to these frequent testings, an open question remains as to whether the students learn because evaluation is important or because of their interest in acquiring knowledge. One way that teacher can gain the attention of students is with a knowledge quiz. The knowledge quiz can be implemented at the beginning of the lesson to check the students' previous knowledge. Students' responses can be used like guidelines for the further course of the lesson. Also, teachers can use a quiz at the end of the lesson to determine the level to which students have understood the

Correspondence:

Dragana Stanojević

e-mail:
dstanojevic@ceo.gov.rs

subject of the lesson. Quiz creates a pleasant surrounding in the classroom where all students have the opportunity to participate. Using quizzes in the introductory part of the class is also a good way to to assess students' knowledge and progress. Due to this role of the quiz, it is very important that the quiz questions are clear, precise and formulated in a such way that they can support teacher with clear information about student achievement. Students who finish quiz before the new lessons begins feel more prepared and less anxious to do the test. Also, they feel that the quiz helped them to progress. (Brown & Talon, 2015)

There are various free online tools that can be used to prepare online quizzes. A survey conducted by the Association of Serbian science professors shows that each school has an average of 28 computers that can be used for teaching students and that every school has the Internet. This data indicates that there are not enough computers for each student in one class that have access to the Internet during teaching process and that the use of these tools would be impossible in most cases.

2. AIMS

The study aimed to investigate the possibilities of applying knowledge quiz as a teaching method in all classes with available computer and projector, and to examine the attitudes of teachers who had use of these teaching methods in mathematics. Based on this research, recommendations were defined for innovating teaching using knowledge quizzes.

3. RESEARCH PROCESS

Teachers who participated in this study had never before used the quiz as a teaching method and had had minimal computer knowledge. In this research, the participants were the classroom teachers of fourth grade students. Training was organized for all the teachers who participated in the survey, where the teachers were introduced with the content available to them for creating the teaching process at one lesson. Also, they were introduced with the ways of creating questions and had the opportunity to independently create questions on the computer. A quiz was given as an example which tests the students' achievements in the field of fractions in the younger grades.

Educational standard are categories into which students will be classified on the basis of their scores. Specify what all students are expected to know and be able to do.

Educational standards contain coherent and rigorous content and encourage the teaching of advanced learning. The educational standards are set by policymaker. Educational standards related to this field are shown in Table 1.

Basic level
MA.1.3.1. The student knows how to read and write fraction 1/n ($n \leq 10$). He is able to recognize that a fraction when plotted.
MA.1.3.2. The student knows how to calculate the half, a quarter and a tenth of the unity.
Intermediate level
MA.2.3.1. The student recognize a fraction a/b ($b \leq 10$, $a < b$) as graphically illustrated in figure divided into b parts.
MA.2.3.2. The student knows how to calculate the n-th part of a unity and vice versa, and compares fractions form $1/n$ ($n \leq 10$).
Advance level
MA.3.3.1. The student knows how to read, formal recorded and graphically display a fraction a/b ($b \leq 10$, $a < b$).
MA.3.3.2. The student knows how to calculate the part a/b ($b \leq 10$, $a < b$) of the unity and use it in problem solving

Table 1. Standards for Fraction, the Regulations on the educational standards for the end of the first cycle of compulsory education for courses Serbian language, mathematics, sience, "Prosvetni pregled", Republic Serbia, 5/2011.

Planning for monitoring students' educational achievement is very important in the learning process because it provides the level of achievement of each of the existing standards at the every level.

The example of the quiz was containing 30 questions. The questions in the quiz were open questions and multiple choices, and each question has passed multiple quality control of the validity of the content. The questions in the example quiz allowed teachers to learn about different kinds of questions they can entrust student achievement (Figure 1, 2, 3 and 4).

Figure 1. Display example quiz
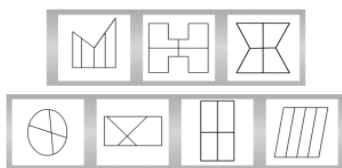
Figure 2. Question Basic level - MA.1.3.1.

Figure 3. Question Intermediate level - MA.2.3.2.
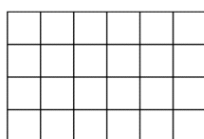
Figure 4. Question Advanced level - MA.3.3.2.

Creating questions for knowledge quiz is a very important part in this teaching method, as the teacher has to think about different segments that could affect the task to determine time for editing and revising the quiz, to minimize student's reading time, has to avoid tricky, misleading items as well as trivial questions. The teacher has to base each item on an assessment objective, try to focus on a single problem and keep wording consistent with student's level. The teacher has to avoid over specific knowledge and item based on opinions. It is necessary to use as many distractors as the item really needs. In multiple choice items, it is required to place options in logical order, keep options independent and not overlapping, try option to be short and avoid statements "all of the above" or "none of the above". Also, the teacher is expected to check all questions to make sure there is one and only one correct option, to take care about the position of the correct option.

Recommendations were also prepared with the rules on how to realize the quiz in the classroom.

Based on the cards they drew, the students are classified into three groups - the same group of students has the same card. The first team which starts is a team with the biggest sum of players years. Each question carries certain number of points which is printed on the slide, and the students choose numbers of questions that will answer. If they do not know the answer for the offered question, another group responds to the question, and if they also do not know the answer, the third group has the right to answer. The student responds only once in the group. When all the students in one group answer questions for once, they may agree which of them will answer the following questions again.

Right after the training most of the teachers have confirmed that they will be using the quiz on at least one class during the school year. Several teachers also expressed doubts in the individual creation of this class, due to lack of computer literacy.

4. RESULTS

Interviews were conducted with teachers who have used the teaching method as a quiz. In these discussions, teachers expressed their views. Out of 30 teachers who were in the sample and participated in the training, 24 teachers participated in interview. An interview was carried at the same time with all the teachers. All interviewed teachers stressed that the students were very interested in participating in such activities. Also, it was especially important for the surrounding in the classroom the fact

that the student weren't marked and that all students had the opportunity to answer a question.

The quiz, which is given as an example, was used by all interviewed teachers and 8 teachers have prepared new quizzes using the given application. The conclusions regarding the creation of the quiz from these discussions with teachers are as follows: students were highly motivated to participate in a quiz; their activities were focused on solving problems regardless of whether they answered the question or some other student was answering; the unity is created in each group; teachers had more precise picture of the accomplishments of students. Teachers who self-prepared the quiz pointed out that this teaching method complemented classes and helped them in an unusual way to monitor student progress and to identify students who may require additional support to overcome certain teaching contents.

5. CONCLUSIONS AND RECOMMENDATIONS

The primary function of the teaching method - quiz is to determine students' achievements. In addition to ensure this all the students are involved in the learning process. The theory and various indicators in the literature suggest that quizzes, as a mean of learning, are leading to the increased interest of students and increased achievements in tests. Research has shown that teachers who are using the sample quiy are able to assess student achievements and to identify content that students need additional support with.

The quiz enables the teacher to clearly point out the aims of the learning process and the key concepts that pupils have to learn. One of the advantages is that teacher gradually asks more complex questions, educates pupils how to use different ways in solving problems, how to relate new teaching material with the previous, how to relate the teaching content with the examples from everyday life, how to relate teaching content from different areas, how to set personal aims in learning.

The teachers are also required to efficiently structure and associate all class segments, and to efficiently use class time. It is very important that teacher establishes and maintains discipline in a constructive way, according to the agreed rules. A quiz is a teaching method that enables the teacher to functionally use the existing teaching aids. Also, if the teachers use the quiz at the end of the lectures, they will check whether the main learning objectives have been achieved.

Students are interested in quizzes, actively participate in class work, their activities show that they have understood the class content. If students need some help, the teacher will provide them with feedback to solve the problem.

Surrounding which is created in the classroom directly depends on the teaching methods that teachers select for the implementation of planned activities. This method is preferable for planning as students and teachers have positive attitudes about knowledge quizzes. Practice shows that it is necessary to change teaching methods in addition to provide involvement and faster progress for all students.

Research shows that all schools in Serbia have a computer and a projector, and that it is possible to organize lessons that will be an integral part of the quiz. Traditional teaching combined with interactive learning is most effective in groups, and the quiz as a teaching method allows interactive learning.

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INTELLIGENT INDUSTRIAL INSTRUMENTATION BASED ON SILICON MEMS PRESSURE SENSORS

Miloš Frantlović[1],
Ivana Jokić[1],
Marina Marjanović-Jakovljević[2]

[1]University of Belgrade
ICTM–CMT, Institute of Chemistry,
Technology and Metallurgy,
Belgrade, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Research and development in the fields of MEMS sensors and intelligent industrial instrumentation, performed at the Center of Microelectronic Technologies (ICTM-CMT), have resulted in scientific and technological advances beyond the state-of-the-art. In this paper, we give an introduction to MEMS sensors, as well as to the concept of intelligent industrial instrumentation. The SP-12 silicon piezoresistive MEMS pressure sensor, the newest type developed and manufactured at ICTM, is described in detail. Subsequently, a new method is presented that enables simultaneous high-performance pressure and temperature measurement to be performed using a single piezoresistive MEMS pressure sensor. It is devised using the sensor's mathematical model, based on sensor characterization data. A newly developed intelligent industrial transmitter was used as a hardware platform for experimental validation of the measurement method. The obtained results indicate that the measurement performance level of the existing industrial equipment can be met or exceeded using the described approach. Implications regarding the practical use of the presented method are discussed. Finally, two intelligent industrial instruments based on the SP-12 sensor and the described method are presented: a pressure transmitter and a liquid level transmitter. The performance and reliability of both products have been proven in harsh industrial environments.

Key words:

sensor, intelligent instrument, MEMS, pressure, temperature.

1. INTRODUCTION

The emergence of micro-electro-mechanical technologies and systems (MEMS), which were mentioned for the first time in 1986 in the USA, started a new era in sensor development, which is likely to last throughout the next decades. New sensor structures based on these technologies can achieve measurement performance comparable or superior to those of conventional sensors, while they are of miniature dimensions and suitable for economical mass-production. Additionally, there are features, effects and mechanisms inherent to micro and nano-structures, which are of interest for sensor realization, while their influence on macroscopic objects is often negligible. One of such effects is adsorption of particles, which is utilized

Correspondence:

Miloš Frantlović

e-mail:

frant@nanosys.ihtm.bg.ac.rs

as the principle of operation of many contemporary chemical and biological sensors (Frantlović *et al.*, 2013). Mechanical MEMS sensors (*e.g.* pressure and flow sensors, accelerometers, gyroscopes) are widely used today and have a significant market share. The most common mechanisms for conversion of mechanical deformation into electrical signal are based on piezoresistivity and capacitance change (Balavalad and Sheeparamatti, 2015). Historicaly first and also the most successful MEMS sensors are silicon piezoresistive MEMS pressure sensors. They dominate in automotive industry (the largest market share of pressure sensors today), and are very common in process industry, aerospace and military industry, medical equipment and consumer products. As a result of continuous research and development of silicon piezoresistive MEMS pressure sensors during the last 3 decades at the Center of Microelectronic Technologies of the Institute of Chemistry, Technology and Metallurgy, University of Belgrade, a variety of products, including sensors and industrial instruments based on them, has been realized and brought to market (Djurić *et al.*, 1986; Matović *et al.*, 1991; Djurić, 1995; Frantlović *et al.*, 2007; Smiljanić *et al.*, 2007; Frantlović *et al.*, 2009; Smiljanić *et al.*, 2012; Frantlović *et al.*, 2014).

For telemetry of physical quantities (pressure, temperature, liquid level, flow *etc.*) in industrial processes, a special kind of electronic measurement instruments is used, usually called industrial transmitters. They are intended for operation in harsh industrial environments and they use robust industrial interfaces for connection with the centralized measurement or control system. In their simplest form, industrial transmitters are electronic devices with analog signal processing and analog output signal (most commonly 4 mA to 20 mA). However, in order to satisfy the ever increasing requirements regarding measurement performance, ease of use, and connectivity, new generations of transmitters emerged, offering digital signal processing, interactive user interface and digital two-way communication. The current generation of industrial transmitters, often called intelligent transmiters, have advanced computing and communication capabilities, which enable them not only to achieve high measurement performance, but also to process data obtained by measuring dfferent quantities, and to perform various additional functions, including self-diagnostics.

A majority of modern pressure transmitters is based on silicon MEMS pressure sensors (piezoresistive or capacitive). The measured pressure is typically within the range from 100 Pa to 10^8 Pa. Regarding the measurement performance, an inherent property of all semiconductor-based piezoresistive pressure sensing elements is a significant parasitic temperature sensitivity of their output signal, which must be minimized by using suitable correction techniques. Such techniques evolved from simple methods using resistor networks to complex digital signal processing algorithms (Frantlović *et al.*, 2009; Rivera *et al.*, 2007). Contemporary high-performance intelligent industrial pressure transmitters based on MEMS piezoresistive sensors exhibit relative measurement uncertainty as low as 0.05% of full scale at reference conditions, and typically >0.15% in the full temperature range.

Industrial temperature transmitters typically use temperature probes based on platinum resistance sensing elements or thermocouples, and the measured temperatures are typically within the range from -270°C to 1500°C. Measurement uncertainty achievable using platinum probes can be much better than 0.5°C (IEC 60751, 2008), while the same value can be achieved only with the best thermocouples (IEC 60584-2, 1989).

In a typical electric powerplant block there is more than 100 temperature and 50 pressure measurement points. While in other kinds of industrial plants the numbers can be significantly different, measurement of both quantities at the same measurement points is needed in many cases. Although industrial transmitters capable of measuring both quantities exist, they are based on separate sensors or sensing elements for each measured quantity. The existing literature boasts only few examples of simultaneous pressure and temperature measurement performed using a single sensing element (Guo *et al.*, 2006; Doelle, 2011). The authors are unaware of such examples based on silicon piezoresistive MEMS sensing elements.

In this paper, a description is given of an SP-12 silicon piezoresistive MEMS pressure sensor developed and manufactured at the Center of Microelectronic Technologies. Subsequently, a method is described that enables simultaneous high-performance pressure and temperature measurement to be performed using a single SP-12 sensor. The obtained results are then discussed, as well as their implications regarding the practical use of the presented method.

2. METHOD

Sensor Description

The newest of the silicon MEMS piezoresistive pressure sensing elements developed and produced at the Center of Microelectronic Technologies is the ICTM

SP-12, intended for measurement of absolute or relative pressure from 10^5 Pa to 10^7 Pa (1 bar to 100 bar) (Matić *et al.*, 2013). The material for its fabrication is a double-sided polished single-crystal n-type silicon wafer with a specific resistivity from 3 Ωcm to 5 Ωcm. Four p-type piezoresistors are formed by boron diffusion on the surface of the sensor's diaphragm, constituting a Wheatstone bridge. Two piezoresistors are in the radial direction and the remaining two in the transversal direction near the edge of the diaphragm. The diaphragm is square, 1.08 mm × 1.08 mm in size, fabricated by silicon bulk micromachining. The diaphragm thickness is from 32 μm to 160 μm, depending on the nominal pressure range of the sensing element. The position of the piezoresistors is optimized for each diaphragm thickness in order to obtain the highest possible linearity of the output signal. The overall size of the sensing element die is 2 mm × 2 mm × 0.38 mm. After fabrication, the die is anodically bonded to a glass support. A photograph of the sensing element mounted on a TO–5 housing is shown in Figure 1a. In order to make a pressure sensor suitable for industrial applications and to ensure optimal operating conditions for the sensing element, a special sensor body must be used. A sensing element packaged in such a body constitutes a pressure sensor. A photograph of an industrial-grade pressure sensor based on the SP 12 sensing element is given in Figure 1b.

Electrically, the SP 12 sensor is a Wheatstone bridge made of pressure-dependent resistors. It is technologically optimized for constant current excitation, I_0. That current generates the voltage V_{out} at the sensor's output port, and V_{br} at its excitation port.
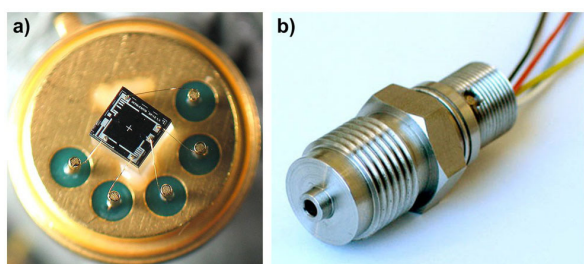
Figure 1. a) Photograph of the SP–12 sensing element mounted on a TO–5 housing, b) industrial pressure sensor based on the SP–12 sensing element

Sensor Characterization

In order to devise a method for simultaneous measurement of pressure and temperature by using a single piezoresistive pressure sensor, experimental charac-

terization of a typical SP 12 sensor was performed. The main objective of the characterization was to determine the dependences of the two output parameters of the sensor ($R_{out}=V_{out}/I_0$ and $R_{br}=V_{br}/I_0$) on both the applied pressure and the temperature.

A simplified block diagram of the measurement setup used for the sensor characterization is shown in Fig. 2. It consists of a high-performance automatic pressure calibrator (Mensor APC600), a temperature chamber (Vötsch VTL7010), a signal acquisition unit developed at ICTM–CMT specifically for this purpose (the dashed rectangle) and a personal computer. A software application is made for the computer to perform three main tasks: communication with both the signal acquisition unit and the pressure calibrator, user interface for measurement indication and instrument control, and data storage. The pressure sensor to be characterized is placed inside the temperature chamber. A high-performance resistive temperature sensor (Pt 100, better than ±0.06°C) is attached to the surface of the pressure sensor, enabling the reference measurement of the pressure sensor's temperature.

The sensor characterization was performed at 10 different temperatures (from 70°C to 20°C), starting from the highest temperature in order to avoid water condensation during the experiment. The nominal pressure range of the sensor under test was divided into 10 equal intervals, yielding 11 equidistant pressure values to be set.
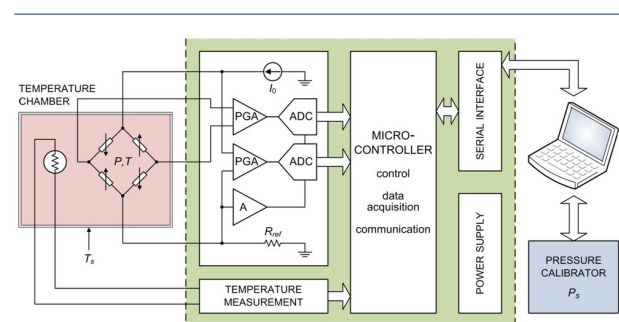
Figure 2. Block diagram of the experimental setup

Additionally, the pressure was set in two passes: first from the lowest to the highest value and then in the opposite direction, so that hysteresis effects could be observed. At each measurement point, the pressure indicated by the calibrator, P [bar], the temperature chamber setpoint, T_s [°C], and the temperature of the sensor under test, T [°C], were recorded as well as the measured values of both sensor output parameters, R_{out} and R_{br}. The entire experiment produces 220 data points and lasts about 8 hours.

In order to evaluate the performance of the tested sensor, an approach is chosen that reflects the most basic application of such sensors, which assumes only offset and span adjustment at the reference temperature. The indication of the measured pressure is given as

$$\hat{P}(R_{out}, R_{br}) = a_0 + a_1 \cdot R_{out}(P, T_{ref}) \qquad (1)$$

where a_0 and a_1 are parameters calculated by fitting the linear function (1) to the experimental data acquired at the reference temperature, $T=T_{ref}=20°C$, using the method of least squares (Wolberg, 2006). The relative pressure measurement deviation from the pressure value indicated by the calibrator at the ith data point is expressed as a percentage of full scale, according to

$$\delta P_i[\%FS] = \frac{\hat{P}_i(R_{out\,i}, R_{br\,i}) - P_i}{|P_{max} - P_{min}|} \cdot 100, i = 1 \text{K } N \qquad (2)$$

where N is the total number of data points ($N=220$), and P_{max} and P_{min} are the maximum and the minimum of the nominal pressure range, respectively ($P_{max}=100$ bar, $P_{min}=0$ bar).

As a figure of merit of the tested sensor utilized for pressure measurement we use the expression $\overline{\delta P} \pm U_P$, where $\overline{\delta P}$ is the relative deviation mean value, and U_p is the expanded uncertainty with a coverage factor of 2 (JCGM, 2008):

$$\overline{\delta P} = \frac{1}{N} \cdot \sum_{i=1}^{N} \delta P_i , \qquad (3)$$

$$U_P = 2 \cdot \sqrt{\frac{1}{N-1} \cdot \sum_{i=1}^{N} (\hat{P}_i - P_i)^2} \cdot \frac{100}{|P_{max} - P_{min}|} . \qquad (4)$$

This representation of results is a robust indicator that describes the deviation of measurement values from the values set by the calibrator as a standard.

A similar approach is used for temperature, obtaining the indication of the measured temperature as

$$\hat{T}(R_{out}, R_{br}) = b_0 + b_1 \cdot R_{br}(P_{ref}) \qquad (5)$$

where b_0 and b_1 are parameters calculated by fitting the linear function (5) to the experimental data acquired at the reference pressure, $P=P_{ref}=0$ bar (relative to the atmospheric pressure), using the method of least squares. The temperature measurement deviation at the ith data point is expressed in degrees Celsius, according to

$$\Delta T_i[°C] = \hat{T}_i(R_{out\,i}, R_{br\,i}) - T_i, i = 1 \text{K } N . \qquad (6)$$

As a figure of merit of the tested sensor utilized for temperature measurement we use the expression $\overline{\Delta T} \pm U_T$, where $\overline{\Delta T}$ is the deviation mean value, and U_T is the expanded uncertainty with the coverage factor of 2 (JCGM, 2008):

$$\overline{\Delta T} = \frac{1}{N} \cdot \sum_{i=1}^{N} \Delta T_i , \qquad (7)$$

$$U_T = 2 \cdot \sqrt{\frac{1}{N-1} \cdot \sum_{i=1}^{N} (\hat{T}_i - T_i)^2} . \qquad (8)$$

Here the current temperature measured by the Pt-100 sensor is taken as the standard and the measurement results are expressed as a deviation from that value. The numerical results showing the performance of the tested sensor, based on the characterization results are given in Table 1. These results confirm that an acceptable level of measurement performance cannot be achieved without an adequate sensor correction method. The method that will be presented here relies on the mathematical model of the sensor, and computer algorithm enabling real-time calculation of both the pressure and temperature value indication.

Sensor Correction Method

Based on the analysis of the experimentally obtained data, a parametric mathematical model of a silicon piezoresistive MEMS pressure sensor has been established, taking into account the influence of the pressure and the temperature on the sensor's output signals. In this case, the goal of mathematical modeling is to determine the sensor calibration functions, *i.e.* the dependence of the measurement indication of both the pressure and the temperature on the sensor's output parameters R_{out} and R_{br}. We have chosen a model consisting of two bivariate polynomials:

$$\hat{P}(R_{out}, R_{br}) = \sum_{j=0}^{m} \sum_{k=0}^{n} a_{jk} \cdot R_{out}^j \cdot R_{br}^k \qquad (10)$$

$$\hat{T}(R_{out}, R_{br}) = \sum_{j=0}^{u} \sum_{k=0}^{v} b_{jk} \cdot R_{out}^j \cdot R_{br}^k \qquad (11)$$

where $\hat{P}$ and $\hat{T}$ are the pressure and the temperature indication, respectively, while a_{jk} and b_{jk} are the parameters to be determined for the given sensor. The values of *m, n, u,* and *v,* and consequentially the degrees of both polynomials, need to be chosen carefully in order to maximize the fidelity of the mathematical model, but keeping in mind the necessary calculation time in the target hardware. In this case, the following values have been chosen: *m=4, n=4, u=2* and *v=4*.

The parameters a_{jk} are calculated by fitting the function given by (10) to the characterization data (P_i, $R_{out\ i}$, $R_{br\ i}$, $i=1, ..., 220$), using the method of least squares (Wolberg, 2006). Similarly, the parameters b_{jk} are calculated by fitting the function given by (11) to the characterization data (T_i, $R_{out\ i}$, $R_{br\ i}$, $i=1, ..., 220$). In this way, the mathematical model of each of the characterized sensors is determined, yielding the corresponding calibration functions for both pressure and temperature measurement. These functions enable simultaneous pressure and temperature measurements to be performed using a single piezoresistive MEMS pressure sensor.

3. RESULTS AND DISCUSSION

For the purpose of experimental verification of the proposed method, an intelligent industrial transmitter, developed at ICTM–CMT, was used as a hardware platform, with the tested sensor built-in. Its simplified block diagram is given in Figure 3. Conceptually, it replaces the measurement system used for sensor characterization (shown in Figure 2), but with two major differences: 1) the separate temperature sensor does not exist; 2) the microcontroller block performs all the data processing (including sensor correction), control functions and communication via an industrial interface.
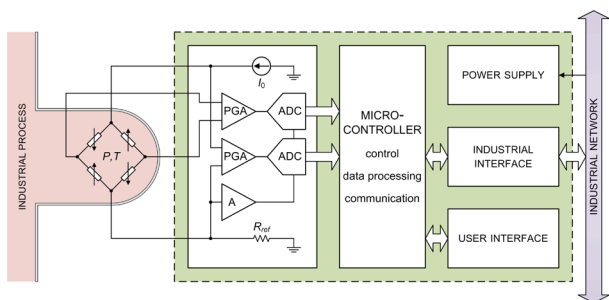
Figure 3. Simplified block diagram of an intelligent industrial instrument for simultaneous pressure and temperature measurement

The instrument performs real-time sensor corrections by calculating (10) and (11) for each set of data appearing at the outputs of the A/D converters and representing the values of R_{out} and R_{br} simultaneously sampled at a certain rate. For that purpose, the parameters a_{jk} and b_{jk} of the given sensor must be stored in the instrument's non-volatile memory or, alternatively, in the sensor's own memory (IEEE 1451.4, 2004). The measurements were performed in a similar way as in the sensor characterization experiment, but this time the pressure and temperature measurement indications provided by the instrument were recorded at each measurement point. The relative pressure measurement deviation, expressed as a percentage of full scale according to (2), is shown in Fig. 4 for the tested sensor. The temperature measurement deviation, expressed in degrees Celsius according to (6), is shown in Figure 5.

Table 1 summarizes the pressure and temperature measurement performance achieved using the tested sensor without the sensor correction (based on characterization data), and with the described correction method applied (based on experimental verification data). When these values are compared, it becomes evident that the method enables a great improvement in both pressure and temperature measurement performance. The pressure measurement relative uncertainty is reduced by a factor of 65.3, while the temperature uncertainty is reduced by a factor of 67.6.

As the proposed measurement method is intended primarily for industrial applications, the main criterion for its applicability is the achievable measurement performance in comparison to that of existing industrial solutions. When pressure measurement is considered, modern industrial transmitters typically have a relative uncertainty of 0.075%FS or worse, depending on the specified temperature range. The results shown in Table 1 indicate that such performance level can be exceeded by using the proposed measurement method, at least in the considered temperature range (-20°C to 70°C).
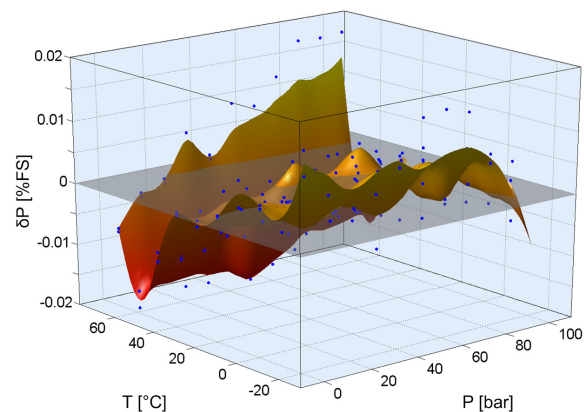
Figure 4. Relative pressure measurement deviation with the proposed method applied, as a function of pressure P and temperature T
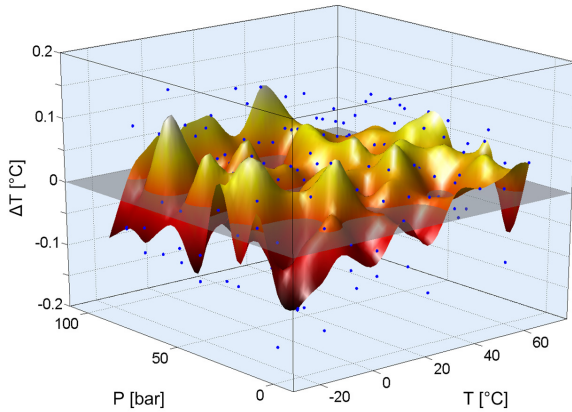
Figure 5. Temperature measurement deviation with the proposed method applied, as a function of temperature T and the pressure P

Temperature measurements in industrial processes are commonly performed by using temperature probes based on thermocouples (TC) or resistance temperature detectors (RTD). The most commonly used TCs are the types J, K, and E, which can achieve ±1.5°C in the temperature range from -40°C to 375°C (Class 1 tolerance (IEC 60584-2, 1989)), but are usable up to 800°C (type J), 1300°C (type K), and 900°C (type E). Also common are the type T TCs (±0.5°C in the temperature range from -40°C to 125°C). The measurement uncertainty of industrial Class B platinum RTDs is given as $(0.3+0.005*|T|)$°C, where T is the measured temperature in the range from -196°C to 600°C for wire-wound RTDs and -50°C to 500°C for film RTDs (IEC 60751, 2008). In terms of temperature measurement performance, the method presented in this paper enabled achieving an expanded measurement uncertainty lower than 0.3°C, which is much better than that of type J, K and E TCs, better than that of type T TCs, and comparable to that of Class B RTDs. However, the temperature range of SP-12 sensing elements is limited by the physical properties of silicon to less than 125°C. This limitation can be overcome by using pressure sensing elements based on SOI substrates (Kumar and Pant, 2014; Guo 2009).

	without sensor correction	with correction applied
$\overline{\Delta P} \pm U_P$ [%FS]	0.053 ± 0.979	−0.001 ± 0.015
$\overline{\Delta T} \pm U_T$ [°C]	3.222 ± 8.520	0.010 ± 0.126

Table 1. Pressure & Temperature Measurement Performance (P_{min} = 0 bar, P_{max} = 100 bar, T_{min} = -20°C, T_{max} = 70°C, m = 4, n = 4, u = 2 and v = 4)

Based on the described intelligent instrument architecture (see Figure 3), and the presented measurement method, two products are developed and produced at the Center of Microelectronic Technologies. The first is the intelligent industrial pressure transmitter, shown in Figure 6a, and the second is the intelligent industrial liquid level transmitter, shown in Figure 6b. They share the same modular hardware platform, which enables the use of up to 2 piezoresistive MEMS pressure sensors, both capable of measuring pressure and/or temperature. The connection with an industrial control system is established via a 2-wire cable. It enables the use of the standard analog 4 mA to 20 mA signal (represents the value of the measured quantity and provides the power to the transmitter), as well as a 2-way digital communication (based on a superimposed modulated signal and a standardized industrial protocol). The performance and reliability of both products have been proven in harsh industrial environments.
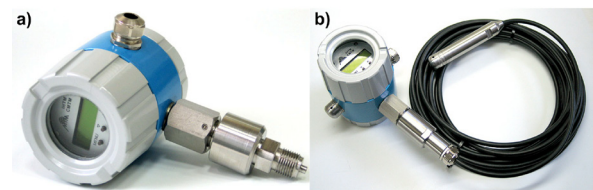
Figure 6. a) Intelligent pressure transmitter TPrs–111 and b) intelligent liquid level transmitter TPns–101

4. CONCLUSION

In this paper an overview is given of MEMS pressure sensors and the current state of the art in the field of industrial instrumentation. A novel measurement method is described that enables simultaneous pressure and temperature measurements to be performed using a single silicon piezoresistive MEMS pressure sensor. The presented results show that the achieved pressure measurement performance (<0.03%FS, -20°C < T < 70°C) is more than adequate for use in high performance industrial pressure transmitters. At the same time, the temperature measurement performance (<0.3°C, 0 bar < P < 100 bar) is better than that achievable with thermocouples, and comparable to Class B platinum resistive thermometers. Although the temperature range is limited by the physical properties of silicon (up to 125°C), it is adequate for numerous applications. This limitation can be overcome by using sensing elements based on SOI substrates. Apart from simultaneous pressure and temperature measurement at

the same point in an industrial process, some other useful applications can be envisioned, including validation of a separate temperature sensor, temperature compensation or sensor diagnostics in multisensor systems *etc.* As the proposed measurement method relies on the existing concept of intelligent industrial pressure transmitters with piezoresistive sensors, some existing types of such transmitters can be upgraded so to include temperature measurement capability at a minimal additional cost.

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ADVANCED ENGINEERING SYSTEMS

THE IMPROVEMENT OF THE INVENTORY PROCESS IN THE COMPANY "BENLIAN FOOD" NIŠ BY APPLYING THE POM-QM 4.0 SOFTWARE

Milan Stojanović,
Dušan Regodić

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

One of the most important factors of an enterprise's efficiency is also adjusting of supply with demand requirements. Logistics, as an integral function of an enterprise that establishes and develops relations with the environment and, in a targeted manner, directs the subsystems of a company towards the main goal of its existence and operation, is the most appropriate tool for managing an enterprise in the modern dynamic environment.

In many enterprises, inventory optimization is a major problem. Mainly, such enterprises are characterized by poor customer service, such as failure to adhere to delivery deadlines. Bearing in mind the state of Serbian companies, few enterprises can boast their applied scientific knowledge in the field of inventory optimization in practice.

The subject of our research is the optimization of the inventory in the company Benlian Food Niš. The management of the company finds it rather significant to know approximately exact quantities needed for the next year. Given the fact that this is an importing company with its production, too, more precise quantities would be of great help, as this would enable management to make more adequate decisions on when and how many products to import and produce.

Key words:

inventory management, optimization, supply chains, forecasting, POM-QM software for Windows 4.0.

1. INTRODUCTION

Forecasting is one of the most important inputs managers develop as a support to the decision-making process. In that sense, managers find the question of whether greater significance should be attributed to quantitative methods of forecasting or to one's own opinion and one's own estimations to be one of the key questions. Experience shows that a combination of quantitative methods and a good estimation, founded on sound logic, is a recipe for good forecasting. Also, the question imposes as to whether there are ways for our cognitive capacities and our estimations founded on them to anticipate unexpected changes in the business environment, which would create conditions for a timely and efficient evaluation of alternative courses of action?

In many enterprises, inventory optimization stands for a major problem. Mainly, such enterprises are characterized by poor customer service, such as a failure to adhere to delivery deadlines. Having in view the condition of Serbian enterprises, few enterprises can boast their applied scientific knowledge in the field of inventory optimization in practice.

Correspondence:

Milan Stojanović

e-mail:
milanstojanovic19@yahoo.com

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The subject of our research is the optimization of inventory in the company Benlian Food Niš. The management of the company finds it rather significant to know approximately exact quantities needed for the next year. Although it is a very successful enterprise, the prediction process is based on the reasoning and opining of the management of the enterprise. Given the fact that this is an importing company with its production, too, more precise quantities would be of great help, because in such a way, management would be making more adequate decisions on when and how many products to import and produce.

For that very reason, the basic goal of the paper is point at the advantages and benefits which the enterprise can achieve by applying a conventional approach to prediction, mainly focused on the development and testing of statistical techniques. In that sense, software packages developed as a support to the multiple criteria analysis models are also a significant segment.

2. THE CHOICE OF INVENTORY OPTIMIZATION SOFTWARE

The contemporary conditions of business doing have imposed upon enterprises basing their business doing on an adequate information support. Without adequate information solutions, there is no cost-effective or profitable business doing of enterprises in the turbulent environment, either. The advancement of technology has had such an impact leading to the emergence of different types of information systems for different fields of business doing inside an enterprise.

The movement of goods must be supported by an information system. When right goods move towards the right place and at the right time and in right conditions, with right documents, right information, *i.e.* answers to all "right" questions must be known (Regodić, 2010, p. 359).

Given the fact that the business doing of an enterprise includes many activities, there are general information systems and specialized IT solutions. When supply, the logistics of inventory and shipment are concerned, information technologies may accelerate the processes, reduce costs and thus be the enterprise's success factor. "Software must be in function of joint work on the rationalization of the production-business processes, but also must be rational by itself: with a few input data and capable of generating purposeful management information." (Stanišić & Regodić, 2009, p. 93).

Planning not supported by computers is impossible in contemporary enterprises. However, integral computer tools are mainly expensive (sometimes, they may even cost several tens of thousands of euros). Apart from this, program solutions require more powerful hardware and software as well as a database system in the process of the implementation of a program solution in an enterprise.

A problem may occur in smaller enterprises unable to afford expensive software solutions, so the quality of their planning is also frequently questionable. Minor program solutions supportive of the complex calculations of planning are helpful in planning and are also an interesting tool. At the same time, they are very powerful computer tools not specially demanding in terms of the computer performances and big capacities of the memory.

Logistics information systems are impossible to do research into, develop and introduce in operating practice (apply) unless there is knowledge of the important features of quality information systems. Quality information systems supporting the logistic aspects of decision making and supporting the work done by the logistics bodies cannot be developed unless the information needs of certain users of information systems (information) are adequately defined and unless the objects of the interest of a logistics system are described in as many details as possible (Andrejić, Milenkov, Sokolović, 2010, p. 34).

In the context of inventory optimization, we shall use the POM-QM solution for Windows in this paper. For the time being, 4.0 is the latest version of this program solution. It should also be emphasized that there are similar software solutions in the market, as well as a large number of different types. Some are available free of charge on the Internet, and some are possible to obtain for just a few euros.

The first version of this software was a DOS version that appeared in 1989, as the PC-POM. The following DOS versions were named AB:POM. The first Windows version, the QM for Windows (Version 1.0) was distributed in the autumn of 1996, as a special but similar program. The POM for Windows (Version 1.1) was distributed in the autumn of 1996 for the first time. The DS for Windows version included the POM and the QM modules and, together with the instructions for use, it was distributed in 1997. The Version 2 of all the three programs was created for Windows 95 and appeared in the autumn of 1999. (Weiss, 2010, p. vii). The upgraded version of the POM-QM for Windows 4.0 came to fruition during 2010, and it is possible to download it free of charge on the Internet.[1]

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[1] For more information about this: http://pom-qm-for-windows-version-4.software.informer.com/ (4th March 2016)

The POM-QM 4.0 software solution consists of more than twenty different modules, and it is possible to have some of them additionally structured as well. Given the fact that there is a large number of complex modules, only those that will be used in the paper will be presented in more detail. This refers to the Inventory and the Forecasting modules.

Principally, work with different modules in a software solution is quite similar. The very beginning is based on entering data, only to be followed by solving and finally interpreting data. Each of the modules enables the entering of new data (File, New) or work with the existing or saved data (File, Open). The POM-QM 4.0 software solution has the following modules: the production program planning, the production line reconciliation, mapping work on machines, the break-even point analysis/cost analysis, capital investment, help when making decisions, forecasting, the theory of games, goals programing, integrated programing, inventories (storing), term planning, allocation, the experience curve, linear programing, the allocation of production resources, the optimization of the order quantity, the Markov analysis, the planning of material needs, networking (the optimization of the route), productivity, project management (PERT/CPM), quality control, reliability, simulation, statistics (average, variation, standard deviation, normal distribution), shipment problem, waiting queues, and results measuring.

Once a module of forecasting is determined, it is possible to present four submodules through the main menu (File, New): Time Series Analysis, Least Squares/Simple and Multiple Regression, Regression Projector, and Error Analysis.

When data have been entered, by pressing the button (Solve), the required calculation is initiated. The results are displayed in several windows, depending on the selected calculation module: BAS (Mean Error), MAD (Mean Squared Error), Standard Error, MAPE (Mean Absolute Percent Error).

When the Inventory module has been selected, as it is the case with the module Forecasting on Command (File, New), we are faced with the possibilities of selecting different submodules: the Economic Order Quantity (EOQ) Model, the Production Order Quantity Model, the Backorder Inventory Model, the Production with Backorders Model, Quantity Discount (EOQ) Model, ABC Analysis, Record Point/Safety Stock (Normal Distribution), Record Point/Safety Stock (Discrete Distribution).

After data have been entered, by pressing the Solve button, the calculation itself is initiated. The results can be displayed in several windows, which depends on the

selection of the module. The coverage of the solution depends on the complexity of the problem observed. The results in this module are mainly displayed in two windows.

In the first window, the results obtained on the basis of the EOQ selected model are displayed: input data (annual needs, costs of ordering, costs of storing and the price), the optimal order quantity, the maximum inventory level, (average inventory), annual setup costs, annual holding costs, unit costs, total costs.

As it could have been seen in the shorter presentation of the POM-QM software solution for Windows 4.0, the software is easy to use. Of course, it is necessary that there should be the knowledge of the formulation of the problem and the purpose of solving the same. It should also be pointed out that the POM-QM software solution for Windows 4.0 is an attractive tool.

Apart from being attractive and easy to use, too, however, it can also be said to have some shortcomings. We are going to try to list them:

- The capacity of some of the modules is rather restricted (almost all the modules allow using a table of no more than 90 data or tables of up to 90 rows and columns);
- The software solution lacks a database, so each time, data need to be entered "manually";
- The results of the solution to the problem in the software solution are not visible in the best possible manner when exported, so, in the majority of cases, it is necessary that their visibility should be improved through other programs;
- Networking and the exchange of information with other tools is not possible, except with Excel, so, in accordance with that, it is impossible to apply in computer networks;
- The program solution is in the English language.
- Yet, perceiving all the mentioned shortcomings, it is possible to conclude that the POM-QM software solution for Windows 4.0 is quite a satisfactory tool that can be used in solving problems in the field of quantitative methods (QM) and production and operations management (POM). The software solution is also fully free of charge and very simple to use, which enables its quick and easy implementation in the enterprise.

Based on the said so far, the key reasons that have contributed to the selection of the software are: (1) the functionalities are sufficient for the application of simple inventory models as is the one applied in the paper; (2)

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the software is relatively easy to use; (3) the software is cost-effective because it is free to use.

3. THE RESULTS AND DISCUSSION

The company Benlian Food doo (limited liability company) was founded by Raffi Benlian in Niš in June 2001, when its main activity was the import and distribution of, first of all, granular, basic provisions. The company is part of an international group doing business on the territory of Central Europe and the Balkans, and in that way, it keeps up with the world trends, which they are trying to bring onto the Serbian market in the best possible way.

The company has quite a wide portfolio. The main activity is the import and packing of rice. Apart from that, there is also a confectionary sector, as well as the sector of pasteurized food, ketchup, dried leguminous vegetables and cereals. Kozmetik plus doo is also within the company. Kozmetik plus is part of the group for the import, processing and distribution of rice for the South-East European market. (http://www.vibilia.rs/srpski/izvestaj/0508/Benlian.pdf, 5th March 2016)

At the beginning of business doing, in January 2002, the company Benlian Food employed five workers. Given the fact that the company is still developing itself, it currently employs more than 250 workers, showing a tendency of increasing the number of its employees. Its annual turnover is higher than 8,000,000 EUR, and the profit of around 2% (http://www.kozmetikplus.com/onama.swf, 5th March 2016)

The company offers over 50 articles and they all belong to the food category, but there are also confectionary products. That is exactly the reason why potential buyers of products are different. The Benlian Food Company's products are present on the territory of Serbia as well as outside that territory. It can be said to be an enterprise focused on the production of products generating the highest profit. Yet, rice is one of the products for which the company Benlian Food Niš is recognizable on the market.

Although it is a very successful enterprise, the enterprise does not base its business operations on the optimization of inventories by applying statistical techniques or some software package. The applied concept of the intuitive planning of the sale of goods has had an impact on an increase in the costs of business operations due to the lacking inventories or the existence of a surplus of inventories.

The inadequate sales plan leads to the problem of inventories in the enterprise. Inventories happen to be either too small or too large, and in both cases, they con-

tribute to an increase in costs. The additional burdening factor is that production depends on import. So, to the extent it is feasible, a detailed sales plan would be significantly helpful in the business operations carried out by the Benlian Food enterprise. In such a manner, the enterprise would be striving for an adequate optimization of its inventories.

In the continuation of the paper, we shall present the example of increasing costs caused by a bad sales plan. The example is based on the data for the year 2015. We have chosen the three different sorts of rice that were being sold the most. The following graph accounts for the sale of the three chosen sorts of rice in 2015.
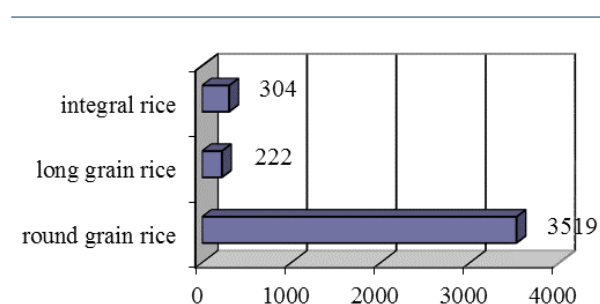
Graph 1: The sale of the three sorts of rice during 2015, expressed in tons. Source: The company Benlian Food Ltd. Niš, inside documentation

On the basis of Graph 1, we can clearly perceive that the sales quantities of the three sorts of rice differ from each other. We should bear in mind the fact that it is the sale achieved in the course of 2015, not the predicted sale on the base of which the enterprise can take measures so as to avoid the consequences of a lack of inventories or redundant ones. However, in 2015, that was exactly the problem. We shall graphically account for the surplus/deficit with respect to all the three sorts of rice.
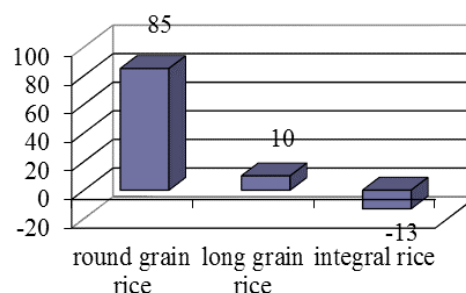
Graph 2. The inventories surplus/deficit in 2015, expressed in tons.

Source: The company Benlian Food Ltd. Niš, inside documentation

On the basis of the presented graph, we can clearly see that, in 2015, there was a surplus of inventories for round grain rice (85t) and long grain rice (10t), and when integral rice is concerned, there was a shortage of inventories (13t). No matter which one of these situations – the surplus or the shortage of inventories – is considered, they both contribute to increasing the costs of business operations.

The prices of individual products, excluding the sales margin, were as follows in 2015 (The company Benlian Food Ltd. Niš, inside documentation):

- round grain rice= 55.00 din/kg,
- long grain rice = 38.50 din/kg,
- integral rice = 56.50 din/kg.

On the basis of the presented data, we shall indicate the level of unnecessary costs in the Benlian Food Niš enterprise. We may also examine the total amount of costs, taking into consideration all the inventories of the enterprise's assortment.

For the presented products, the value of the surplus/deficit of the inventories is obtained by multiplying the price by the quantity of the surplus/deficit of the inventories (respectively).

- round grain rice = 55.00 RSD * 85,000kg = 4,675,000.00 RSD/godišnje,
- long grain rice = 38.50 RSD * 10,000kg = 385,000.00 RSD/per annum, and
- integral rice = 56.50 RSD * 13,000kg = 734,500 RSD/per annum.

On the basis of the presented, the total costs of the surplus/deficit of the inventories of the observed products amount to 5,794,500.00 RSD/per annum.

As we have already mentioned, having in view the complete assortment of the Benlian Food Niš enterprise, the total annual costs of the surplus/deficit of the inventories are for sure far greater.

For that particular reason, we propose inventory optimization in the Benlian Food enterprise by applying the POM-QM software solution for Windows 4.0., which in turn will lead to far more realistic sales plans as well, which will ultimately result in a reduction in the costs of business operations, too.

The table below is an account of the data on the sale of round grain rice for the last two years, per months, *i.e.* in the period 2014-2015. In accordance with the period of the observation of the sales trend, the forecasting (forecast) will refer to the year 2016.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2014	261	289	316	298	280	264	299	282	289	306	261	288
2015	316	335	367	328	299	336	358	345	314	307	354	386

Table 1. The data on the sale of round grain rice in the period 2014-2015, in tons.

Source: The company Benlian Food Ltd. Niš, inside documentation

Picture 1. The input data for the selected product in the POM-QM software for Windows 4.0.

The process of forecasting by applying the POM-QM software solution for Windows 4.0 instructs us to enter the requested data into the program, so as to calculate all the parameters necessary for linear regression.

The data on the sale of round grain rice for the two years are entered in the main window for entering data. After the data have been entered, whether the entered data are accurate should be checked, after which by pressing the Solve button, the results necessary for solving the set problem are obtained very quickly and easily. Apart from that, the program also enables a graphical display of the results.

The results obtained by means of the correlation method of the regression analysis according to the least squares method, on the basis of the calculation done by the POM-QM software for Windows 4.0, are as follows:

- Bias (Mean Error) = 0
- MAD (Mean Absolute Deviation) = 18.84
- MSE (Mean Squared Error) = 536.04
- Regression line = has the Y shape = a + b*x = 268.51 + 3.45*month (x)
- Correlation coefficient = 0.72
- Coefficient of determination (r^2) = 0.51.

The graphical display of the forecasting of the sale of the round grain rice of the company Benlian Food Niš is presented in the following picture.

By summarizing the obtained results of the forecasting, the following can be highlighted:

- the total sale of round grain rice in 2014 was 3,433t;
- the total sale of round grain rice in 2015 was 4,045t;
- according to the forecasting for 2016, the sale will be greater than in 2014 and 2015, and will amount to 4,484.4 t.

Inventory optimization on the basis of the forecasting is continued by using the Optimal Order Quantity model (the EKN model). The core purpose of the Optimal Order Quantity Model in an enterprise is how to lower the costs incurred due to a lack or a surplus of inventories.

The input data for the Optimal Order Quantity model for round grain rice (the observed product) are as follows:

P = 4,484.4t – the obtained forecasting for 2016,

the purchase price: N_c = 59.00 din/kg, *i.e.* 59,000 din/t

the costs of ordering a single delivery: T_n = 146,000 RSD

the costs of storing: s_z = 59,000*0.12 = 7,080.00 din/t

The POM-QM program solution for Windows 4.0. determined 18.84 – the monthly level – for the mean average deviation (MAD). On the basis of that, we can define the lower and the upper limits of the event, namely:

the lower limit of the event: 4,484.4 – 2.5*12*18.84 = 4,484.4 – 565.2 = 3,919.2t

the upper limit of the event: 4,484.4 + 2.5*12*18.84 = 4,484.4 + 565.2 = 5,049.6t
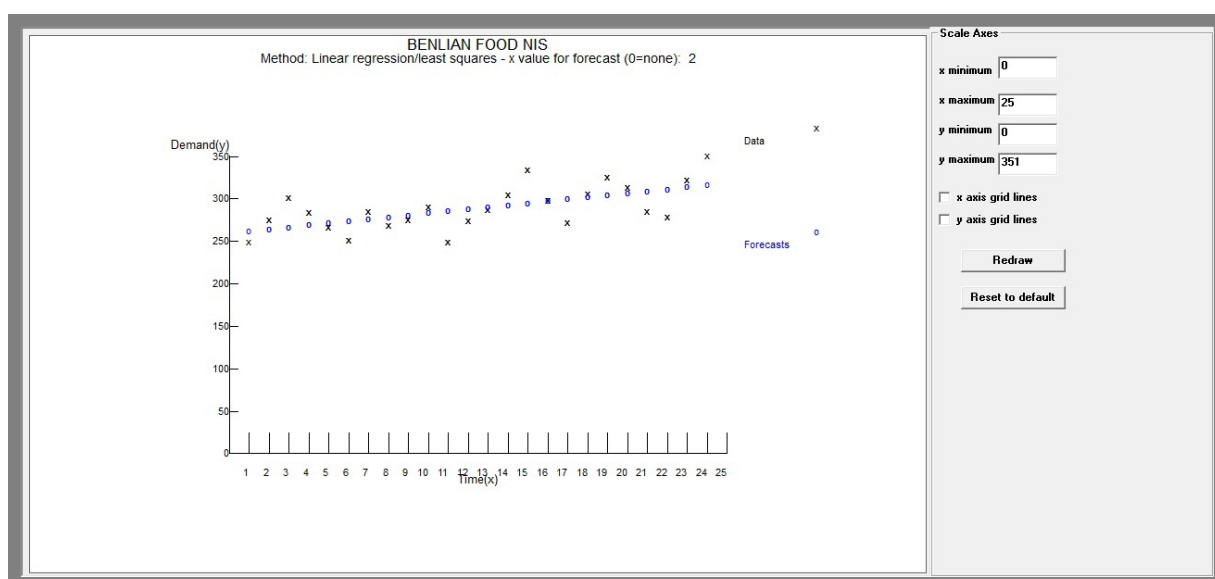
Picture 2. A display of the forecasting of the sale of round grain rice on the basis of the POM-QM software for Windows 4.0.

By entering the data in the POM-QM program solution for Windows 4.0., the results are obtained so that, on the basis of the four scenarios, namely:

1. a normal distribution at the level of 95% of the supply level – the lower limit -2σ (-2.5*MAD),

2. a normal distribution at the level of 95% of the supply level – the upper limit +2σ (+2.5*MAD),

3. a normal distribution at the level of 95% of the supply level – the upper limit +/-2σ (+/-2.5*MAD),

4. intuitive ordering,

we could make a decision on the scenario with the most optimal solution for the company Benlian Food Niš.

The optimal order quantities and the number of purchases according to the different scenarios are accounted for in the following table.

Optimal Order Quantity:	Number of orders:
1st scenario: 402.4t	10 times
2nd scenario: 456.34t	11 times
3rd scenario: 430.06t	10.43 times
4th scenario: 2,328.5t	2 times

Table 2. The optimal order quantities and the number of the purchases according to the different scenarios.

After comparing the optimal order quantity and the number of orders, it is also significant to make a comparison between the total costs and the annual quantities of all the four scenarios. For that very reason, the same is going to be shown graphically.
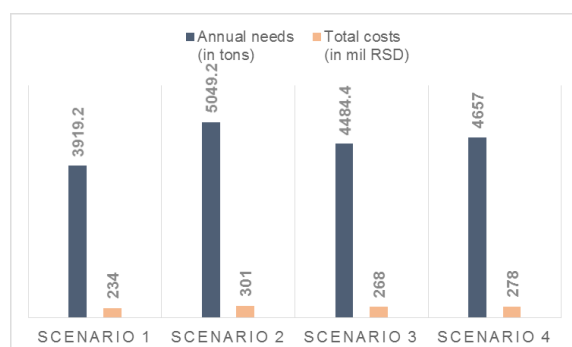
Graph 1. A comparative display of the total annual costs and quantities of different scenarios.

The presented data are clearly indicative of the fact that Scenario 1 is the most acceptable scenario for the Benlian Food enterprise with respect to the costs. Scenario 1 envisages costs in the amount of 239 million RSD, whereas the other scenarios envisage greater costs, namely:

◆ Scenario 2 envisages costs greater by 63 million RSD which is about 26% greater than the costs according to Scenario 1,

◆ Scenario 3 accounts for costs greater by 30 million RSD, *i.e.* about 13% in excess of the costs according to Scenario 1,

◆ Scenario 4 envisages costs greater by 40 million RSD, *i.e.* about 17% greater than the costs according to Scenario 1.

By applying Scenario 1 when placing an order for round grain rice, the costs of business operations would surely be lower than they were in the previous period because the costs of the surplus/deficit of the inventories would be reduced to the minimum. As we could see, due to the surplus/deficit of the round grain rice inventories in 2015, the costs amounted to around 5.8 million RSD. Having in view the large number of the products in the assortment of this enterprise, the application of the proposed optimization has its economic justification. The economic effects of the application of Scenario 1 in the business operations conducted by the enterprise would be measurable only in the next year, when there is a clear insight into the costs of the surplus/deficit of the inventories.

However, we should bear in mind the fact that there is no written rule telling us when an enterprise should be applying some of the scenarios. The permanent monitoring of the level of inventories and sales flows imposes itself as a necessity so as to prevent too high a level of inventories or a shortage of the same.

The idea of optimization, on the example of the company Benlian Food Niš, also indicates the fact that it is impossible to calculate all on the basis of various methods, but that it is necessary that the opinions of the company's management should also be included in making decisions on inventory optimization. Even when statistical methods are used, it is not a rare case that results are adjusted according to experts' assessments. Managers usually have access to a broad spectrum of information they have to integrate so as to make a forecast.

CONCLUSION

The proposed inventory optimization brings results in many segments, but the key effects are reflected in inventory optimization in the sales plans of the company

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Benlian Food Niš, and accordingly, in the reduction of the costs. In practice, that would mean that, due to the implementation of one such system, the enterprise would in a simpler manner draft its purchase plan that would deviate less from the intuitive forecasting of the management of the enterprise. Simultaneously, a more advanced inventory management system would be established. Yet, the most significant segment would be the one in the domain of avoiding unneeded costs increased due to inaccurate sales plans and lacking/excessive inventories.

As the basic preconditions for the implementation of one such inventory optimization in an enterprise, the following ones can be mentioned: employees must be ready to permanently educate themselves, because the basic knowledge of the planning methods and techniques, as well as in the field of logistics are necessary; the intuitive application of methods is necessary in order to obtain appropriate results; it is necessary that they should have knowledge of working in a software program for operations management and quantitative methods, such as the used program POM-QM for Windows 4.0. (or a similar program solution) for the purpose of supporting the planning process.

We also need to mention that time is an important factor for the implementation of the mentioned solution. It is not realistic to expect that the whole of the process can be ended in a short time period, since the process as a whole requires a certain period of time, in the context of which we should bear in mind the fact that the most time will be dedicated to educating employees.

Apart from that, it is rather important that there should be an essential support provided by the management for the whole of the process. The experiences gained with the employees at the Benlian Food Niš enterprise are very positive ones and they were really very friendly. However, business secret, mainly adhered to by enterprises when their business documentation is concerned, appears to be one of the limiting factors for writing papers of this kind is. When we speak about enterprises which deal with the sale and implementation of program solutions and have to keep business secret in accordance with the executed agreement of business cooperation, then the approach quite differs.

One of the advantages of the proposed optimization is the costs of introduction. The costs of the implementation of the proposed solution are negligible, so that it is impossible to speak about an increase in financial costs. Thus, the used software solution is free of charge, and if it should be bought, no significant funds are required. Ultimately, to have knowledge of the Excel software program in the field of planning is sufficient.

In the end, it should be said that the proposed solution would be very beneficial for the Benlian Food Niš enterprise, as well as for many other enterprises. Given the fact that the management and employees of the majority of Serbian enterprises forecast their sales plans on the basis of their own discretion (feeling) rather than on the basis of some concrete methods or program solutions, simultaneously their forecasts are of a poorer quality. Upon the successful introduction of the proposed solution, there is one thing for sure – there would be an increase in the accuracy (quality) of sales plans.

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ADVANCED ENGINEERING SYSTEMS

METHODOLOGY FOR PERIODIC COMPLIANCE CONTROL OF COMPOSITE RESERVOIRS INSTALLATION IN MOTOR VEHICLES

Dragan Nikolić[1],
Predrag Popović[2],
Zoran Masoničić[1],
Siniša Dragutinović[1],
Predrag Bralović[1],
Branko Spajić[1]

[1]Vinca institute,
Belgrade, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The paper points out the problem of periodic compliance control of composite reservoirs installation in motor vehicles and necessity of designing methodologies in this field. The survey indicated that with expert systems application periodic compliance of composite reservoirs installation can be achieved.

The paper presents the design of an expert system for visual control of composite tanks for storing compressed natural gas as a fuel for motor vehicles, using a shell expert system as a tool to design the knowledge base.

The knowledge base is designed using production rules. The expert system is tested on a concrete example. The research results point to the possibility of periodical compliance control of composite reservoirs installation in motor vehicles using the designed knowledge base. Also, the quality of visual control, reducing the time for analysis and reasoning on the state of composite reservoirs and auxiliary equipment for storing compressed natural gas as a fuel for motor vehicles, is achieved using the designed expert system.

Key words:

reservoirs installation, composite reservoirs, motor vehicles.

1. INTRODUCTION

Pursuant to regulations, standards and rulebooks of the Republic of Serbia, motor vehicles put into traffic must meet the appropriate conditions depending on the vehicle's category, motor fuel they use, their purpose, *etc.* The vehicles using compressed natural gas as motor fuel are subject to special regulations related to technical properties of the equipment and installations for compressed natural gas, to the instructions issued by the vehicle manufacturer, as well as to the Rulebooks on testing of vehicles using compressed natural gas as the vehicle motor fuel. Some of these rulebooks are the following: SRPS EN ISO 11439 – standard for reservoirs designed for storing natural gas under high pressure [17], UN-ECE R110 – rulebook for type approval of vehicles using CNG as motor fuel [15], SRPS ISO 19078 – standard related to control of reservoirs and installations for CNG. Professional and competent staff are performing visual control of composite reservoirs for storing compressed natural gas as a fuel for motor vehicles in accordance with the SRPS ISO 19078 [18] standard, which requires having experience and knowledge on reservoirs, installation, natural gas and visual control.

Correspondence:

Dragan Nikolić

e-mail:
nikolic.dragan1980@gmail.com

However, in order for the procedure of visual control of composite reservoirs to be harmonized and unique when applied by all professional and competent individuals performing such visual control of composite reservoirs for storing CNG, there needs to be a harmonized methodology for periodic control of compliance of composite reservoirs installation in motor vehicles. The necessity towards harmonization of methodology for periodic control of compliance of composite tanks has led the authors to investigate possibilities of information system application to introduce systematic approach into the process of periodic control. The issue under observation is such that it requires information systems to have the knowledge base and possibility to make conclusions based on facts. One of possible directions of research to resolve the issue in question relates to designing an expert system that would enable systematic approach of periodic control of composite tanks for storing compressed natural gas as a fuel for motor vehicles.

2. LITERATURE REVIEW

Authors have noted that there is a frequent appearance of fire in buses using CNG if the reservoirs were compliant with the regulation ECE UN R110 [15]. Authors have stated that improvements are needed in the safety control system.

In the last 10 years, there has been an increase in the use of CNG motor fuel vehicles in Europe due to environment protection reasons [6, 9, 7, 14, 16, 19]. According to 2005 data, it has been estimated that there are about 500,000 vehicles of different types in Europe (buses, passenger vehicles, etc) using CNG as motor fuel.

Most vehicles using CNG in traffic have been recorded in Italy, although the increase in the number of passenger vehicles using CNG is expected in many countries of the European Union due to numerous reliefs that owners of such vehicles get. Natural gas is stored in vehicles in metal or composite reservoirs under 200 bar pressure. Reservoirs in buses are serially connected (reservoir system) and placed at the top of the vehicle.

Compared to liquid fuels, the use of CNG in buses bears additional risks:

- explosion of reservoirs and accompanying pressure waves; reservoir fragments during explosion present individual danger; thermal effects as a result of joined explosion and combustion of released natural gas and ultimately explosive environment joined with pressure and thermal effects.

External causes such as traffic accidents, thermal impacts, etc, present main causes leading to the mentioned reservoir explosion accidents. Although regulations of UN ECE include all preventive actions to prevent accidents on vehicles using CNG as motor fuel from happening, recent accidents in France and Germany indicated the necessity of revision of this topic.

Zamanianet al [20] have indicated that air pollution in the last decade is an extremely great problem of capital and that the use of alternative fuels in vehicles is, therefore, one of solutions. Iran is the second largest global producer of natural gas, so the use of vehicles using CNG as motor fuel is extremely great. However, the authors state that different climatic area and sensitivity of natural gas need to be particularly considered due to probability of explosions. In 2009, Iran had 750,000 recorded vehicles using CNG. Iran is the fourth country in the world as per the number of vehicles using CNG. In order to examine the most frequent causes of accidents in vehicles using CNG, the authors used the Delfi method, i.e. a series of questionnaires in three series (where the results of the first series of questions were used to generate the second series of questions and so on successively in three series).

The first step in the examination was identification of experts who will provide answers to questions. Experts are professionals for CNG installation and safety who work at automobile factories, traffic police, etc. Questions asked to experts were to identify the most important parts of CNG system:

- Reservoir/s;
- Pressure indicator or fuel level indicator;
- Pressure reduction device (with temperature activation);
- Automatic valve of the reservoir;
- Manual valve;
- Pressure regulator;
- Gas flow regulator;
- Excess flow limiting device;
- Gas-air mixer (carburetor or injector);
- Filling unit or filling connector;
- Flexible fuel conduits;
- Rigid fuel conduits;
- Electronic control unit;
- Connectors;
- Gas-impermeable housing for components installed in the trunk and passenger sections. If the housing can be destroyed in fire, the pressure

reduction device must be included in that gas-impermeable housing

- Non-return valve;
- Safety valve;
- CNG filter;
- Pressure and/or temperature transducer;
- Fuel selection system and electric system.
- Additional automatic valve may be combined with pressure regulator.

The following step in the research has been related to experts awarding evaluation to each component of the CNG system per level of importance based on their experience.

The experts considered the following components to be the most important from the safety aspect: safety valve, connector and rigid conduits. At the same time, these are also the critical elements where ruptures, leaks, *etc*, may occur.

The existing literature has no recorded research on application of expert systems for visual control of tanks for storing compressed natural gas, but there are papers on application of expert systems in diagnostics of malfunctions on motor vehicles [8, 13]. There are also several patents related to designing of expert systems in motor vehicles [1, 3, 10, 12].

3. DEVELOPING METHODHOLOGY

The development of methodology for harmonization of periodic control of composite reservoirs installation in motor vehicles refers to defining methodological steps by which any control should be performed. Based on the rulebook R110 that refers to type approval of vehicles using CNG as motor fuel and long-term experience in the control of installation of composite reservoirs in motor vehicles, the following methodological steps have been formulated:

- preparatory activities,
- check of reservoir marking,
- control of installation of reservoir,
- control of reservoir installations,
- identification of reservoir surface damages,
- identification of reservoir impact damages,
- identification of reservoir thermal damages,
- identification of reservoir abrasive damages,
- identification of reservoir chemical damages,

- identification of reservoir atmospheric damages,
- report on the performed control.

In order to perform the stated methodological steps, a set of questions has been defined for the person authorized to perform visual control of composite reservoirs to ask in the stated scope and order to establish harmonization of periodic visual control of composite reservoir installation in motor vehicles. The defined list of control questions has been based on the rulebook R110 that refers to type approval of vehicles using CNG as motor fuel and long-term experience in the control of installation of composite reservoirs in motor vehicles, in the following way:

- Q1. Determining if preparatory activities have been performed (removal of dust from the reservoir, installation area) in order to be able to perform the visual control procedure;
- Q2. Determining if the reservoir marking has been performed in accordance with the standard requirements;
- Q3. Surveying the owner on any conditions or incidents that might have led to damages to the reservoir or installations;
- Q4. Determining if all installation blocks, girders and other components are in good condition and properly secured;
- Q5. Determining if the installation has been executed as per the current regulations;
- Q6. Determining if all components of the installation have been tightened and secured;
- Q7. Determining if the reservoir installation is properly vented;
- Q8. Determining if the line from PRD unit is designed for high pressure;
- Q9. Determining if the PRD unit is in good condition;
- Q10. Determining if the line connected to the reservoir is made to enable reservoir dilatations caused by internal pressure;
- Q11. Determining if there are damages to the installations caused by chemicals, abrasion, humidity, etc;
- Q12. Determining if the line connected to the vehicle is properly fixed with appropriate rubber backings in the span of about 60 cm;
- Q13. Perform the procedure of visual control of reservoir surface for traces of surface damages

(if there are traces of damages, determine if their depth is under 0.25mm);

- ◆ Q14. Perform the procedure of visual control of reservoir surface for traces of impact damages (if there are traces of damages, determine if their depth is under 0.25mm);

- ◆ Q15. Perform the procedure of visual control of reservoir surface for traces of abrasion damages (if there are traces of damages, determine if their depth is under 0.25mm);

- ◆ Q16. Perform the procedure of visual control of reservoir surface for traces of thermal damages;

- ◆ Q17. Perform the procedure of visual control of reservoir surface for traces of chemical damages;

- ◆ Q18. Perform the procedure of visual control of reservoir surface for traces of atmospheric damages;

- ◆ Q19. Determining if there has been the reservoir discoloration, if there are bubbles, caps, etc.

- ◆ Q20. Determining if there is a minimum of 12.5mm of gap between the reservoirs in installed position (gap not less than 9.5mm is recommended for guards);

- ◆ Apply new control label if all Question's (Q1-Q20) answers were Yes.

The stated methodological steps that would lead to harmonization of the procedure of periodic visual control of composite reservoirs installation in motors vehicles are the basis for building an expert system. The defined list of control questions has been rephrased into production rules in IF-THEN form. Answers to these questions, which are of the YES/NO form, are provided by a user [4].Connecting rules has been performed by chaining them in forward [11]. The rules are chained forwards up to the last one only if all criteria have been met for issuing the certificate on performed periodic control. If any of the control questions is not met, the expert system shall issue the final advice or conclusion to suspend the control procedure with the explanation that it is necessary to perform an appropriate activity of replacement, installation, tightening or repair at the authorized service. With rules chained in this way we obtained the inference mechanism represented by a decision tree, fig.1.

The expert system has been tested on a concrete example of composite reservoir. The Figure 2 presents a fragment of inference.
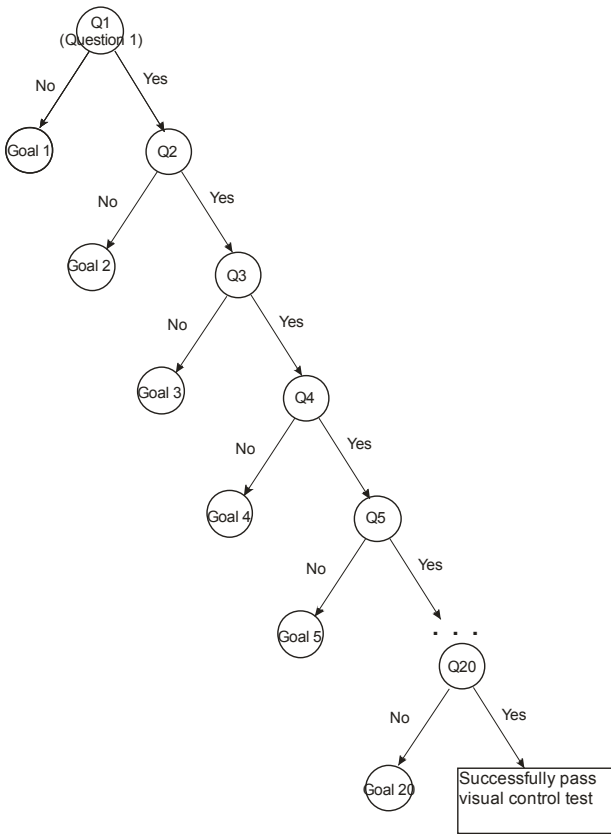
Figure 1. Decision tree

IF Q1:   Have preparatory activities been performed (removal of dust from the reservoir, installation area) in order to be able to perform the visual control procedure? Yes

AND Q2: Has reservoir marking been performed in accordance with the standard requirements? Yes

AND Q3: Has surveying the owner on any conditions or incidents that might have led to damages to the reservoir or installations been performed? Yes

AND Q4: Are all installation blocks, girders and other components in good condition and properly secured? No

THEN

GOAL: Please secure all installation blocks, girders and other components and replace blocks/ girders/ components that are not in good condition and then proceed with visual control

Figure 2. Fragemnt of inference

Based on the specific answers for the tank evaluated in the process of testing of the expert system for visual control of composite reservoirs for storing compressed natural gas as a fuel in motor vehicles, we obtained the finding that the installation blocks, girders and other components are not in good condition and/or properly secured, so expert system has suggested to secure all components if are they not well secured or replace components which are not in good condition, and then to proceed with visual control inspection.

4. CONCLUSION

The research demonstrated that the control of composite reservoirs for storing compressed natural gas as fuel in motor vehicles is an extremely present problem having in mind the number of motor vehicles in traffic, as well as forecasts of the number of motor vehicles to be in traffic in the forthcoming period. Having in mind the existing legal regulations in our country and the problem of non-compliance of the procedure for visual control of composite tanks for storing compressed natural gas as a fuel in motor vehicles at different motor vehicles testing centers in our country, the proposal is to further develop the methodology for harmonization of periodic visual control of composite reservoirs installation in motor vehicles.

Advantages of application of expert system for visual control of composite tanks for storing compressed gas as a fuel in motor vehicles are reflected in the systematic approach of the process for performing periodic visual control, while disadvantages of the same are reflected in the necessity of testing the designed solution and making conclusions on potential problems in exploitation based on operation in realistic conditions.

Further development of the expert system for visual control of composite tanks for storing compressed gas as a fuel in motor vehicles refers to addition of visual presentations of the observed installation system based on which the expert system could perform diagnostics. Likewise, extending the list of rules and improving the existing decision-making structure are also possible development directions for the expert system for visual control of composite tanks in motor vehicles.

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ADVANCED ENGINEERING SYSTEMS

DEVELOPMENT OF OPEN-SOURCE SOFTWARE FOR ARABIC TEXT STEMMING AND CLASSIFICATION

Ashrf Ali Nasef,
Marina Marjanović-Jakovljević

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

This paper presents implementation of a software tool for Arabic text stemming and classification. The software tool is based on open source implementation of the Lucene based Light stemmer for Arabic language and it enables stemming and classification into 12 categories (religion, economics, sports, science, computers, history, medicine, entertainment, engineering, literature, politics and food).

Key words:

arabic language, text mining, stemming, text classification, open source code.

1. INTRODUCTION AND THEORETICAL BACKGROUND

The Arabic language is the seventh most frequently used language worldwide. There are more than 310 million native Arabic speakers scattered throughout the world.

It is considered that over 38 million Arabic people use the Internet at least once a month, while the total Internet penetration (the relation between the overall population and the users of the Internet) extended to 11.1% [1]. This number presents just half of the global average (21.9%). Nevertheless, there are indicators showing that this number will grow rapidly. The largest number of Internet users comes from Egypt (8.6 million), then Morocco (7.3 million) as well as Saudi Arabia (6.2 million). Concerning Libya, Internet penetration was rather low, *e.g.* in 2010 it was slightly below 14% (13.77%) [2]. But, the growth of Internet users in Libya has almost an exponential trend for the period 1999-2010 [1].

It wasn't until the early 90's when the Arabic IR research developed. The representation of Arabic text and coding were in the center of the researchers' attention prior to that. There has been a certain number of studies about various methodologies of integrating morphology: root, stem, light stem and no-stemming and in addition to that, the use of non-rule based statistical models or n-gram models.

The analysis of Arabic text mining and Arabic IR research has shown that, due to language specifics, Arabic language text mining task can be quite challenging compared to other languages. Even though extensive research activities regarding this subject matter have been performed, which results in significant achievements, there is still a huge amount of work to be done in order to align Arabic language IR and text mining tools with

Correspondence:

Ashrf Ali Nasef

e-mail:
ashraf8259@yahoo.com

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those existing for Western widely spoken languages such as English, German, French and Spanish. Arabic language stemming is a task that requires research as well Arabic text classification. Also, open source software tools/components for Arabic text mining are at infancy stage, as can be seen from the most prominent relevant open source project "*Arabic Computational Linguistics*" [3].

Concerning the rapid expansion of the Internet and the fact that it's mostly used nowadays to search for information, there is a need to develop tools for Arabic text mining. Since the Arabic language possesses a complex morphological structure, this will be a demanding task as the next section will show.

2. ARABIC LANGUAGE AND ARABIC STEMMERS

Arabic language

Arabic letters

Words in the Arabic language are constituted of twenty-nine constant letters. Arabic letters are classified into two types: letters of signification and letters of construction. We use letters of signification for sentence formation and modification of nouns and verbs, while letters of construction are used for word formation. Arabic prefixes can be formed of letters of signification and they can be one letter or a combination of two or more. Additionally, the shape of most letters is determined by their position in a sentence, as well as by the adjacent letters.

Arabic Affixes

Affixes in the Arabic language could be a letter or a letter combination. For example, certain suffixes are added to words in order to change their form from singular to plural, while other suffixes are added to imply masculine or feminine gender. By adding the affixes to a noun, we can get 1440 different verb forms. Affixes are classified according to their position in the word: prefixes are added to the beginning of the word, suffixes to the end of the word, while infixes are added into the middle of the word.

Arabic vowels

The Arabic language has vowels (short, long and double) and consonants, but unlike in English, in the Arabic language, the main (short) vowels are represented by a symbol and not by a letter. The symbols are added below or above the text. Short vowels in the Arabic language are very powerful. They determine the pronunciation of the word and can also change its meaning. In Arabic modern writing, these short vowels are omitted so Arabic writing can be vocalized or unvocalized. This omission of short vowels causes problems when the words are placed into a certain context and this is a large barrier for Arabic text processing.

Arabic root base system

The Arabic language is a Semitic language with a root system foundation. Unlike English, roots in Arabic can only be verbs. These roots are mostly 3 literal words and it is supposed that there are about 10000 independent roots in the Arabic language. Regular and irregular tenses, nouns or the adjectives are created by adding suffixes, infixes or prefixes. Words that originate from the same root don't have to be related semantically, whereas one root can also have various meanings.

Nouns and pronouns

In Arabic, a noun is derived from the root by applying specific patterns. Nouns in the Arabic language can at the same time possess a regular and irregular plural, which means that Arabic nouns have duals. Nouns in the Arabic language possess either feminine or masculine gender. The Arabic language pronouns are classified into: personal pronouns, demonstrative pronouns, possessive pronouns, and relative pronouns. We use personal pronouns instead of nouns. Demonstrative pronouns are analogous to this/that and these/those. Relative pronouns are analogous to English who, which, what *etc.* and as far as Arabic text processing is concerned they are considered to be stop words. Alternatively, possessive and object pronouns demonstrate that some pronouns are word suffixes. Possessive pronouns are added to nouns to refer to possession, or to turn them into definite, while object pronouns are added to verbs.

Arabic Stemmers

According to [5]: "As far as the information retrieval and linguistic morphology are concerned, stemming is the activity of reduction of inflected (or derived in some

cases) words to their base, root or stem - typically the written form of a word."

There are two different categories of Arabic stemmers according to the necessary level of analysis. They are classified into stem-based or root-based stemmers. A morpheme or a combination of linked morphemes to which an affix can be added is called a stem. On the other hand, a root is the initial word form without any alteration process. Khoja's stemmer represents the most famous Arabic stemmer. In addition to that, Light stemmers with light 1, 2, 3, 8 and 10 stemmers are also widely known.

Khoja's Stemmer

The Khoja algorithm is used for the removal of suffixes, prefixes and infixes, whereas pattern matching is used to isolate roots from the dictionary. Khoja's stemmer algorithm as presented in [4] consists of the following steps:

1. Replace initial إ أ آ with ا

2. Eliminate stop words.

3. Eliminate punctuation, diacritics and non-letter forms.

4. Eliminate definite articles from word beginning.

5. Eliminate the letter (و) from the word beginning and (ة) from the word end

6. Eliminate prefixes and suffixes

7. Make a comparison between the words in the dictionary and the obtained word. If the obtained root doesn't have a meaning, the initial word is returned without any modifications

Certain problems are present in the algorithm, particularly regarding proper nouns or broken plurals. Furthermore, the dictionary needed to be maintained regularly to add new words.

Light stemmers

Light stemmers containing light 1, 2, 3, 8 and 10 have shown to outperform previous light-stemmers as well as Khoja's root based stemmer [4]. Light stemmers don't cope with infixes or certain patterns. It simply removes prefixes and/or suffixes. Larkey's light 10 stemmer algorithm [7] as presented in [4] consists of the following steps:

1. Eliminate stop words,

2. Eliminate punctuation, diacritics and non-letter forms, as well as the non-Arabic forms,

3. Initial إ أ آ is replaced with ا

4. Switch ىto يandةto ه

5. Eliminate the letter و from the word beginning just in case that the obtained word has more than three letters,

6. Eliminate definite articles ال . لاو . لاف. لاك .لاب . بال from the word beginning just in case that the obtained word has two or more than two letters,

7. Eliminate the suffixes تا . نو . ني . هي . ةي . ه . ة. ي . اه . نا . from the word end (longer one first) just in case that the obtained word has two or more than two letters.

Many suffixes are ignored by the Larkey's light stemmer, which can be the reason for a high rate of understemming errors. Moreover, the suffix and prefix list could be original letters.

3. OPEN SOURCE BASED ARABIC STEMMING AND CLASIFICATION TOOL

Using the Lucene based Arabic light stemmer from Arabic Computational Linguistics project [3], we've constructed an Arabic stemming tool that helped us to develop the Arabic language classifier tool additionally.

In this work, a brief outline of the idea will be presented.

Arabic stemming tool prompts the user for a file containing Arabic text and then stems and displays all words included in the text. The program consists of three parts: graphical interface, file parser and the stemmer.

Graphical interface consists of the initial dialog used to browse a file and start the stemming and the results display window. The initial dialog provides for selecting the file containing the text to be stemmed.

File parser is a class that takes the chosen file and parses its content into an array of words and turns the content of a file into an array of strings. These strings will be stemmed later on. Line by line of a text form of the file is read by the class, whereas the StringTokenizer class is used to separate words. The characters that are excluded from the final results are : .,!?;:"() and all white spaces.

The stemmer consists of Arabic normalizer, Arabic stemmer and utilities for processing character arrays.

The architecture of the program is shown in Figure 1.

Figure 1. The architecture of the Arabic stemmer

Two screen shots illustrating user interface are presented in Figures 2 and 3.

Figure 2. Graphical interface for selecting file to be stemmed

Figure 3. Graphical interface for displaying stemming results

Classification tool

The classifier prompts the user to input a folder and classifies Arabic files from the selected folder into 12 categories: religion, economics, sports, science, computers, history, medicine, entertainment, engineering, literature, politics and food. The classifier firstly stems the words from each individual document and then finds two keywords in each document. Using the database dictionary where all words are tagged, documents can be classified based on their key words. The classifier also has a training mode which allows the user to tag newly found words.

The architecture of Arabic classifier tool is depicted in Figure 4.
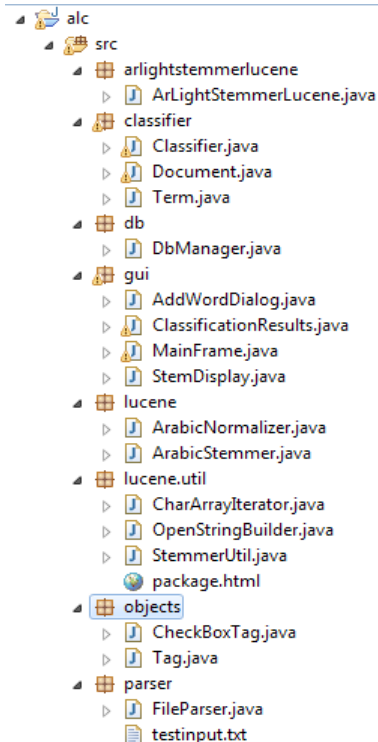
Fig. 4. The architecture of the Arabic classifier

The classifier consists of 5 parts: the stemmer and the file parser both described in the previous chapter, the interface to the database, the graphical interface for prompting and displaying the results and the classifier.

The interface to the database is in the file DbManager.java, a singleton with the methods for adding and selecting items from the database.

Added classes to the graphical interface are MainFrame.java which is the opening dialog, AddWordDialog.java which is the dialog for tagging newly found words and the class which is a frame for displaying results- ClassificationResults.java.

The Classifier.java class is the class that does the actual classification. Important classes for classification are Document.java and Term.java. These classes abstract the document and the term in text mining.

Two screen shots illustrating user interface are presented in Figures 5, 6 and 7.
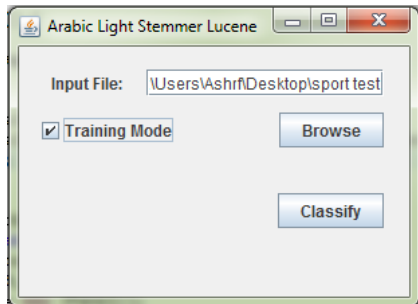
Figure 5. Graphical Interface for Choosing the folder containing the File to be Classified or used for Training
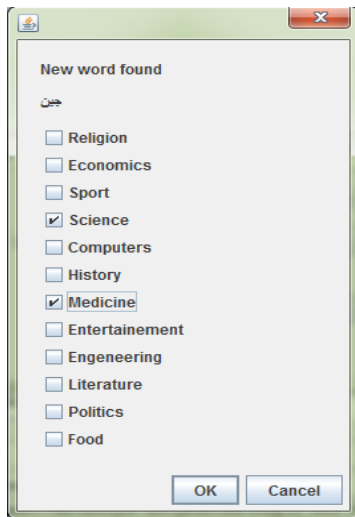
Figure 6. Graphical Interface for Tagging words in the Training Mode
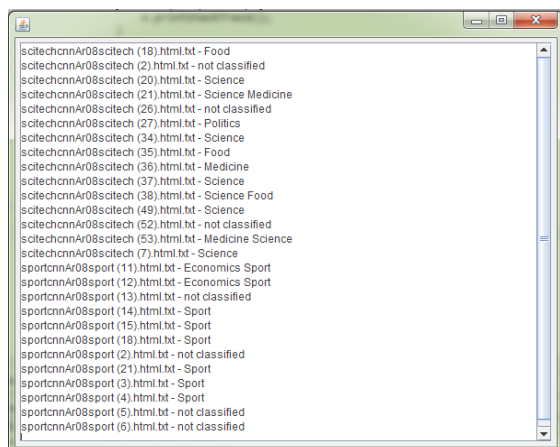
Figure 7. Graphical Interface for Display Results

4. CONCLUSION AND FUTURE WORK

The aim of this paper was to present the author's work on developing software and graphical interface for Arabic text stemming and classification.

Based on the previous analysis of literature sources, the Internet as searched for available open source solutions aimed at Arabic text mining, and suitable (most complete/mature solution) open source software components for constructing software tool for Arabic text stemming and classification were selected and integrated to form a tool prototype. Finally, the prototype was tested against planned functionalities.

Based on the analysis concerning Arabic text mining and Arabic IR research, it can be concluded that Arabic language text mining can be quite difficult compared to other languages, mainly due to language specifics. Even though extensive research activities regarding this subject matter exist, which results in significant achievements, there is still a huge amount of work to be done in order to align Arabic language IR and text mining tools with those existing for Western widely spoken languages such as English, German, French and Spanish. The Arabic language stemming is one task that requires further research as well as Arabic text classification. Also, open source software tools/components for Arabic text mining are at infancy stage, as can be seen from the most prominent relevant open source project "Arabic Computational Linguistics".

Taking into account the results achieved so far and conclusions derived by this master thesis, further research could be divided into two directions. One line is further research concerning Arabic computational linguistics and Arabic text mining (developing different approaches of incorporating language morphology), while the other line is development of open source software tools/components aimed at Arabic text mining and their applications to various fields such as spam filtering, creating suggestion and recommendations, monitoring public opinions, *etc*.

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ADVANCED ENGINEERING SYSTEMS

SOFTWARE FOR MODELING, ANALYSIS AND DESIGN OF FILTERS WITH LC SECTIONS AND QUARTZ CRYSTALS

Miroslav Lutovac[1],
Vladimir Mladenović[2]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]University of Kragujevac,
Faculty of Technical Sciences,
Čačak, Serbia

Abstract:

Filters that consist of LC sections and quartz crystals can be modelled by LC equivalent sections and represented as rational functions of very high order. In this paper, we present software that can be used as the template notebook for modeling, analysis and design of the known filter structure. A method for automated generation of schematic model of crystal filter as a ladder LC structure is described. The filter transfer function can be derived as closed-form expression from schematic model so that other analyses can be performed, such as sensitivity analysis and parameter optimization in order to satisfy the desired filter specifications.

Key words:

crystal filters, LC filter, quartz filter.

1. INTRODUCTION

The analysis and design of lossless LC filters are extensively covered in numerous books and papers (Lutovac *et al.*, 2015). That was the main reason to use the established methodology and developed procedures to design other types of filters. Manual derivation of transfer functions is possible only for low-order circuits.

The design and analysis of filters with small number of elements can also be time-consuming in the case when each element is replaced with a more complex circuit model. Although numeric software can be used for completing the most frequently used task, the symbolic approach shows benefits in optimization.

Application of conventional software for the design and analysis of complex filter structure is subject to errors due to the limited accuracy of numerical methods. The analysis of the impact on the value of certain parameters can be done by inverse engineering, but they often make mistakes due to the limited accuracy. In the existing software solutions, only approximate and empirical methods were used.

The problem can be solved exactly using computer algebraic methods so that all filter parameters can be described using symbols (Wolfram,

Correspondence:

Miroslav Lutovac

e-mail:

mlutovac@singidunum.ac.rs

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2015). Symbols can be substituted by numeric values only when it is necessary, for example, for plotting the graphics of some filter functions. When the complexity of the functions is extremely large, certain parameters can be represented as a ratio of integers, and thus retain the accuracy of the final results.

The fact that all parameters are symbols (including complex frequency) provides the possibility to derive the frequency of extremes, to approximate function in a certain range of interest, to replace each element with the more complex electrical model, or to compute the sensitivity function to element values. In this way, the analysis of the impact of certain parameters is facilitated and optimal value of some parameters can be computed under some constrains. As an example, the resonant frequency of a complex filter can be expressed in terms of some filter elements.

2. NEW SOFTWARE - TECHNICAL SOLUTION

The technical solution – new software (released in 2015) is tested at the Institute "Mihajlo Pupin" in Belgrade as a scientific result of the project TR32048. The authors of this software are Miroslav Lutovac, Snežana Dedić - Nešić, Irini Reljin, Ana Gavrovska, and Dubravka Jevtić. This paper presents the main principles that were used for developing this software.

Software is distributed in the form of notebook, with all descriptions and program. The first part of the notebook consists of interactive drawing schemes where crystal units are described as impedance. All the essential characteristics can be automatically derived from the scheme. Verification was done using numeric software.

Notebook Format

The main part of the program looks like a separate file formatted as a chapter in the book, with the title, the subtitle and text descriptions, as shown in Figure 1.
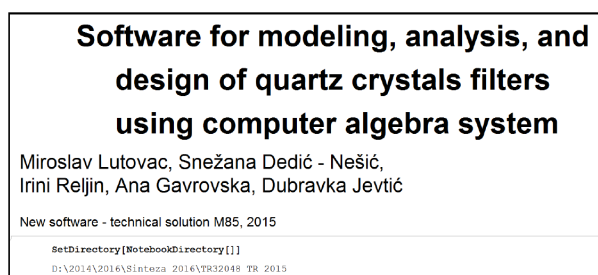
Figure 1. The first part of the notebook with title and subtitle.

Loading Knowledge

The special folder contains the files with the knowledge that is derived and tested in another project, also available as the technical solution for the project TR32048 (developed in 2014).

Figure 2 presents part of knowledge that contains the model of quartz crystal unit as impedance, real part and the imaginary part.

Figure 3 shows part of the program that loads knowledge from several files. The purpose of one knowledge file is to clear predefined variable definitions so that new variables can be used without interfering with previous program executions. The last file contains the pure functions that will be used for computations in this main program.

Figure 2. Knowledge thas is saved in separate file and loaded in the notebook.

Figure 3. Loading knowledge in the main program.

Verification of Knowledge and Characteristics

After loading the knowledge from the third file cu2015.m, the values of elements can be represented as ratio of integers, and thus all further derivations are exact.

Figure 4 illustrates that the pure function entered into the main program (that contains previously saved knowledge of the imaginary part of the impedance of the crystal unit) can be used in the same manner as built-in function.

This approach is particularly useful when the derived functions are already verified, and it is not necessary to re-check the accuracy of the formula. Figure 4 is used in this program just to perform the comparison with the previously published results and to show that the function curve is correct with identical numerical values of parameters.
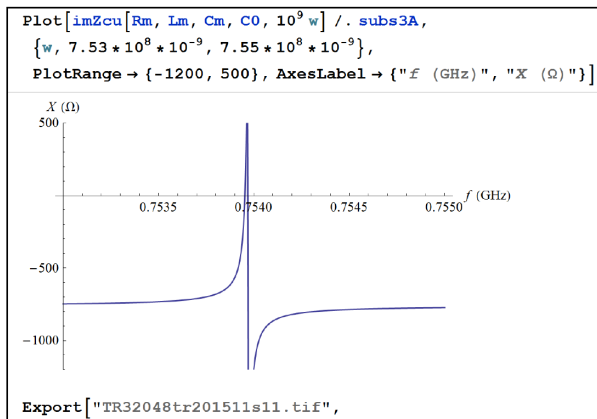
Figure 4. Drawing characteristics of function loaded into the main program.

Using Knowledge for Deriving new Properties

The last line of the code in Fig. 4 shows how the resulting graphics can be exported in the corresponding figure format with the required resolution.
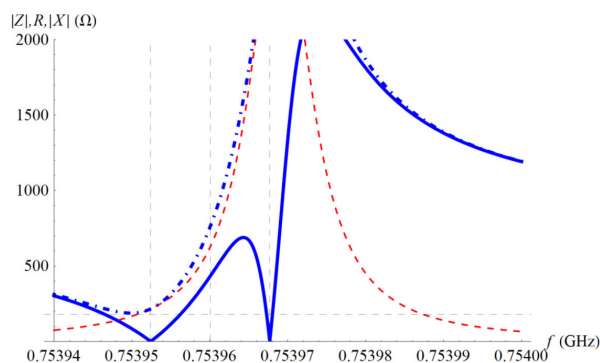
Figure 5. Illustrating more characteristics of the crystal unit.

Figure 5 presents the impedance, real and imaginary part of impedance of the crystal unit, where all main features can be observed, such as the frequency when the imaginary part is equal to zero or where there is the minimum of the impedance.
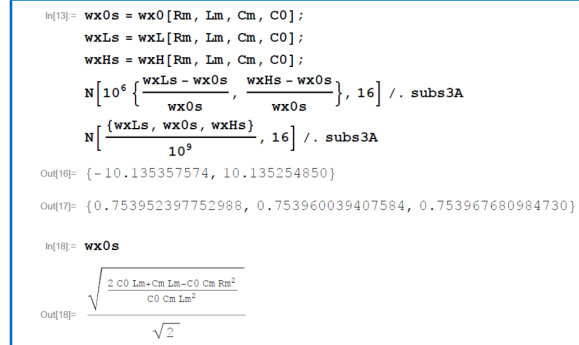
Figure 6. Calculation of the characteristic frequency of the crystal unit.
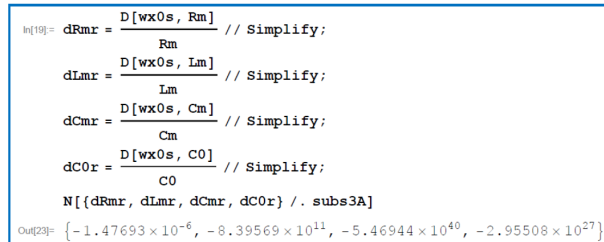
Figure 7. Calculation of the sensitivity of the crystal unit.

Figure 6 shows how the pure functions that are loaded as knowledge can be used for deriving other function in the symbolic form, and how to compute for specific numeric parameters. Each function can be called with the symbolic values of the arguments, which makes it possible to calculate some other functions such as frequency sensitivity to changes in the parameters of the crystal units, as illustrated in Figure 7.

When numerical values have to be computed, a substitution rule is performed using notation "/.".

3. EMBEDDING KNOWLEDGE INTO SYSTEM

The second part of the software uses the knowledge of the crystal units for the design of more complex structures. For example, a filter which consists of 6 quartz crystal units, such that the two individual crystals are of type ZA, two of type IA, and one type ZB and ZC

(different types means the same structure but different element values). Other components of the filter as resistors, capacitors, and coils, are marked in the figures with symbolic values.
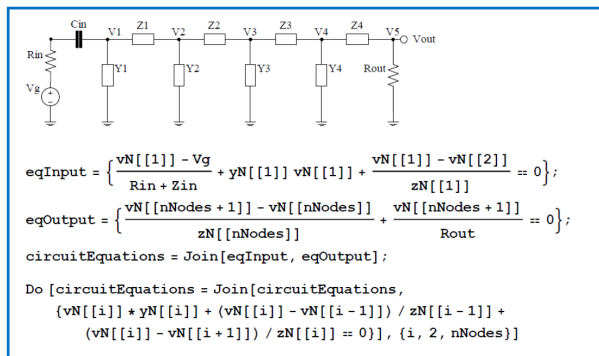
Figure 8. Automated drawing and setting up a system of equations.

The basic concept of this software solution is to define the system structure, in this case a ladder structure, and to automate the design procedure. The more general structure can be modified using substitution rules, where each element of the ladder structure is replaced with more complex element models. The initial structure can be used for setting the system of equations or drawing the system, so that technical documentation is prepared during the design stage. Knowledge of some elements (such as mathematical and electrical model of crystal units) is tested in the first part of the software description. This way, we avoid typesetting errors because electrical schematic and mathematical representations are the result of the same initial system structure.

For systems that have a repeated structure, the list of specification for schematic drawings and description of the system by equations are done using the simple program such as that in Figure 8.

Knowledge with drawing functions can also be saved in a separate file and loaded into the main program before drawing the system. For drawing the system, different symbolic names can be used. The names of the variables can be prepared as a separate substitution list, and the same replacement rules can be used for drawing and solving the system. As solving relies on symbolic manipulation, substitution of the simple model with the more complex model is performed at the final stage.

After solving the equations, the obtained result of the transfer function can be so complex that it cannot be displayed, as seen in Figure 9. More than 5500 symbols are omitted in the reported result. This example shows that it is impractical manual solving of the system.
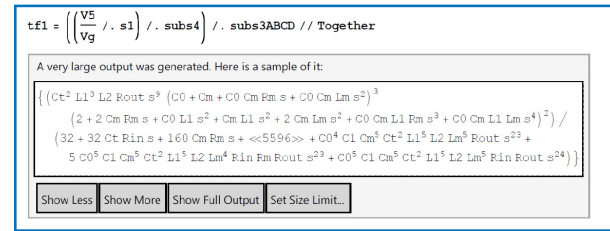
Figure 9. Symbolic result that cannot be displayed.
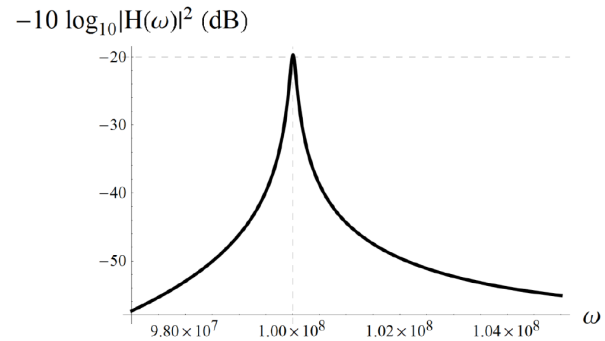
Figure 10. Filter attenuation of the crystal filter.

In a similar manner, the magnitude function and the filter attenuation can be derived, as shown in Figure 10.

Although expressions are very complex, they may be used for further derivations, such as the sensitivity of the magnitude function with respect to any filter parameters. Graphics of sensitivity with respect to three elements of the filter are shown in Figures 11, 12, and 13. It is important to notice that all three sensitivities are equal to zero at the resonant frequency. This means that the low-sensitivity properties of lossless ladder structures are retained in the more complex system when passive components are replaced by crystal units.
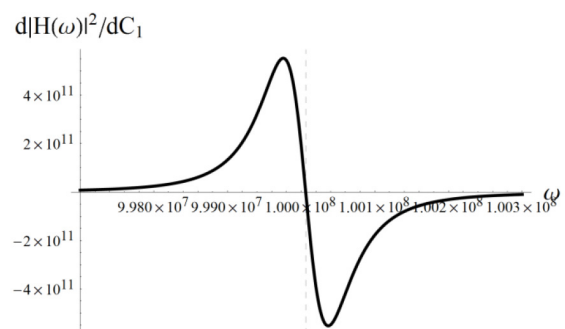
Figure 11. The derived sensitivity with respect to C_1.

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$d|H(\omega)|^2/dL_1$
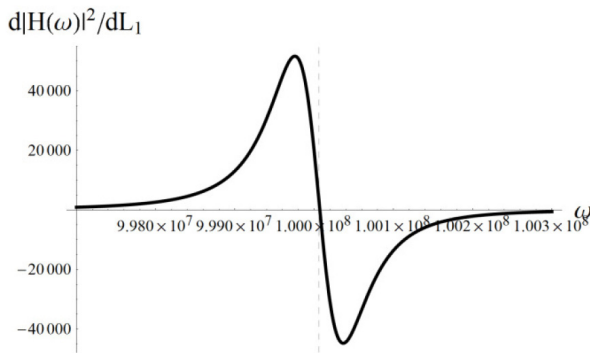
Figure 12. The derived sensitivity with respect to L_1.

$d|H(\omega)|^2/dL_2$
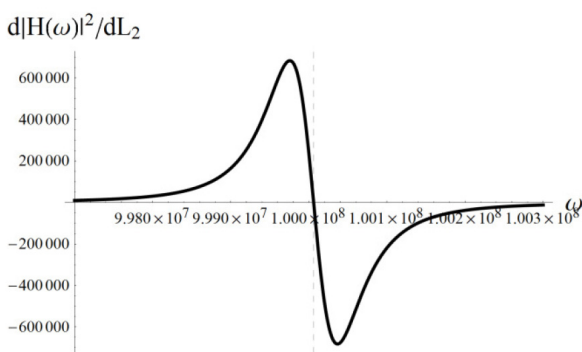
Figure 13. The derived sensitivity with respect to C_2.

$-10\log_{10}|H(\omega)|^2$ (dB)
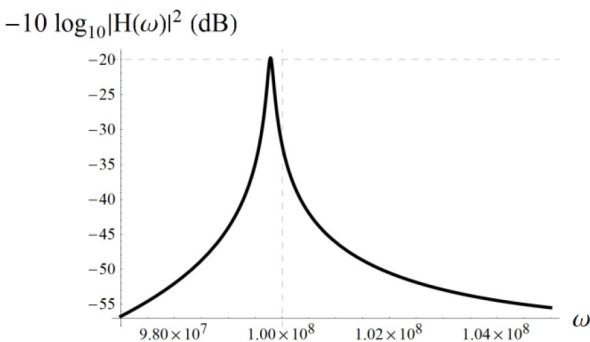
Figure 14. Magnitude response for increased value C_1 of 1.5%.

The robustness of the magnitude function with respect to element tolerances can be proved by drawing magnitude response for different element values, as illustrated in Figures 14, 15, and 16. This result is important for fabrication of crystal filter, because it provides the influence of each element and how to organize testing and tuning strategy.

$-10\log_{10}|H(\omega)|^2$ (dB)
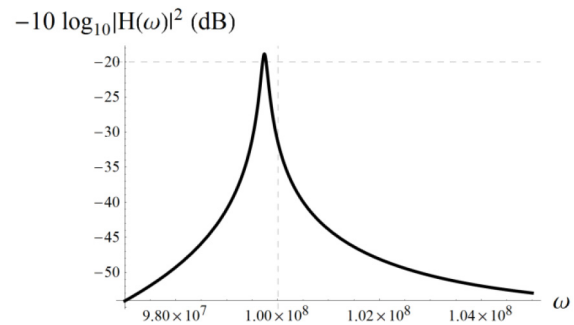
Figure 15. Magnitude response for increased value L_1 of 8%.

$-10\log_{10}|H(\omega)|^2$ (dB)
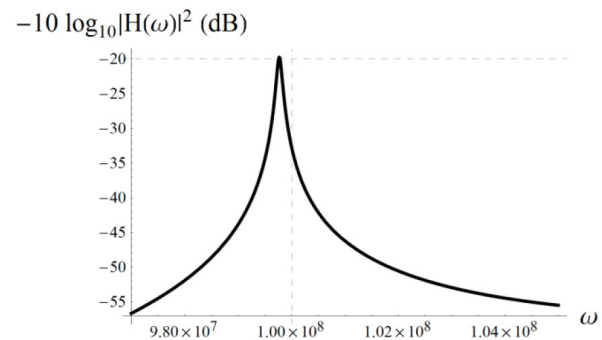
Figure 16. Magnitude response for increased value C_2 of 0.5%.

4. SUMMARY

The software described in this paper presents the referenced document that contains all required knowledge and procedures for modeling, analysis and design of quartz crystals filters. After entering only a number of filter sections, the rest of the procedure is automated. The future work is to provide graphical user interface, while the knowledge from this software can be saved as a separate file.

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MOOC AS AN INSTRUMENT OF INFORMAL AND LIFELONG LEARNING

Srđan Trajković[1],

Dragan Cvetković[2],

Vladan Radivojević[1]

[1]College of professional Studies
Belgrade polytechnics,
Belgrade, Serbia

[2]Singidunum University,
Belgrade, Serbia

Abstract:
This paper has a purpose to inform and draw attention to MOOC as an instrument of education which can be used in various ways. We will present the basic facts of MOOC and its possibilities. The elementary facts about participants will be shown in a manner that will help us to see opportunities for the improvement of MOOC as a serious learning platform.

Key words:
MOOC, MOOC providers, MOOC organization, learning.

1. INTRODUCTION

Over the last several years, MOOC has attracted considerable attention as an instrument of education. They have been developed in order to develop and attract the attention of potential students at some Universities. Nonetheless, they have rapidly become a tool for education and learning.

The first significant characteristic is that a very big number of students can be included in any course of their interest. Another important feature is that the time and place for attending the course is not essential. It can be anywhere in the world and at any time zone. Also, communication with other students and lecturers is always possible by any kind of communication technologies. In some ways, students and a lecturer in their mutual communication manage to come to new knowledge in some specific areas.

Also, some important universities and educational institutions have recently developed specific platform for this way of learning. So, we are introduced to Coursera, Udacity, edX and other platforms. We will also explain a different kinds of MOOC.

2. WHAT IS MOOC?

MOOC is basically an online course which has no limitation in number of participants and includes no fee for registered participants. Even the name MOOC defines its purpose – **M**assive **O**nline **O**pen **C**ourse. This implies that as many participants as registered can follow all lessons and they do not have to pay any fee.

Correspondence:
Srđan Trajković

e-mail:
strajkovic@politehnika.edu.rs

Also, all lessons are online on the web so that the participants can access them at any time.

When we discus MOOC-s for first MOOC, we mean a course which was performed in year 2008 by the name "Connectivism and Connective Knowledge" (also known as "CCK08"). After this course, a lot of different MOOCs were developed. Significant increase in the number of MOOCs was recorded in the period 2012-2013. Very large number of educators consider this way of learning as significant improvement of learning methods.

In the beginning, all courses were developed like discussion between organizer of course and other participants as equal. Of course, the organizer implied thesis for discus as primary learning materials.

Figure 1. MOOC – massive open online courses

In latter periods, MOOC developed in two ways: cMOOC and xMOOC. The key difference between them is in the principled approach for learners. In cMOOC, the learners aggregate to a base of knowledge with their own experience in such way that the base of knowledge is richer with deferent type of information connected to primary thesis of course. On the contrary, xMOOCs are based more on classical type of courses, but all materials (lectures, readings *etc*) are free for registered students and dispositional for student at any time and from any place.

3. PROVIDERS OF MOOC

In late years of 20th century was enrolled a movement that propagate Open Educational Resources (OER). This was the idea that knowledge is public good, and that every person have right to be educated. In such manner of thinking many educators begin to organize courses for free. Among others even MIT and Stanford universities.

As MOOCs appear in educational sphere many of educators initiate their own platforms for providing such services.

The best known providers of MOOC are Coursera, P2PU, Udacity, Udemy and edX.

For example, Stanford and Princeton Universities stand behind Coursera, and Georgia Institute of Technology, San Jose State University, Google, Salesforce.com, Facebook, Cloudera, Nvidia, Autodesk, Cadence support Udacity.

So, we can see that very big "players" are involved in this form of education.

Figure 2. Most significant MOOC providers

Unfortunately, there is no provider for MOOC in Serbia for courses in our language, but the MOOC can be launched even by individual. Maybe we can consider a possibility to create our Serbian platform for MOOC. This will make a great opportunity for universities and maybe government to establish a base for free learning on a voluntary basis.

4. ORGANIZATION OF MOOC

An organization of MOOC is not that difficult. It can be organized by one person or group of people with the same interest.

The first step would be to choose the theme of MOOC. Very often MOOC starts with one goal and then it develops in different direction. Organizers of MOOC must take a good preparation including the research of potential learners and how developed knowledge of the given topics of course are in targeted group of listeners.

The second step is good advertisement of course, so that the number of listeners can be very large. This is crucial for every MOOC. The larger number of participants the better discussion and exchange of opinions during the course. In that manner, the development of knowledge will justify organization of such course.

In the next step, the organiser of MOOC must choose a communication platform for the course. That means that organizer must choose application for exchange of information and data between participants and organizer. Communication can be based on the Internet, Web, android platform or some other platform. Very often, it is a combination of all the above.

One of important steps of organization of courses is choosing a way of identification and authentification of participants in the course. The course is open and everyone can join the course. it is also good to know the participants, are, which group of population is interested in course, in the age structure of participants *etc*.

Also, identification and authentication are important if organizers want to test the final level of knowledge of their participants. Some participants wish to get a certificate of passing the course and that is also a reason to make an identification and authentication of participants.

5. PARTICIPANTS OF MOOC AND THEIR MOTIVATION

Who are the participants of MOOC, what is their motivation? How do they attend the course? How many of them has finished the course?

First of all, any possible participant has to possess elementary computer literacy. He should be good user of the Internet and web applications he uses in communication with other participants.

Usually, the participants of MOOC are young persons. Pupils from high school or undergraduate students are mostly participants of courses. However, insome specialised courses, participants can be graduate students, masters, PhD student and PhD's. Due to the fact that the course is in different languages, there is a need for knowledge of at least one foreign language

But if MOOC is developed as local platform for example as government platform for courses then participant will attend courses in the local language, but the structure of participants can be very various.

Motivation of participants can differ greatly. To be able to hear the famous popular lecturer on his way, through the need to improve the level of knowledge necessary for their basic needs to study, or to obtain information about future studies

Most participants attend course through Web applications but there are participants who attend course through mobile phone platforms *etc*.

Statistics of participants who finish course successfully is not exact but the percentage is not very big. About 7% of all participants get certificate for their course. Different reasons may cause this. Part of participants thinks that course did not meet their interest, some of them don't want to pay fee for certificate, and other students have lost interest of subject during the course.

The statistic shows that the students from more developed countries get better results in finishing courses then the students from undeveloped countries. This situation can be explained by the fact that the IC technology is not well implemented in the system of education and communication in these countries.

6. ADVANTAGES AND DISADVANTAGES OF MOOC

MOOC as organized aspect of education has advantages but also disadvantages.

An advantage of MOOC is its mass. Very large number of participants can be involved in transfer of knowledge. That fact must generate new idea and implementation of knowledge in practice. Another advantage is that participants don't have to be at one place.
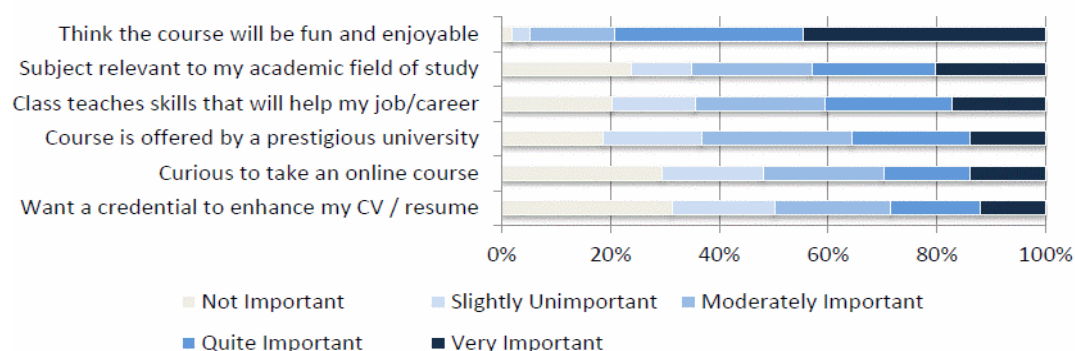
Figure 3. Motivation of participants to enroll a course

Participants can join a course from all around the world. Everything is based on personal interest of organizers, teachers and students. MOOC can be used in various forms of education.

Big disadvantage of course is that a very small number of participants who have completed the course, and a much smaller number of those who receive a certificate that they completed it. Difficulty of identification and authentication is also one of the big problems for MOOC organizers.

7. POSSIBILITIES OF MOOC

In the beginning, MOOCs were used in the way to develop discussion between participants. The leader of the course was the person who makes initiative and leads participants through the main subject of course.

The next generation of MOOC developed a more classical approach in education. We have professors who lead students through their lectures and homework. In this kind of course, the advantage is the possibility of free access of students from any place in the word. They have to know foreign language if they are from different language region.

But we think that in our case, in Serbia, we can develop several variations of courses.

Possibilities of MOOC depend on our creativity. Organizers can use it in various ways. MOOC can be used most in education, but it can also be used in many other fields.

The government can develop MOOCs as courses for introduction laws and procedures. Also, all government institutions can develop their own MOOCs to inform people and explain to them their rights and obligations. This kind of MOOC can be repetitive. They can serve the government also to see how people react to new procedures and laws.

MOOCs can be used by all levels of education from basic to high level, to encourage and develop a desire of pupils and students to educate in specific directions. The faculties can use MOOC also to introduce to students new procedures during studies. Also, MOOC can be used to arouse interest in possible future students.

MOOC can be used as a tool to get pre-exam points, or even to pass the exam of subject. If we can make an accreditation of MOOC and MOOC platform, it will be possible for students to participate in the course and then to verify knowledge through certificate of course as exam of faculty where he is a student. In some cases, courses can be modules of one subject and then several courses can be validated as one exam. This will give the opportunity to a student to organize his time and recourses and to choose in which he/she wants to participate.

The student will have possibility to choose a time and place when and where he/she wants to attend the course. Faculties and Universities can in this manner save their resources because they will need less space and less teaching staff.

If such idea has a good basis, some educational institutions can merge their recourses even if they are not from the same town or even country.

It will create an opportunity, for example, for students from Serbia to take a part of some course on MIT, and maybe a students from Germany will take part of course of English in Serbia. They will both get the certificate for their exams at basic faculties where they are students.

Because MOOC do not have age limitations for participants everybody can use it to refresh and to improve his knowledge. In this way, it is an instrument for lifelong learning.

In many was MOOC communication function as P2P network and in such way MOOC give a possibility to participants
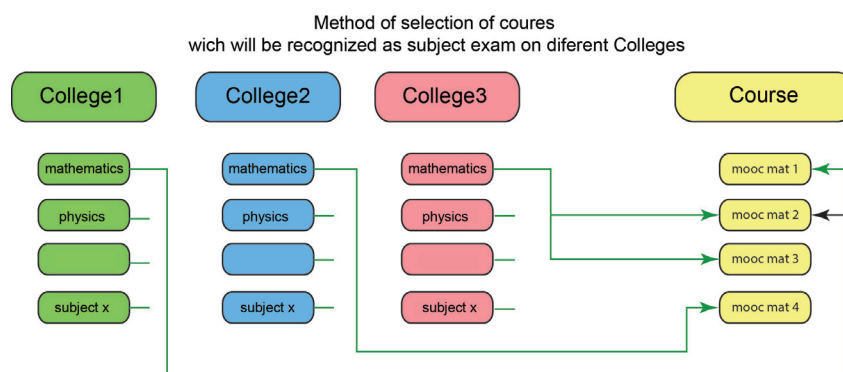
Figure 4. Method of selection of adequate course for exam recognition

to communicate even on other issues which are not subject of the course. In this communication, participants can develop knowledge in some other specific field.

8. CONCLUSION

Perspectives of MOOC depend on the development of technology and ability of people to use it. In this way of learning, we don't have age limitation or academic knowledge. Everyone from everywhere can join the course and develop personal or professional knowledge.

Providers developed global platforms for MOOC, but we think that also a local platform can give good results, especially in knowledge improvement in administration and communication with population.

It has not been properly developed in our region, which needs to be taken into consideration. This fact must be taken seriously. Our opinion is that state, with all its institutions including all educational institutions, must develop a platform for MOOC as a matter of national interest.

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ADVANCED ENGINEERING SYSTEMS

REDUCTION OF SNOW AND RAIN NOISE IN SPATIAL DOMAIN

Ratko Ivković[1*],

Mile Petrović[1],

Dragiša Miljković[1],

Petar Spalević[2],

Ivana Milošević[3]

[1] University of Priština,
Faculty of Technical Sciences,
Kneza Miloša 7, Kosovska Mitrovica,
Serbia

[2] Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[3] The School of Electrical and Computer
Engineering,
283 Vojvode Stepe, Belgrade, Serbia

Abstract:

Digital images created under different weather conditions, such as snow and rain can lose clarity. The theory of digital image processing defines these cases as images with extremely high level of non-brightness (noise reduction in image), while visual can be interpreted in another way. This paper presents practical examples of noise reduction of snow and rain. Algorithms are defined and modified in MATLAB software package and then used or applied to the original images. Gained visual and numerical results provide a clear contribution to the reduction of this type of problem.

Key words:

digital image processing, noises in the spatial domain, median filter, averaging filter, robust multimodal method.

1. INTRODUCTION

Depending on the scientific area from which is observing, the digital image and its contents can be interpreted in so many ways. Freedom in interpretation depends on the theoretical framework through which the content of image is viewed. In this sense, while the Socio-Humanities sciences give more freedom in the interpretation of images, that mostly can be on an individual level, the interpretation of digital images through technical and technological sciences doesn't provide freedom and the analysis must be precise in comparison to clearly defined theoretical framework.

Correspondence:

Ratko Ivković

e-mail:

ratko.ivkovic@pr.ac.rs

Image 1. Snow effect - level of noise 51-57%

Image 1 can be interpreted in many ways. From the point of view of Socio-Humanities or Art sciences, it can be considered the social moments, the body language, the relationship between the actors, style, staff, lighting, and many other elements. However, observing Image 1 from the technical and technological aspects, mainly from the point of view highlights of multimedia teachings, and in the narrowest sense of digital image processing and computer graphics. The resolution, brightness levels, compression, compression type, the bit depth, format are just some of the aspects of observation and assessment. One of the very important parts of the theoretical contemplations of digital image processing is the analysis of image quality by observing noise. This feature is being considered in the assessment of the quality of digital images. The concentration of a particular type and level of noise defines the circumstances in which the image:

- Generated – Due to imperfections of the lens or sensor,
- Processed - Depending on the set of filters that are used,
- Compressed - depending on the degree and type of compression depends on the format of the record,
- Transmission - certain types of noise that occur during transmission,
- Or representations – sync of image with systems and devices.

Taking into consideration the basics of digital image processing and observing the elements for assessment of the quality, *etc*. Image 1 has extremely high level of noise, even though it does not acquire such visual impression. According to the theoretical model that is described in the paper [1], the noise level on the observed image is from 51-57%, depending on the applied method of analysis, with the presence of Salt & Paper and Lorenz noise. Although the image has an Entropy of 7.5918 bit, a resolution of 4k, recorded in TIFF format without compression, *etc*., all of parameters indicate that the image has high quality level. That example shows that the evaluation of the quality of digital images is very complicated, that it varies from situtaion to and the quality evaluation must carefully approach today's available parameters. In this case, the image elements which are part of the snowflakes and winter idyll, according to the theory of digital image processing represented noisy, and the image loses its clarity. Models of analysis showed that more than a half of the image affected two above-mentioned types of noises.

On the other hand, if we observe the technical and technological uses of digital images in video surveillance systems, using modern applications on mobile phones can be provided with a situation that create additional problems, although the images are created by using high-quality equipment. Different weather conditions creates additional problems and therefore, it is necessary to remove certain elements of the image to ensure clear visibility.

The theoretical framework of digital image processing, and controlling system needs to provide an opportunity for further consideration and making base for additional analysis for recording image in different weather conditions.

2. THEORETICAL FRAMEWORK

Conditions at which images are made are different. For example, images which are made in the reduced level of brightness conditions are full of different kinds of noise, which are mainly hidden in the lower part of spectrum. This is explained by the "nature" of image sensors, where the optical spectrum is converted into the electrical, and which depend on the amount of photons that fall on the sensor. Newer generation of cameras has some of the algorithms for reducing the consequences of this problem. Paper [2] gives the comparative analysis of the algorithms for this use. Along the lines of the aforementioned, the period of the day can differently influence the noise concentration in the photo. Various weather conditions taken in accordance with their impact on the process of creating the image, can be represented as:

- Static - fog, mist,
- Dynamic - snow and rain.

With the aim of processing the photo in a way with the highest quality possible, it's necessary to have as much information as possible, and to apply the certain filter or filter set afterwards, so that the desired results may be acquired.

Median Filter

Median filters are one of the most important linear filter representatives for reducing the noise in spatial domain. Algorithm is created in a way that it can be practically used for almost all of noise types. Even though it is practically present in the Digital Picture Processing since the 1974, different modifications of this type of filter are in use today [3]. It works according to the following principle:

- Sub-matrix is defined (the lowest value is 3x3, then 5x5, *etc*.),

- Pixel values are sorted in RGB scale from the lowest to the highest,

- Next, the mean value of sub-matrix is determined,

- A new image, based on the newly defined sub-matrix values, is created.

Averaging filter

In the past several years, science papers are full of different modifications of Marion filter based on matrix pixel equalization [4]. Of them all, the filter of average value gives the highest quality results, with the minimal losses. The main difference to the original Median filter is in sub-matrix modification, which, with the help of already defined function, gives prescribed values for the matrix.

$$avg = \frac{1}{9}\begin{vmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{vmatrix} \qquad (1)$$

Robust Multimodal Method

This method is based on the modification of Appearance Based Techniques and Texture Based Techniques, and it is used for the detection and recognition needs in the field of forensics. After the analysis with the use of the two already mentioned methods, the received intermediate result is subjected to the processing with the auxiliary algorithm (Sobel's edge detection) [5]. The idea of this robust method is to get an image with more clearly highlighted edges, which is very important for situations when it is necessary to highlight certain image segments.

3. METHODOLOGY

All of the images that are used in this paper have met high standards under all of the criteria of the theoretical basis of Digital Picture Processing and can be regarded as high quality ones. Table 1 confirms that.

Parameters	Original images		
	Image 1	*Image 2*	*Image 3*
Entropy (bit)	7.5918825681917	7.52882843046	7.7571971429
Resolution	4k	4k	4k
Format	TIFF without compression	TIFF without compression	TIFF without compression
Bit depth	24	24	24
Level of "noise"	51-57%	43-49%	44-52%

Table 1. Characteristics of original file

Image 2. Rain effect - level of noise 43-49%

From the given table, it can be seen that all of the photos used in the analysis are in the TIFF format without the compression with the aim to avoid the degree of compression that would have influenced the results. Entropy values, as a measure of the potential of digital picture, are close to maximum value of 8-bit, which tells us that the picture suitability for processing is at the highest level.

Image 3. Snow effect - level of noise 43-49%

The resolution is 4K, or 4x(1920x1080) pixels, and it is chosen so that the noise concentration wouldn't bring into question the elements of the images (snow and rain) which are being processed, or so that the elements would be considerably higher than the noise. Peak signal-to-noise ratio (PSNR) can be brought into question only in the situations when the entropy of the image is reduced by more than 50% at the same resolution [6], which is not the case in any of the output pictures, as shown in Table 2. In accordance with that, PSNR, as a parameter of the ratio of quality, is not needed to additionally process.
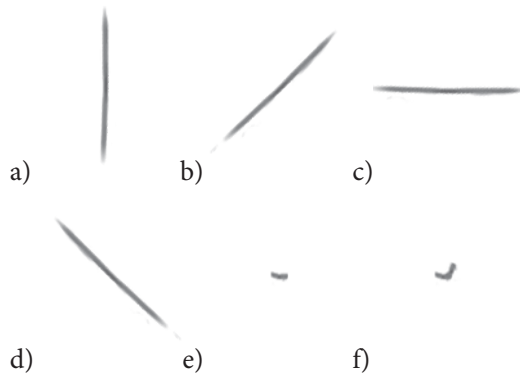
Image 4. Elements for detection

Figure 1. The system of processing and data presentation

Robust Multimodal Method is used in a changed form, instead of using it as a method for detection and identification, it is used only as the part of the algorithm for the detection. The algorithm for detection of snow and rain is used instead of the parts of the algorithm for the face detection, defined by Image 4. Image a, b, c and d are used for detection of rain, and pictures e and f are used for the detection of snow. After the detection is done, the application of filtering object surroundings with Median filter is executed, and in the other case, it is done with the Averaging filter.

Using the work principles of Median filter, the surrounding which is processed around the pixel which is found in the segment is equal to 5. Suggested value is optimal for the work of filter, taking into account that all the original images are in high resolution and the minimum value of sub-matrix of 3 would not suffice the filtration needs. This means that every pixel within the observed segment (snow or rain) is processed by one of the two chosen filters Within 5x5 sub-matrix (25 pixels).

Output results will be measured with and without the application of Robust Multimodal Method, with the aim to establish the most suitable method for the defined situations. Output format, resolution and bit encryption must be the same as in the original pictures, while it is only relevant to measure values of Entropy and those results must be discussed in comparison to original images.

4. RESULTS AND DISCUSSION

In addition to direct results, processed by Median filter and Average Filter, the output results will be presented through its processing with Robust Multimode Method, and filtered afterwards through one of two aforementioned filters, as shown in Figure 1.
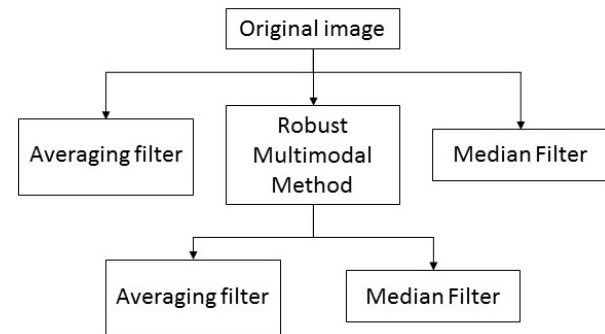
Image 6. FSV (Image 2)

Taking into account all the above-stated, it is particularly difficult to measure the quality of the recovered images, because it is the elimination of the theoretical and not the visual, noise that is performed. It is therefore necessary to carefully choose the parameters for quality assessment.

Entropy	Processed images		
	Image 1	*Image 2*	*Image 3*
FSV	7.5519243868	6.99161506224	7.6850299211
Median filter	7.5082709899	6.92097987035	7.6296431793
RMM+FSV	7.5585118996	6.99459868863	7.6870607584
RMM+Median	7.5225612962	6.93149403639	7.6328074342

Table 2. Entropy value of processed images

When it comes to digital images, Signal-to-Noise ratio (SNR) refers directly to the assessment, as measured sum of the absolute value of values of pixels per channel [7]. However, this parameter is used to assess the degree of noise if imaging entries.

For the very reason that this paper describes the filters which are used to reduce noise in the spatial do-

main, this parameter will be evaluated in an inverse direction. That is, how much the level of "noise" is reduced after the processing.

Image 7. Median (Image 2)

Image 8. RMM + FSV (Image 2)

Model of the structural similarity between images (SSIM) is one of the most relevant parameters for assessing the similarity between the images of identical resolution, when comparing the structure, brightness, *etc*. As the analysis in this paper assumes that the processed image is of the same resolution as the original one, and taking into account that the brightness level has not been the subject of processing, thus this parameter is to measure the degree of structural changes. In other words, the processing efficiency in different conditions will be assessed.

SNR	Processed images		
	Image 1	*Image 2*	*Image 3*
FSV	0.0410427188	-0.0070738471	-0.018227675
Median filter	0.0953577406	-0.0116922656	-0.023191450
RMM+FSV	0.0408306969	-0.0008631447	-0.018227675
RMM+Median	0.0940025298	-0.0011810269	-0.023191450

Table 3. SNR value for processed images

SSIM	Processed images		
	Image 1	*Image 2*	*Image 3*
FSV	0.6939945486	0.95703518207	0.8833340273
Median filter	0.4473046474	0.81613967931	0.5591761556
RMM+FSV	0.6961799824	0.96355902244	0.8846010149
RMM+Median	0.4558532665	0.85954572031	0.5636025893

Table 4. SSIM value for processed images

Image 9. RMM + Median filter (Image 2)

By analyzing the numerical results from Table 2, it can be clearly determined that the values of the entropy of processed images are negligibly lower than the ones of the original images. This indicates that the potential of the processed images remains high, and it can be subjected to any further processing with almost the same degree of entropy. Although minor, this situation confirms the theory from [8], that images with the highest level of brightness after processing will lose the highest degree of entropy. Image 6, 7, 8, and 9 are images resulting from processing of Image 2 with FSV, Median filter, RMM with subsequent application of FSV and RMM with the Median filter, respectively. Having established the visual and numerical advantage of processing through RMM + Median filter, due to the compactness of the work, Image 10 and Image 11 represent the processing of Image 1 and Image 3.

Image 10. RMM + Median filter (Image 1)

The Signal-to-Noise ratio (SNR) as defined in this situation indicates that processing by using the Median filter reduces the "noise" for the most part, and that this situation is most pronounced along with the RMM algorithm. The negative value of Signal-to-Noise refers to the shift of the histogram of RGB spectrum to white color, while the positive value refers to the shift to black. Based on this, we can further measure the "nature" of the noise based on the level of the brightness.

Model of the Structural Similarity (SSIM) gives the most distinct facts for the assessment of the quality of processed images. Namely, as according to the theory, the complete similarity between the two images has a maximum value of 1, and since the compared images have the same resolution and the degree of brightness, comparison is based on the structure, so the lower value SSIM is preferred in this situation. As in the case of observation of the SNR parameter, the implementation of Median filter with or without RMM shows the best characteristics.

Image 11. RMM + Median filter (Image 3)

CONCLUSION

Along with all numerical data, at this degree of digital image processing development and all of the possible ways to process an image, the visual experience in some certain situations represents the more relevant value of quality than the mathematical model, especially when the high resolution pictures are in question. Still, in the examples shown in the paper, and under the defined conditions, the best results are shown by the partial application of Median filter defined on the basis of the Robust Multimodal Method.

Future research will be carried out within the confines of video format filtering, partially or selectively within isolated or IPB frames, as well as in Steam regime. Contextual research direction can be towards theoretical consideration of the noise level in relation to the level of brightness.

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ADVANCED ENGINEERING SYSTEMS

INDUSTRY 4.0: THE FUTURE CONCEPTS AND NEW VISIONS OF FACTORY OF THE FUTURE DEVELOPMENT

Dragan Vuksanović,

Jelena Ugarak,

Davor Korčok

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The aim of this paper is to show the direction of Industry 4.0 future development and the future concepts of the Factory of the Future. The application of new technology based on cyber-physical systems and the Internet leads to significant improvements, such as increase of automation and shorter period between the development of a new product and its market launch.

Key words:

industry 4.0, factory of the future (FoF), smart factory, internet of things (IoT), augmented (Virtual) reality.

1. INTRODUCTION

The world around us has been changing on a daily basis along with development of human civilization. Therefore, technical and technological developments of production are changing as well. Industry 4.0 is a model that shows how industrial production follows the latest developments and changes over time. Thereby, the man, machine and the production itself constitute the force in one intelligent and independent network.

Correspondence:

Dragan Vuksanović

e-mail:

draganvuksanovic@yahoo.com
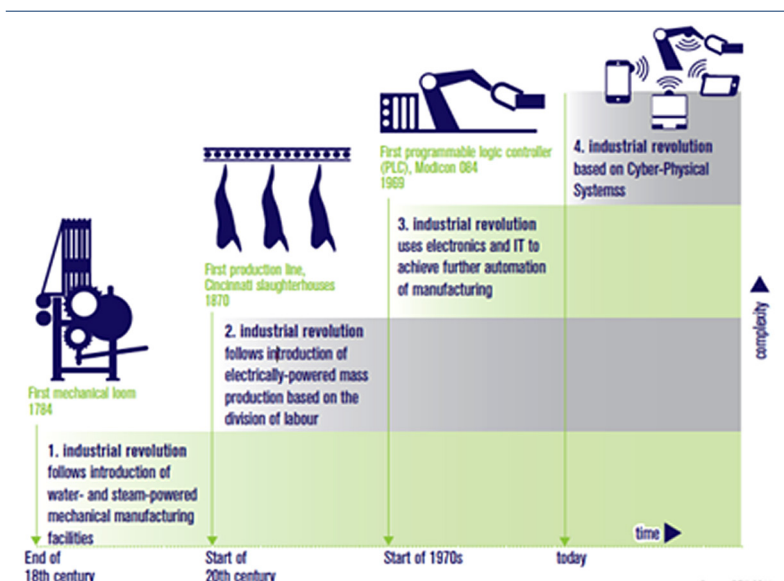
Image 1. The four stages of the industrial revolution [1]

The term "Industry 4.0" means the smart factory in which smart digital devices are networked and they communicate with raw materials, semi-finished products, products, machines, tools, robots and men. This industry is characterized by flexibility, efficient use of resources and integration of customers and business partners in the business process.

In a networked factory, robots and men are becoming equal partners, having a higher degree of artificial intelligence in relation to the previous generation of robots. The sense sensors that respond to the slightest signal are embedded into the robots, which enables the cooperation between robots and workers.
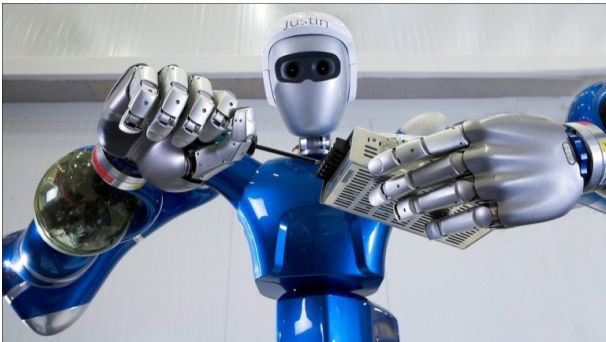
Image 2. An example of future smart robot [2]

The use of digital technology leads to drastic changes in the business models. In order to achieve this, the so-called digital innovation is required. In order to turn a lot of innovations into reality as quickly as possible, the production must become more flexible. Two factors that will help to achieve this goal are hardware and software solutions for the real-time evaluation of data. PLM's digital innovation can be applied to the smart production in a way to influence the entire product life cycle, from 3D product design and tools for 3D simulation, through automation and system for product control, supply chain management and logistics, till the recycling.

The aim of all these activities is to increase productivity (by drastically shortening the time period between the development of a new product and its delivery to customers in the market for 50%), efficiency (automation allows for greater flexibility, better quality of products and more efficient production) and energy savings (e.g. while waiting for materials processing, robots can be switched off, if necessary, which saves up to 15 of electricity) to ensure competitiveness in the global market.

Image 3. The McKinsey Digital Compass maps Industry 4.0 levers to the 8 main value drivers [3]
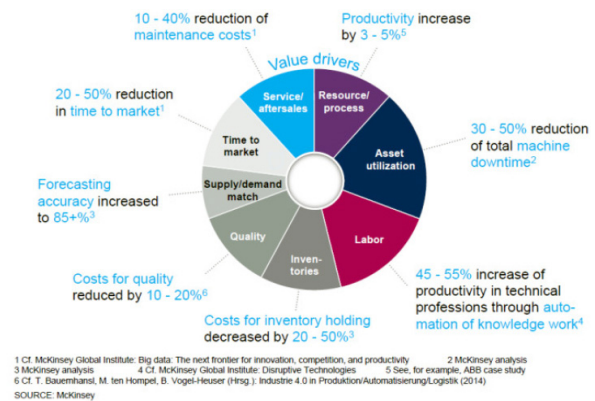
Image 4. Industry 4.0: How to navigate digitalization of manufacture sector, McKinsey [3]

2. THE ACTION PLAN FOR THE FOURTH EUROPEAN INDUSTRIAL REVOLUTION

The world's leading producers and the market do not stand still, they are drastically changing and adapting to the new trends every day. During the roundtable of key industry leaders (suppliers of digital technology, manufacturing, chemical and aircraft industry), held on Janu-

ary 11th 2016, the Commissioner and CEO of revolution "Industry 4.0", Mr. Gunther Oettinger, announced the adoption of an Action Plan for the Fourth European industrial revolution based on four "offensives" [4]:

1. First offensive tells about the necessity for all industrial companies (especially small and medium-sized), from any sector and any part of the EU, to enable an easy access to digital infrastructure and to make innovations.

2. Second offensive stands that the car industry, aviation industry and energetics must take the European leadership in digital industrial railway track.

3. Third offensive is dedicated to the labor force, i.e. to promotion of digital skills across Europe and its regions, at all levels of education and training, in order to prepare workers for the digital revolution and to benefit from it. According to the European Commission for "Industry 4.0" estimation, 150.000 new IT professionals are necessary every year.

4. Fourth offensive tells that countries should adopt common smart regulatory solutions for intelligent industry - how to regulate liability and security of the autonomous systems, ownership and use of industrial data. Digitization of industry by its nature involves cross-border transactions and none of the single Member State is able to find answers to global challenges.

Image 5. Industry 4.0 capabilities develop across five dimensions and four stages [5]

3. WHAT DOES THIS MEAN FOR SERBIA?

According to the WEF's survey [3], by 2020 five million workplaces could be lost due to using digitalization in industry of modern countries. Also, it will quickly stop the market demand for the products created by outdated technologies due to the lack of quality and such production would have to be shut down due to high costs and inefficiency. If applied, the digitization will have a significant impact on the industries of developing countries like Serbia. First of all, there must be some change in the "way of thinking", followed by education of all employees, from managers to the production line workers. According to Mrs. Mocan [17], there are four main reasons why developing countries need digitalization:

1. Government inefficiency and poor service delivery;

2. Increasing the digital skills gap between modern and developing industries;

3. Decrease of corruption - A study by Suffolk University found that as the use of information and communication technology by governments increases so corruption decreases;

Digitalization is not the possibility anymore, but the necessity of the modern world.
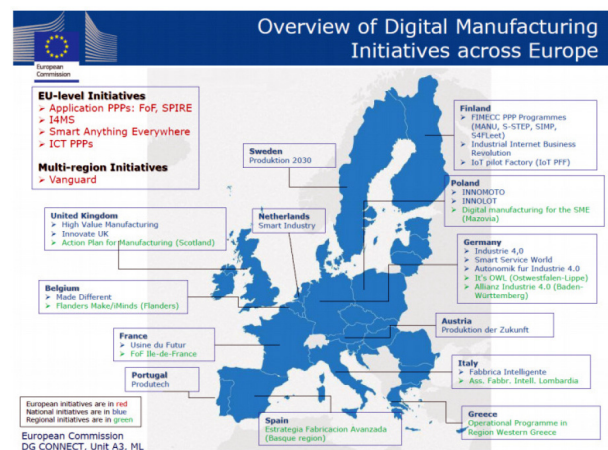
Image 6. Appendix B: Overview of digital Manufacturing Initiatives across Europe [6]

4. WHAT IS NEEDED FOR THE INTRODUCTION OF INDUSTRY 4.0

Industry 4.0 includes [8]:

1. Factory 4.0:
   - Robots,

- ◆ Autonomous Vehicle (unmanned vehicles),
- ◆ 3D Printing / Additive Manufacturing,
- ◆ Advanced Manufacturing System,
- ◆ Sensors (sensors - data collections),
- ◆ Industrial mobile devices (platform),
- ◆ Nanotechnology / advanced materials,

2. Cyber Security (Information Security),

3. Software for data processing - Big Data,

4. Logistics 4.0,

5. Mass Customization (a large number of custom),

6. Internet of Things (IOT),

7. High-quality team of employees and experienced team of associates.
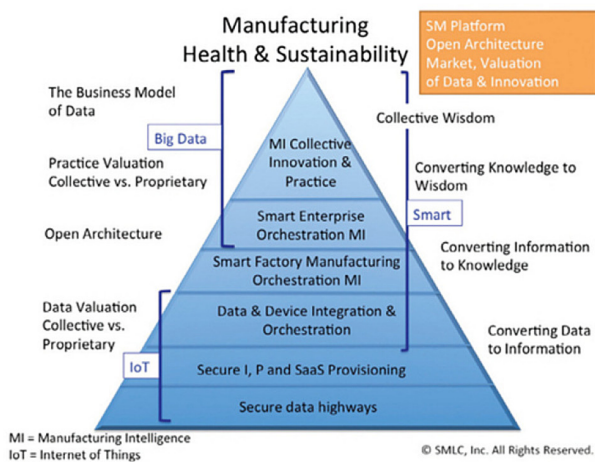
Image 7. Industry 4.0.: Smart Manufacturing's next act [7]

Image 8. Ten key findings of the survey [5]

5. WHAT MAKES INDUSTRY 4.0 HAPPEN?

1. Networked systems provide connectivity for local decentralized information processing;

2. Progressive miniaturization allows for small, low-cost and high-performance sensors and actuators;

3. Auto-ID for customized product manufacturing creates unique identification and links to the virtual world;

4. Intelligent field devices using software that allows for the global dynamic distribution of functionality is an integral part of the system integration;

5. Mobile Device Management (MDM): man-machine interfaces for intuitive operation of complex systems without special training.

Image 9. The Industry 4.0 factor organizes itself based on a network of communication-capable components [9]

Comparison between the main features of today's factories and factories of the future of Industry 4.0 is shown in Table 1. [10]:

	Data Source	Today's Factory		Industry 4.0	
		Attributes	Technologies	Attributes	Technologies
Component	Sensor	Precision	Smart Sensors and Fault Detection	Self-Aware Self-Predict	Degradation Monitoring & Remaining Useful Life Prediction
Machine	Controller	Productibility & Performance	Condition-based Monitoring & Diagnostics	Self-Aware Self-Predict Self-Compare	Up Time with Predictive Health Monitoring
Production System	Networked System	Productivity & OEE	Lean Operations: Work and Waste Reduction	Self-Configure Self-Maintain Self-Organize	Worry-free Productivity

Table 1. Comparison of today's factory and an Industry 4.0. factory [10]
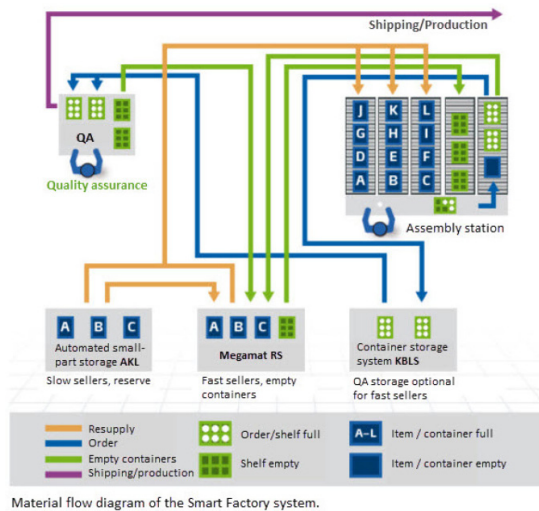
Image 10. Material flow diagram of the Smart factory system [11]

Image 11. The real Industry 4.0 revolution is in business models [12]

People who are employed in companies must be the main driver of changes and innovations related to the introduction and implementation of Industry 4.0. Image 12 shows a comparative overview of the main skills that employees currently have and the skills they will have obtained by 2020 in order to make the Industry 4.0 possible [14].

Image 12. Comparison of top 10 skills in 2015 and 2020 [14]

6. CONCLUSION

Industry 4.0 is the new industrial revolution of the 21st century, which enables companies to create "smarter" products and services by reducing costs and increasing efficiency, where the human factor is crucial for the application and the work is based on the existing literature in the area.

Smart Factory makes a solution which, due to the system's automated procedures, uncomplicated setup including simple, need-based installation, and, ultimately, high degree of scalability, can help companies in the manufacturing sector further optimize their processes and significantly boost their internal efficiency.

Five million workplaces could be lost due to digitalization in major industrialized nations by 2020. Also, it will quickly stop the market demand for the products made with outdated technologies due to the lack of quality and such production would have to be shut down due to high costs and inefficiency.

Finally, as Mr. Warren G. Bennis said [16]:

"*The factory of the future will have two employees: a human and a dog. The task of the human will be to feed the dog. The dog will have the task to dissuade the human to touch the automated systems.* "

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MIXER LINEARIZATION BY MODIFIED BASEBAND SIGNALS

Aleksandra Đorić[1],

Nataša Maleš-Ilić[2],

Aleksandar Atanasković[2],

Bratislav Milovanović[3]

[1] Innovation Centre of Advanced Technologies,
Niš, Serbia

[2] University of Niš,
Faculty of Electrical Engineering,
Niš, Serbia

[3] Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

In this paper, the linearization of the Gilbert downconverter mixer at the receiver is performed by two different methods that exploit the modified baseband signals. The signals for linearization in both methods are formed and processed in digital domain after demodulation. In the first method, the modified baseband signal is adjusted in amplitude and polarity and injected at the mixer. The linearization signals in the second method, which are also formed in the baseband and set on the appropriate amplitude and phase, modulate the fundamental carrier second harmonic and then lead to the mixer. The linearization effects of the linearization methods on the third- and fifth-order intermodulation products are compared for the case when the signals for linearization are driven at the transistors' drain of the RF stage differential pair in the Gilbert cell. The influence of the linearization signals delay on the results is analysed as well.

Key words:

Gilbert mixer, baseband signal, downconversion, intermodulation products, linearization.

1. INTRODUCTION

In modern wireless communication systems, a very important feature is the linearity of the transceiver which is predominantly determined by power amplifier in the transmitter and mixer in the receiver. Mixers allow the conversion process and frequency modulation/demodulation of the digital information in the transmitters/receivers. Since Gilbert mixer is characterized by good conversion gain over a wide frequency range it finds application in frequency downconverter in the receiver.

Various techniques for the linearization of the mixer (Ellis, 1998; Kim *et al.*, 2002; Liang *et al.*, 2008) have been proposed in the literature, such as feedforward, predistortion, a technique based on transconductance cancelation of the third-order, techniques based on the insertion of the second harmonic and/or the difference frequency signal in the analog domain (Ock *et al.*, 2001; Lou *et al.*, 2008; Theodoratos *et al.*, 2007).

Correspondence:

Aleksandra Đorić

e-mail:
alexdjoric@yahoo.com

This paper analyses the impact of the two different linearization techniques that use the modified signals in the baseband in order to linearize the mixer used as a downconverter (Atanasković *et al.*, 2013, 2015). The modified baseband signal is the product of the second-order nonlinearity of a nonlinear system induced by the useful baseband signal. In both methods, the baseband I and Q components of the signal are digitally processed and prepared for the linearization. In the first method, properly formed signals for linearization are adjusted in amplitude and polarity and led to the mixer. The second linearization method uses also adequately modified signals for linearization that are set in amplitude and phase in the baseband. The formed signals modulate the fundamental carrier second harmonic and modulated signals are inserted at the mixer.

This paper encompasses the brief theoretical basis behind the applied linearization methods and compares the mixer linearization results achieved by two linearization approaches. The results are obtained in the simulation process for QAM signal where I and Q components are sinusoidal signals with frequency spacing between spectral components of 200 kHz and 2 MHz. The effects of linearization are deliberated for two levels of the input signal. Additionally, the impact of linearization signals delay on the intermodulation products suppression is investigated.

2. THEORETICAL ANALYSIS

The theoretical approach of the proposed linearization methods is based on nonlinearity of the transistor output current. The FET's dominant nonlinearity can be represented by polynomial model in the form of Taylor's series as given by equation (1) (Pedro and Perez, 1994; Aikio and Rahkonen, 2005; Heiskanen *et al.*, 2003):

$$
\begin{aligned}
i_{ds} = {} & g_{m1}v_{gs} + g_{m2}v_{gs}^2 + g_{m3}v_{gs}^3 + \\
& + g_{d1}v_{ds} + g_{d2}v_{ds}^2 + g_{d3}v_{ds}^3 + \\
& + g_{m1d1}v_{gs}v_{ds} + g_{m2d1}v_{gs}^2 v_{ds} + g_{m1d2}v_{gs}v_{ds}^2 + \cdots
\end{aligned} \tag{1}
$$

The transistor's drain current (i_{ds}) depends on the voltage between the gate and the source (v_{gs}), which is expressed by transconductance terms g_{mx}. The dependence of the drain current on the voltage between the drain and the source (v_{ds}) is represented by the drain conductance terms g_{dy}. In addition, the drain current is expressed as a function of voltage between the gate and the source and voltage between the drain and the source by using mixed coefficients g_{mxdy}. The order of each coefficient can be calculated as x+y.

Figure 1 shows the schematic diagram of the receiver including the mixer linearization circuits of both methods.

Equation (2) represents the two signal components in the baseband, in-phase, I and quadrature phase, Q components, at the demodulator output in the receiver:

$$
\begin{aligned}
I &= \left(c(t)\acute{v}_s\right)\cos(\phi(t)) \\
Q &= \left(c(t)\acute{v}_s\right)\sin(\phi(t))
\end{aligned} \tag{2}
$$

In the first method, the signal for linearization is generated in the baseband in the following form:

$$
BB_{\text{mod}} = I^2 + Q^2 \tag{3}
$$
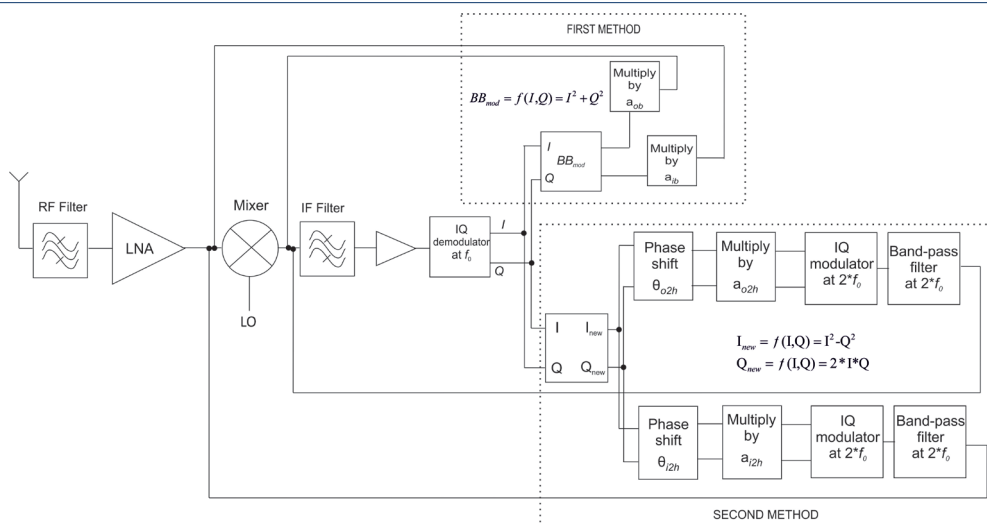
Figure 1. Schematic diagram of the receiver with the mixer linearization circuit

It is further processed in the baseband multiplied by coefficients $a_{\{ib|ob\}}$ in order to be adjusted in the amplitude and polarity. The shaped signals for linearization are fed to the mixer circuit through the serial LC circuit.

In the second method, I and Q components are modified in the baseband to form the in-phase and quadrature-phase components of the signal for linearization in the forms:

$$I_{new} = I^2 - Q^2$$

$$Q_{new} = 2Q \qquad (4)$$

The created signals for linearization are separately tuned in phase $\theta_{\{i2h|o2h\}}$ and amplitude $a_{\{i2h|o2h\}}$ across two branches. Properly adjusted signals modulate signal at frequency of the fundamental carrier second harmonic and run to the mixer through the bandpass filters designed at the second harmonic central frequency. Indexes *ib*, *ob, i2h* and *o2h* in subscript refer to the signals for linearization prepared for insertion in the mixer cell, as indicated in Figure 1. The signals for linearization are injected at the drain of RF stage differential pair in the Gilbert mixer.

Due to the transistor nonlinearity in the Gilbert cell, the modified linearization signals and the desired useful signals are interfered through the transconductance and the mixed terms of the second-order, according to the analysis performed in (Atanasković *et al.*, 2013, 2015). The influence of conductance terms g_{dx} in (1) can be neglected based on the analysis carried out in (Aikio and Rahkonen, 2005; Heiskanen *et al.*, 2003). As a result, the additional third-order nonlinear products are generated to reduce the original intermodulation products distorted by the transistor nonlinear characteristic.

3. LINEARIZATION RESULTS

The impact of the deployed linearization methods on the reduction of the intermodulation products was analyzed for the mixer in the heterodyne receiver (Figure 1). The linearization was applied to the Gilbert mixer that performs frequency downconversion of the RF input signal from 1 GHz to 200 MHz. In the process of ADS simulations and analysis, the transistor MOSFET model in the mixer cell was used.

The Gilbert mixer cell was tested for QAM modulated signals which comprise the I and Q single tone baseband components. The frequency spectrum of such a signal contains two components spaced around the carrier frequency and we analysed the cases when spectral components are separated by 200 kHz and 2 MHz.

Linearization of the mixer was performed for the case when the signals for linearization are driven at the transistors' drain of the RF stage differential pair in the Gilbert cell. The frequency of the local oscillator is 1.2 GHz and carrier frequency of the input signal is 1 GHz. Also, the input power of the RF carrier is Pin_{RF} = -20 dBm and -30 dBm, while the power of the signal from the local oscillator is Pin_{LO} = -3 dBm.

In both methods, the optimization of adjustable parameters of linearization signals was carried out to suppress the third-order intermodulation products, IM3 and to restrain the fifth-order intermodulation products, IM5 at the levels below the reduced IM3 products.

Figures 2 and 3 show intermodulation products, IM3 and IM5, before and after the linearization for both linearization methods. The graphs clearly indicate that greater reduction degree of the IM3 products was achieved by applying the second linearization method for both RF carrier input power levels. The nonlinear IM3 products are reduced to a maximum of 10 dB in the first linearization approach, while the suppression levels in the second method range from 18 to 25 dB for -20 dBm RF signal input power until maximum 30 dB for -30 dBm power level. However, it should indicate that conversion gain of the mixer is by 1 dB lower in the second linearization method comparing to the first method due to the bandpass filters in the linearization circuit connected to the mixer.

Additionally, it is noted that different linearization results regarding the IM5 products are gained by two linearization methods. In the first method, power of the IM5 products increase significantly compared to the levels before the linearization but retain at levels of the same order as linearized IM3 products. However, in the second method, levels of the IM5 products in the linearization process are dwelled close to the IM5 power before the linearization.

The impact of the linearization signal delay on linearization results is also evaluated. The analysis shows that for the delays up to 50 ns, the results of the IM3 suppression for spacing between the signals of 200 kHz stay unaltered. As for the 2 MHz frequency spacing, it was concluded that the increase of the delay reduces the ability of the IM3 products reduction. Table I represents the levels of the IM3 products before and after the linearization for both methods when the linearization signal delay is included in the simulation process. The effects of the signal delay of 10, 30 and 50 ns are investigated

a)

b)
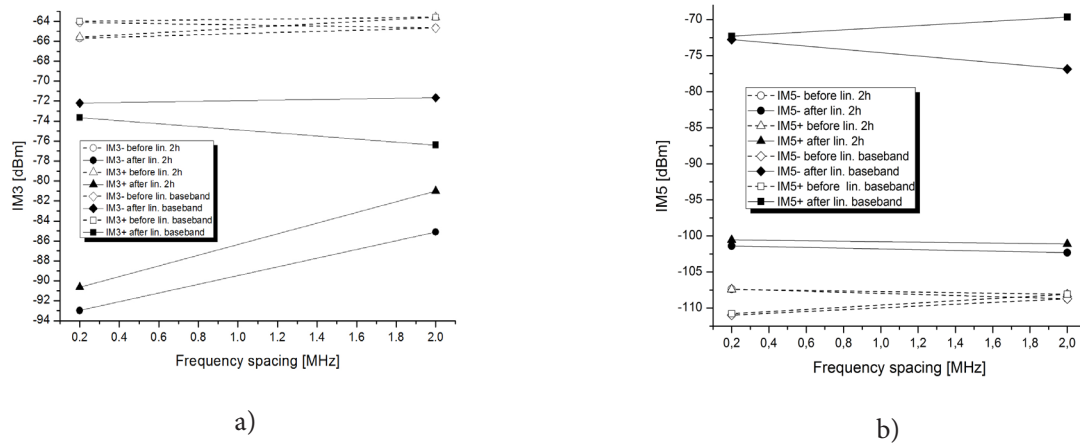
Figure 2. Intermodulation products before and after the linearization for
Pin$_{RF}$ = -20 dBm, Pin$_{LO}$ = -3 dBm: a) IM3 i b) IM5

a)

b)
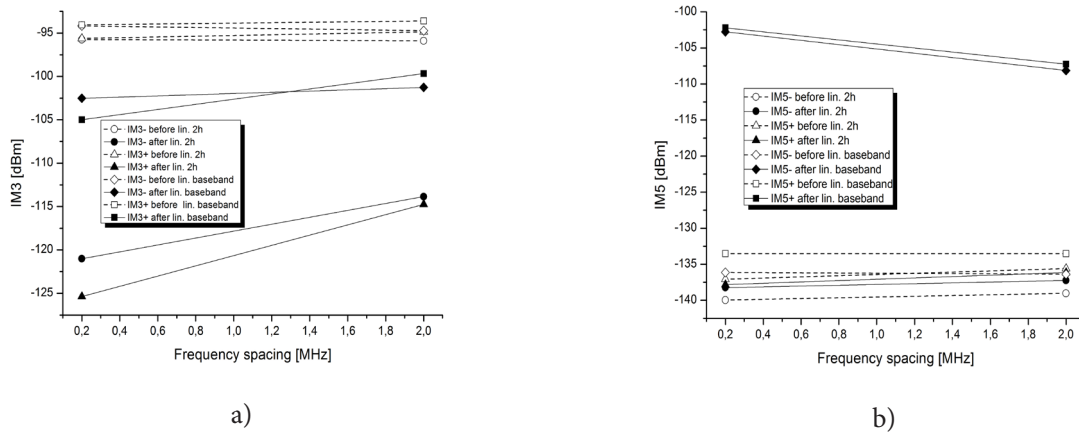
Figure 3. Intermodulation products before and after the linearization for
Pin$_{RF}$ = -30 dBm, Pin$_{LO}$ = -3 dBm: a) IM3 i b) IM5

for both input power levels. It should be noted that with the increase of the delay, the reduction of the IM3 products slightly recedes, so that the levels of IM3 products remain barely beneath the unsuppressed IM3 products for 50 ns signal delay.

	PinRF = -20 dBm				PinRF = -30 dBm			
Delay [ns]	IM3-[dBm] I method	IM3+[dBm] I method	IM3-[dBm] II method	IM3+[dBm] II method	IM3-[dBm] I method	IM3+[dBm] I method	IM3-[dBm] II method	IM3+[dBm] II method
Before lin.	-64.67	-63.53	-64.67	-63.59	-94.72	-93.60	-95.9	-94.863
After lin.- without delay	-71.65	-76.39	-81.115	-79.939	-101.26	-99.66	-113.849	-114.749
10	-70.37	-67.50	-75.783	-79.351	-99.9	-97.42	-107.1	-110.637
30	-67.875	-64.367	-70.095	-74.182	-97.677	-94.254	-101.058	-102.88
50	-65.82	-62.17	-67.331	-69.978	-95.82	-92.12	-97.933	-99.06

Table 1. The Impact of the Linearization Signal Delay

4. CONCLUSION

This paper describes two different approaches of exploiting the modified baseband signals for linearization of the Gilbert mixer in the receiver. The main role of this mixer is downconversion of the input signal carrier frequency from 1 GHz to 200 MHz. The test was performed for the QAM signal whose I and Q components are sinusoidal signals and the spectrum contains two frequency components symmetrical around the carrier frequency. The proposed linearization methods use I and Q signals that are adequately processed in the digital domain at the receiver with the aim to form signals for linearization. Linearization effects for different input power levels and different frequency spacing between signal spectral components are examined for the case when the signals for linearization are fed at the transistors' drain of the RF stage differential pair. It is inferred that the results accomplished in reducing the intermodulation products of the third- and fifth-order are better for the second linearization approach. Additionally, it is observed that the linearization signal delay does not affect the results of the IM3 products suppression for signal separation of 200 kHz. However, for the 2 MHz frequency spacing, decrease of the IM3 products with the increase of the linearization signals delay slightly aggravates, so that for 50 ns signal delay the levels of IM3 products remain slightly under the levels of the non-linearized IM3 products. It should be noted that the typical values of the signal delay in commercially available receivers are of the order of a few tens of the picoseconds.

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THE USE OF MOODLE IN TEACHING SPANISH AT THE DEPARTMENT OF IBERIAN STUDIES AT THE FACULTY OF PHILOLOGY IN BELGRADE

Stefan Bondžić

University of Belgrade,
Faculty of Philology,
Čika Ljubina 18-20, Belgrade, Serbia

Abstract:

The constant progress of technology is notable in all spheres of human life, as well as in education. The global expansion of the Internet and computers has changed the approach to learning and teaching. Today, universities and other educational institutions around the world, apart from traditional lectures, offer the possibility of e-learning and distance learning, thereby promoting blended learning. The information and communications technology plays a significant role in education and various studies have confirmed its importance in teaching a second language. Moodle stands out among several virtual learning environments as being most frequently used globally. This e-learning service has found its use at the Faculty of Philology at the University of Belgrade, where it is actively used in teaching Spanish among the students of Spanish, as well as those who learn Spanish as a second language. This paper presents the advantages of ICT in teaching a second language, an increase in the efficiency and motivation among the students attending courses within the virtual learning environment. It also presents how Moodle is used in teaching Spanish, what types of materials are the most attractive and effective for learning.

Key words:

moodle in foreign language teaching, blended learning,
e-learning materials, motivation.

1. INTRODUCTION

The possibilities of new technologies available to humanity in the 21st century have significantly raised the bar in terms of quality and expectations of the educational process, which includes the teaching of foreign languages. Foreign language teachers have the ability to communicate with their students outside the classroom in the virtual learning environment, with plenty of useful reading materials in accordance with their needs. In this way, the educational process spontaneously starts to take place outside the classroom. On the other hand, learners can count on the constant presence of lecturers and the possibility of online consultations in order to overcome difficulties. Moodle, as a free online global learning platform, has also been used at the Faculty of Philology in Belgrade since the academic year 2010/2011, with over 300 open courses and 7500 registered users.

This paper presents the advantages of using information and communications technology (in further text: ICT) in teaching, their positive

Correspondence:
Stefan Bondžić

e-mail:
bondzic.stefan@gmail.com

impact on student motivation and the manner in which Moodle is used in teaching Spanish at the Faculty of Philology. In a poll carried out in June 2015, around 101 students were surveyed, mainly those from the second, third and fourth year of studies at the Department of Iberian Studies, who attend courses of Contemporary Spanish language (G3-G8). Research shows the attitude of the students towards this virtual learning environment, their favorite and/or most efficient types of materials for work, motivation and interest in learning outside the classroom. Special attention is paid to the needs of students, as well as to their evaluation of the attractiveness of the material available in a particular year of study. The results, in addition to a descriptive analysis, may serve as a guide and provide suggestions for future use of Moodle and the improvement of the courses.

2. THE USE OF ICT IN FOREIGN LANGUAGE TEACHING

The research has shown that the application of ICT when teaching foreign languages brings benefits to both learners and lecturers. Among the most important areas in which e-learning has an impact on the teaching of foreign languages are developing basic skills, motivation and language learning ability outside the educational institutions (Ristić, 2006: 105). A survey realized by the BECTA (British Education Communications and Technology Agency) highlighted some of the key benefits for students that enable ICT in teaching:

- Digital educational resources allow students individual and personalized work and progress according to their own interests and prior knowledge (Condie & Munro, 2007: 60).
- Digital educational resources motivate pupils and enable their deeper involvement in the classes, and therefore acquire knowledge more easily (Condie & Munro, 2007: 66-67).
- In addition, the possibility of learning through experiences that are adopted through video-conferences, and via e-mail, reflects positively on grammar, vocabulary and use of tenses (Ristić, 2006: 105).
- Other important benefits of using ICT in education for teachers of foreign languages:
- Educational attainment is increased via the use of technology, e-learning, since interactive technologies motivate students and teachers.

- Wide choice of resources supports individual needs of the students, whereas multimedia materials (text, visual, sound) give teachers the opportunity to introduce new, interactive and collaborative technologies.
- The possibility of evaluation of each student as well as easy tracking of and individual work and progress with the help of interactive tests with automatic evaluation (Ristić, 2006: 105).

3. THE IMPACT OF ICT ON MOTIVATION

ICT already form part of everyday life and therefore are widely used in education, but also in teaching foreign languages (Fitzpatrick & Davis, 2003).

With the support of ICT in the classroom, language skills are developed faster, whereas they also promote the development of intercultural awareness. Another benefit is easier access to ICT authentic materials, and multimedia materials stimulate progress in learning, as they reach more students. (Klimova & Poul, 2014: 54). According to the research conducted at the University of Lancaster, the use of ICT in education leads to positive outcomes in the field of motivation, especially when the usage of ICT is oriented towards research and presentation of the previously performed work, as well as when used to support the inclusion of students in the educational process (Passey, Rogers, Machel & McHugh, 2004: 3). All of the lecturers stressed out that increased motivation was notable among the students, while only individual technical problems, or limited access to the computer and the Internet outside the school, were a negative factor when making assignments and using the information and communication technologies. (Passey *et al*, 2004: 33)

The European Commission report on the use of new technologies and the Internet in teaching of foreign languages within the *ImpaCT2 study*, points out that students at schools that have used ICT in teaching recorded better results, and that a significant positive correlation between the use of ICT in teaching language and score on the final examination (Fitzpatrick & Davis, 2003) could be observed. ICT in teaching encourage student motivation, facilitate course management and provide access to attractive material for processing various teaching units. They are also useful because they provide the opportunity to learn outside the classroom- students can work independently at home (Passey *et al*, 2004: 62).

4. MOODLE AS A VIRTUAL LEARNING ENVIRONMENT

Moodle is free, highly flexible software for e-learning, ("Home." Thefreedictionary.com) distance learning or blended learning. ("About Moodle. 'Moodle.org), and is also course management system, *i.e.* virtual learning environment; its title comes from the abbreviations for Modular Objected Oriented Dynamic Learning Environment - Moodle ("Home." Thefreedictionary.com).

The creator of the Moodle is Martin Dougiamas, whose aim was to provide a platform for online courses that would encourage a collaborative approach to building and content selection for teaching. The first version was launched on the 20th of August, 2002 and ever since a constant effort has been made to improve this virtual environment and its function ("History." Moodle.org).

The advantage of Moodle is its practical use and easy access: users (lecturers and learners) need just a username and a password to access this virtual environment for learning.. Taking into account that this is an online platform, users can access anytime, anywhere, from any computer that has Internet connection. Therefore, it is considered an excellent system that allows users the autonomy in learning, and encourages a collaborative approach to the learning process among the students (Warth-Sontheimer, 2011: 4).

Moodle is an open system when it comes to the material selection and course organisation. As a virtual learning environment, it does not offer predetermined materials, but allows lecturers to choose, create and download the material from the Internet or other sources.

Today, Moodle has a customer base that includes 56,831 registered sites with 75,895,336 users, divided into 8,396,861 courses, in 221 countries ("Moodle Statistics." moodle.org).

Moodle platform can be downloaded for free from the official website of the association and is compatible with all major operating systems such as Windows, Linux, Mac OS, Unix, and all systems that support PHP database.("Installing Moodle. 'Moodle.org) With the rapid development of technology, Moodle can be accessed via mobile phones running the operating system Android, iOS, or Windows Phone ("Mobile Home". Moodle.org).

5. MOODLE AND BLENDED LEARNING

Moodle, as a virtual learning environment, has got multiple applications in the classroom: it can be used for distance learning, but also supports the standard, traditional model of teaching and blended learning. This environment gives complete flexibility when choosing the materials and organizing lessons so that each course can be fully adapted to the needs of the students.

Blended learning involves the type of learning in which the student gets the knowledge inside the educational institution, by the traditional form of teaching, while the other part is realized by means of electronic services (Staker & Horn, 2012: 3). Traditionally, this type of learning is described as a combination of teaching and learning through Internet and digital media with the usual manner of teaching in the classroom, which includes the physical presence of students and lecturers (Friesen, 2012: 1). On the other hand, some authors define this process as the union of different teaching modalities combined with synchronous and/or asynchronous web technologies that facilitate interactive, reflective and collective learning (Lupshenyuk & Adams, 2009: 717). Still, some describe it as a hybrid process that is based on traditional teaching methods (face to face) and internet learning that takes place both in the classroom and outside - online, where learning through the Internet and digital media becomes a natural extension of the traditional learning process (Liebowitz & Frank, 2011 by Al-Ani1, 2013: 99).

Many studies have shown that the use of Moodle in the classroom encourages learning outside the classroom, and that is undoubtedly useful both to the lecturers and students (Al-Ani1, 2013: 9 of 9). In addition, the usage of Modle as a learning management system, which is based on socio-constructivist learning model (Melton, 2008 by Al-Ani1, 2013: 99) provides access to learning aimed at the students and encourages the lecturers and students to active work in the educational institution at home, contributing at the same time to development of constructive learning (Govender, 2009 by Al-Ani1, 2013: 99).

According to these sources, it is obvious that the use of the virtual learning environment is one of the most beneficial aspects of restructuring strategies in learning, since it is intended for students, giving them the ability of an intensive immersion in the learning process (Al-Ani1, 2013: 100). In addition, when it comes to higher education, it has been noted that with the use of Moodle the number of students who drop out has reduced, while there has been a significant improvement of the average notes (Lopez-Perez, V., Perez-Lopez, C., & Rodriguez-Ariza, 2011 by Al-Ani1, 2013: 100).

6. MOODLE IN EDUCATION

From the pedagogical point of view, Moodle supports the socio-constructivist approach to education, encouraging students and teachers to contribute to the educational process (Brand, 2005: 20). With the help of these pedagogical principles, Moodle provides a flexible learning environment. Also, another important factor in blended learning is the ability of a lecturer to properly conduct a thoroughly planned and organized syllabus of the subject. This refers to the combination of classroom activities and those realized online by students outside the classroom (Krasnova & Sidorenko, 2013).

Numerous studies confirm the increased motivation among the learners, as well as the higher efficiency during the learning process when Moodle is used, compared to the traditional model of teaching, according to the research conducted at the University of Tallinn (Siirak, 2012: 95).

Students showed a higher level of interest and motivation for the courses that have used Moodle as a learning support, and confirmed that they achieve better personal contacts, as well as being successful in the learning process, while progressing faster and simultaneously learning from each other (Siirak, 2012: 95).

7. THE USE OF MOODLE AT THE DEPARTMENT OF IBERIAN STUDIES AT THE FACULTY OF PHILOLOGY IN BELGRADE

Moodle, as a virtual learning environment, is being used at the Department of Iberian Studies, Faculty of Philology in Belgrade, since the 20011/12 academic year. Today there are over 300 courses and 75000 registered users. Moodle has also found its use in the teaching of the Spanish language, since subjects such Contemporary Spanish Language in all four years of study (G1-G8) count on the support of the virtual courses within the Moodle platform.

This paper examines whether the students find Moodle to be a useful mean of support in the learning process. Also, it will investigate the matter of the blended learning method with the support of Moodle, as well as the type of material the students feel most comfortable to work with, and which type of content is considered to be the most effective for developing language competences.

In June 2015, the students of the second, third and fourth year of the study program Spanish, Hispanic Literature and Culture were surveyed (101 students) in order to investigate their views and thoughts on the use of Moodle platform in the subjects Contemporary Spanish Language (G3-G8).

8. DESCRIPTIVE STATISTICS ON A SAMPLE OF RESPONDENTS WHO ATTEND MOODLE COURSES CONTEMPORARY SPANISH LANGUAGE G3-G8

In general, text files in all three years of study have not been labelled as particularly attractive, nor inefficient. However, the respondents who did not indicate their year of the study labeled the text documents somehow more attractive - the average of their responses is 2.75.[1] Taking into account all of the answers, the average score of attractiveness of the text documents is 3.02 (Table 1).

When it comes to the attractiveness of audio files, average values are slightly lower when compared to text files. Second-year students gave the audio files the lowest rating (3.43), while the third-year students compared with an on average record, labelled them better (3.10). On the overall, an average note of 3.21 indicates that audio files are not highly attractive, but still not repulsive to the students (Table 2).

Video records were the least attractive to the students who did not mark their year of study (3.33), as well as to the students of the second year (3.29). This type of content was more interesting to the students of the third (2.93) and the fourth year (2.74). Generally, videos are were more attractive than the first two types of content, and it is evident that the average rating is growing according to the level of study. Therefore, we can conclude that proficient students prefer to work with multimedia material such as video recordings, since they have a higher level of language competence, while other students are still not at that level. Overall ratings of the video materials is slightly above average, 2.93 (Table 3).

Presentations are, in general, estimated as slightly more attractive type of material than the video files (2.85). Second-year students find this type of content as highly attractive (2.07), while the third-year students labelled presentations as least attractive- 3.14 (Table 4).

Graphic materials, also, were not labelled as particularly attractive nor as very unattractive content (2.95). Fourth-year students (3.11) and students who did not indicate their year of studies (3.13) have estimated this

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1   Note: rank 1- the most attracitve, rank 5- the least attractive

Year of study		What content is the most attractive to you (Text files)					
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	M
Second	Number	3	4	1	2	4	3.00
	Percentage	21.4	28.6	7.1	14.3	28.6	
Third	Number	9	2	5	3	10	3.10
	Percentage	31.0	6.9	17.2	10.3	34.5	
Fourth	Number	13	8	4	9	13	3.02
	Percentage	27.7	17.0	8.5	19.1	27.7	
Unlabelled	Number	4	0	1	0	3	2.75
	Percentage	50.0	0	12.5	0.0	37.5	
In total	Number	29	14	11	14	30	3.02
	Percentage	29.6	14.3	11.2	14.3	30.6	

Table 1. Distribution of text files as the most attractive content per academic year

Year of study		What content is most attractive to you (Audio files)					
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	M
Second	Number	3	0	2	6	3	3.43
	Percentage	21.4	0.0	14.3	42.9	21.4	
Third	Number	2	7	10	6	4	3.10
	Percentage	6.9	24.1	34.5	20.7	13.8	
Fourth	Number	4	7	18	11	7	3.21
	Percentage	8.5	14.9	38.3	2 3 4	14.9	
Unlabelled	Number	1	2	1	2	2	3.25
	Percentage	12.5	25.0	12.5	25.0	25.0	
In total	Number	10	16	31	25	16	3.21
	Percentage	10.2	16.3	31.6	25.5	16.3	

Table 2. Distribution of audio files as the most attractive content per academic year

Year of study		What content is most attractive to you (Video files)					
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	M
Second	Number	2	3	2	3	4	3.29
	Percentage	14.3	21.4	14.3	21.4	28.6	
Third	Number	8	5	3	7	6	2.93
	Percentage	27.6	17.2	10.3	24.1	20.7	
Fourth	Number	10	12	12	6	7	2.74
	Percentage	21.3	25.5	25.5	12.8	14.9	
Unlabelled	Number	2	1	1	2	3	3.33
	Percentage	22.2	11.1	11.1	22.2	33.3	
In total	Number	22	21	18	18	20	2.93
	Percentage	22.2	21.2	18.2	18.2	20.2	

Table 3. Distribution of video files as the most attractive content per academic year

Year of study		What content is most attractive to you (Presentations)					
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	M
Second	Number	4	7	2	0	1	2.07
	Percentage	28.6	50.0	14.3	0.0	7.1	
Third	Number	2	8	6	10	3	3.14
	Percentage	6.9	27.6	20.7	34.5	10.3	
Fourth	Number	10	11	6	13	7	2.91
	Percentage	21.3	2 3 4	12.8	27.7	14.9	
Unlabelled	Number	0	4	2	2	0	2.75
	Percentage	0	50.0	25.0	25.0	0	
In total	Number	16	30	16	25	11	2.85
	Percentage	16.3	30.6	16.3	25.5	11.2	

Table 4. Distribution of presentations as the most attractive content per academic year

type of content slightly less interesting the second-year (2.79) and third-year students (2.72), who found it more appealing (Table 5).

All second-year students stated that they receive their favorite type of content from the lecturers often enough, which is also the case with the 89% of the students who did not mark their year of study. However, 53% of the third-year, and 23% of the fourth-year students, states that they do not receive their most attractive type of material often enough. On the overall, 28% of respondents believe that the lecturers do not upload their favorite type of material often enough (Table 6).

The respondents reported that they were mostly influenced by the materials which led them to listening to a song or a music album (50%) seeing a movie (46%) and reading some articles (44%). About 17% of the respondents said that a specific content influenced them to read a book, while 12% of the students remarked that they were encouraged by some of the material from Moodle to visit a photography exhibition or some other visual works. Second-year students show that it was music which had the strongest impact (71%), as well as among the third-year students (56%). On the other hand, respondents from the fourth year of study pointed out that they were mostly influenced to see a movie (49%), which is in line with their abovementioned answer about the most attractive type of material- video. It is highly positive and encouraging that only 12% of the students said that none of the materials affected them in any way (Table 7).

The students were mostly affected by text files - 48% marked them, as well as video recordings - 45% of respondents reported that this type of material influenced them to see or search for different content. The respondents were least interested in graphic materials (15%), presentations (19%) and audio files (25%). When it comes to the second-year students, most of them were affected by text files (71%), which also have a distinguished overall rating among the third-year students, who equally labelled text and video files (47%). Once again, there is a significant increase in the average rating of video files, according to the year of study: 21% of the second and 47% of the third-year students have marked this kind of material as well as 51% of the fourth-year respondents marked video files as a type which had most influence on them and encouraged them to continue with academic activities outside the classroom (Table 8).

This table shows types of materials that influenced students, but taking into account only the respondents who labelled a certain type of material with the highest rating (1- most attractive). About 55% of the respondents who

marked text documents as the most attractive material pointed out that it was precisely this type of material that influenced them most to view certain content. Among the students who labelled audio files as the most attractive material, the highest percentage of respondents, 40%, marked text, audio and video files as a material that had most influence on them. About 82% of the respondents who labelled video files as the most attractive material pointed out that it was precisely this type of material that influenced them most to view certain content. In addition, the highest percentage of respondents who consider presentations as the most attractive type of material, pointed out that text files had most influence on them (50%); the situation was similar with the students who labelled graphic materials as the most attractive type of material- 55% (Table 9).

Second-year students considered text documents to be the most effective materials for progress in learning the Spanish language - 86% of the respondents marked this option. Third-year students also labelled text and video files: 47% of the respondents selected these two types of materials as the most effective. Fourth-year students point out video files as the most effective type of materials (64%), followed by text files and presentations (40%). When looking at the overall results, the lowest percentage of the students marked graphic files as the most effective material for the learning process (12%), followed by audio files (29%), while the most effective material for learning are videos (51%) and text files (48%). There is a notable decline in the preference for text files as the year of study is growing: 86% first-year students marked this type of material as the most effective content for learning, but this percentage decreased among the respondents in the third (47%) and the fourth-year of study (40%). On the other hand, the average rating of video files grew with the year of study: 21% of the respondents from the second year, 44% of the third and 51% students from the fourth year of study marked this type of material as the most effective. Such dynamics of increasing average grade was observed with audio-record: 14%, 28% and 34% of the second, third and fourth year of study (Table 10).

At this point the respondents' answers about which materials their lecturers upload frequently can be linked to the answers about the most efficient materials for an advance in the learning process of the Spanish language. So, it is notable that about a half of the respondents labelled text files (48%) and videos (51%) as the most efficient. However, although the respondents stated that teachers often upload text documents to Moodle (1.87), this is not the case with video files (3.32). Therefore, it might be

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Year of study		What content is most attractive to you (Graphic material)					
		Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	M
Second	Number	3	1	7	2	1	2.79
	Percentage	21.4	7.1	50.0	14.3	7.1	
Third	Number	8	7	5	3	6	2.72
	Percentage	27.6	24.1	17.2	10.3	20.7	
Fourth	Number	10	9	7	8	13	3.11
	Percentage	21.3	19.1	14.9	17.0	27.7	
Unlabelled	Number	1	1	3	2	1	3.13
	Percentage	12.5	12.5	37.5	25.0	12.5	
In total	Number	22	18	22	15	21	2.95
	Percentage	22.4	18.4	22.4	15.3	21.4	

Table 5. Distribution of graphic files as the most attractive content per academic year

Year of study		Do you think your teacher sends you the most attractive type of material often enough	
		Yes	No
Second	Number	14	0
	Percentage	100.0	0.0
Third	Number	15	17
	Percentage	46.9	53.1
Fourth	Number	36	11
	Percentage	76.6	2 3 4
Unlabelled	Number	8	1
	Percentage	88.9	11.1
In total	Number	73	29
	Percentage	71.6	28.4

Table 6. Material upload frequency per academic year

Year of study		Did any of these materials influence you to see / listen to / read					
		Movie	Music	Book	Article	Photo	None
Second	Number	5	10	5	8	1	0
	Percentage	35.7	71.4	35.7	57.1	7.1	0.0
Third	Number	17	18	3	12	7	4
	Percentage	53.1	56.3	9.4	37.5	21.9	12.5
Fourth	Number	23	19	7	22	4	7
	Percentage	48.9	40.4	14.9	46.8	8.5	14.9
Unlabelled	Number	2	4	2	3	0	1
	Percentage	22.2	44.4	22.2	33.3	0.0	11.1
In total	Number	47	51	17	45	12	12
	Percentage	46.1	50.0	16.7	44.1	11.8	11.8

Table 7. Distribution of the impact that different types of materials have on students

Year of study		What type of material has influenced you				
		Text files	Audio files	Video files	Presentations	Graphic files
Second	Number	10	4	3	3	4
	Percentage	71.4	28.6	21.4	21.4	28.6
Third	Number	15	9	15	9	8
	Percentage	46.9	28.1	46.9	28.1	25.0
Fourth	Number	21	9	24	7	3
	Percentage	44.7	19.1	51.1	14.9	6.4
Unlabelled	Number	3	3	4	0	0
	Percentage	33.3	33.3	44.4	0.0	0.0
In total	Number	49	25	46	19	15
	Percentage	48.0	24.5	45.1	18.6	14.7

Table 8. Distribution of the type of material per year of study which has encouraged students to work independently

Type of material which was designated as the most attractive		What type of material influenced you to browse certain content				
		Text files	Audio files	Video files	Presentations	Graphic files
Text files	Number	16	6	9	6	1
	Percentage	55.2	20.7	31.0	20.7	3.4
Audio files	Number	4	4	4	2	3
	Percentage	40.0	40.0	40.0	20.0	30.0
Video files	Number	6	5	18	0	4
	Percentage	27.3	22.7	81.8	0.0	18.2
Presentations	Number	8	4	5	4	2
	Percentage	50.0	25.0	31.3	25.0	12.5
Graphic files	Number	12	7	10	5	5
	Percentage	54.5	31.8	45.5	22.7	22.7

Table 9. The most attractive materials and their impact on students

Year of study		What content and materials on Moodle you consider to be the most effective for progress in learning the Spanish language				
		Text files	Audio files	Video files	Presentations	Graphic files
Second	Number	12	2	3	4	1
	Percentage	85.7	14.3	21.4	28.6	7.1
Third	Number	15	9	15	13	6
	Percentage	46.9	28.1	46.9	40.6	18.8
Fourth	Number	19	16	30	19	4
	Percentage	40.4	34.0	63.8	40.4	8.5
Unlabelled	Number	3	3	4	2	1
	Percentage	33.3	33.3	44.4	22.2	11.1
In total	Number	49	30	52	38	12
	Percentage	48.0	29.4	51.0	37.3	11.8

Table 10. Ranking of the most effective learning materials by year of study

necessary to increase the amount of videos being uploaded to Moodle, since the respondents believe that this type of content is very effective for learning process, especially among the third and fourth-year students. When it comes to graphic files, the respondents reported that these are the least frequent type of material on Moodle (3.42), but they also feel that they are the least useful for the learning process- only 12% of the respondents chose them as the most effective.

9. OBJECTIONS AND SUGGESTIONS

As the biggest objection students indicated that the system stops working if there are many people connected. This usually happens when they sign up term papers or during tests. Half of the respondents pointed out this problem. A small number of students also highlights an inadequate use of the platform by the lecturers, poor organization, errors in automatic evaluation of certain tests, *etc.*

Learners suggested uploading more diverse materials, and their participation in the diffusion of materials, as well as better organization. Respondents especially emphasized that they would like more audio and video materials.

10. CONCLUSION

This paper describes the benefits of using ICT in teaching, its positive impact on the student motivation and progress, of the students, with the main features of Moodle as a virtual environment that facilitates blended learning. On this occasion, in order to gain an insight into the use of Moodle in the teaching of the Spanish language at the Faculty of Philology in Belgrade, 100 students have been surveyed. Although the study is limited since there is no test group to compare the results with, highly positive responses of the learners cannot be disputed.

The results show that the learners' favorite and/or most efficient type of material to work with, as well as

increased motivation and interest in learning outside the classroom. The general impression is very positive and the students have particularly pointed out the possibility of consulting with their colleagues and easy access to materials at one place, as well as faster access to the information concerning the course and materials.

When it comes to the upload frequency of the most attractive materials on Moodle, it is noticeable among the students of Spanish, that they believe their lecturers do not deliver their favorite type of material quite often enough. Therefore, it may be a good idea to post videos and presentations more frequently. Of course, it is necessary to bear in mind the needs and level of knowledge of each year of study. For instance, the average rating of a video as a favorite material to work increases from the second to the fourth year of study along with the increase of language competencies, while the average score of text files is decreases. .

The results showing the impact of Moodle to students' activities outside the classroom are encouraging: as much as 88% of the surveyed students of Spanish indicated that they were inspired by some of the online content, read a book, an article, watched a movie in Spanish, *etc.* When it comes to the role of Moodle in blended learning, it is obvious that it has not entirely achieved its potential, since the majority of surveyed students (85%) said that they weekly spend one hour maximum with this learning platform. However, in the long run, and this percentage could probably improve, should the lecturers pay particular attention to the expressed needs and preferences of the student with enough online material for practice.

Since it came into use in the school year 2010/2011 at the Faculty of Philology, Moodle has consolidated itself as an important platform for the exchange of information, following the material and syllabus, which provides a fundamental possibility of electronic learning. It allows communication, both between the teachers and students, and promotes socialization, getting to know each other and dealing with the formal barriers between the students and teaching staff, which is especially important when it comes to learning foreign languages. The general opinion of the students on the Moodle platform is highly positive, though there is still much space for further progress. Namely, it is necessary to pay attention to students' suggestions and criticisms concerning the course organisation, the lack of material for exercise in order to take advantage of the opportunities that this virtual learning environment offers, and ensure optimal outcomes.

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SURVEY MODEL:

1. Year of study   1   2   3   4

   - Do you use Moodle during this academic year? YES / NO

2. Do you have access to the Internet? YES / NO

3. Did you recieve any instructions about how to use Moodle? YES / NO

   - Do you consider those instructions necessary? YES / NO

4. How many times per week do you access the Moodle course in contemporary Spanish Language?

   A) 0-1

   B) 2-4

   C) 5-6

   D) Everyday

   E) More than 5 times a week

5. How many hours per week do you spend with the Moodle course in Contemporary Spanish Language?

   A) 1 hour maximum

   B) 1-3h

   C) 3-5h

   D) More than 5 hours a week

6. Do you consider Moodle to be useful for the information necessary about the course Contemporary Spanish Language? YES / NO

7. Which type of material is the most attractive to you? Rank them from 1 to 5 (the most attractive: 1; the least attractive: 5).

   ☐ Text files

   ☐ Audio files

   ☐ Video files

   ☐ Presentations

   ☐ Graphic files

   - Other _____

8. Do you think that the lecturer sends you that type of material often enough?

   A) Yes.

   B) No

9. What type of material does you lecturer upload most frequently? Rank the materials. (the most frequent: **1**; the least frequent: 5).

   ☐ Text files

   ☐ Audio files

   ☐ Video files

   ☐ Presentations

   ☐ Graphic files

   -    Other _____

10. Did any of these materials influence you?

    A) See a movie

    B) Listen to a song or a music album

    C) Read a book

    D) Read an article

    E) Take a look at an online gallery of photos

    F) Other _____

    G) No, none of the materials from the Moodle influenced me in any way

11. If your answer to the previous question is positive, please select the type of material that influenced you most. (choose two answers as maximum)

    A) Text files

    B) Audio files

    C) Video files

    D) Presentations

    E) Graphic files

    F) Other _____

12. Wich type of content or material do you consider most efficient for learning a language? (choose two answers as maximum)

    A) Text files

    B) Audio files

    C) Video files

    D) Presentations

    E) Graphic files

    F) Other _____

13. What language competencies can be best developed via Moodle?

    A) Oral production

    B) Written production

    C) listening comprehension

    D) Reading comprehension

14. Do you consider some of the language competences to be marginalized on Moodle? YES / NO

    If the answer is YES, please state which one:

    A) Oral production

    B) Written production

    C) Listening comprehension

    D) Reading comprehension

15. What are the biggest advantages of Moodle? (choose two answers maximum)

    A) Constant online presence of the lecturer

    B) Possibility of online consultations with other colleagues

    C) Availability of materials at one place

    D) Faster access to information

    E) Other _____

16. Moodle´s biggest deficiency is _____
    _____

17. Your suggestion: how to improve Moodle course in Contemporary Spanish Language _____
    _____

ICT IN FOREIGN LANGUAGE LEARNING AND TEACHING

BLOOM'S TAXONOMY REVISITED
IN THE CONTEXT OF ONLINE TOOLS

Milena Nikolić,
Tijana Dabić

University of Sinergija,
English Language and Literature
Department, Bijeljina,
The Republic of Srpska, B&H

Abstract:

The Bloom's taxonomy has turned sixty this year. Nevertheless, it seems it has never seized to lose its educational value across various disciplines in spite of certain changes that occurred in 2001 when it was redefined by Anderson and Krathwohl. At the beginning of the 21st century, the need emerged for the Bloom's Taxonomy to adapt to the new ways of thinking and learning that appeared as a result of the ever-changing Digital World. The purpose of this paper is to give an overview of the Bloom's taxonomy and to present the Bloom's Digital Taxonomy Map by Andrew Churches via a case study of three tasks, performed by the use of online educational tools, in the course of applied linguistics and language teaching 2 at the Faculty of Philology, English Language Department and Literature at the University of Sinergija in Bijeljina. The presented can be useful for language professionals teaching English at all levels of education. The teachers can choose from the variety of tools depending on their students' language proficiency level and the technical possibility in the classroom.

Key words:

bloom's taxonomy, ELT, online tools, 21st century skills,
tertiary education, applied linguistics.

1. INTRODUCTION

There has been a distinctive and growing need in our education for the engagement of higher order thinking skills from early childhood (Rajović, 2012) throughout the whole educational process (Collins, 2014). In this way, students not only acquire necessary knowledge and skills, but they also apply them to new situations. It is this kind of thinking that applies to life outside school where thinking is characterised by a series of transfer opportunities rather than as a series of recall assignments to be done (Brookhart, 2010). Besides the requirement of expanding the range of thinking skills at disposal, one has to bear in mind the fact that we live in the digital world and that we mostly teach the generations of digital natives (Prensky, 2010). As a result, there is a growing demand for both teachers and students to be digitally literate and fluent (Crockett, Jukes, & Churches, 2011). The state of being both (digitally literate and fluent) very often implies the use of various educational tools in teaching (Crockett, Jukes, & Churches, 2011; Dabić, 2014; Hart, 2015; Silaški, 2012). This paper is focused on presenting the teaching and learning environment created for the purpose of our course that tries to meet all the requirements regarding the employment of higher-order thinking skills and digital literacies and fluencies. Our main focus is the deployment of Bloom's

Correspondence:

Milena Nikolić

e-mail:
mnikolic@sinergija.edu.ba

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Taxonomy Map (Churches, 2007) and online educational tools (Popplet, Facebook, Voicethread, Google Search and Trello). In order to achieve the above-stated, the students were assigned three tasks within the course entitled Applied Linguistics and Language Teaching II[1] at the Faculty of Philology, English Language and Literature Department at the University of Sinergija in Bijeljina, where they demonstrated the use of all six levels of thinking (traditional and digital aspect included) via online educational tools.

2. THE OVERVIEW OF BLOOM'S TAXONOMY EVOLUTION

In 1956, Benjamin Bloom developed his taxonomy of educational objectives that has become the key tool in structuring and understanding the learning process which fitted into one of three psychological domains (cognitive, affective and psychomotor). The psychomotor domain refers to manipulative, manual or physical skills, the affective domain includes attitudes and feelings whereas cognitive domain encompasses processing information, knowledge and mental skills. The cognitive domain as the one in which most of the work in the curriculum development has taken place includes the objectives which deal with the recognition of knowledge and development of intellectual abilities and skills. According to the taxonomy defined in the handbook entitled Taxonomy of Educational Objectives edited by B.S. Bloom, there are six thinking skills on the scale from lower to higher hierarchical order: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, 1956: 18). We will provide a brief summary of six thinking skills in chronological order suggested by the Bloom's Taxonomy (see Figure 1 for verb list in each subcategory).
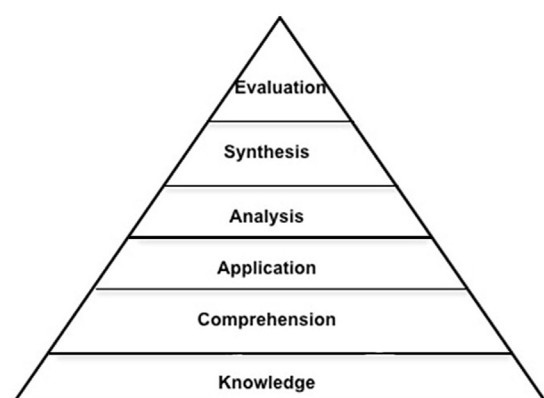
Figure 1.

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1 Due to the limited paper length, the tasks performed throughout the course of Didactics aimed at using new online eductional tools are not going to be described here. However, the results bear a striking similarity to those presented and discussed in this paper.

1. Knowledge, as the lowest order thinking skill, is defined as the ability to recall previously learned material (specifics and universals, methods and processes, a pattern, structure, or setting). The psychological processes of remembering are stressed. The process of relating is also involved in the knowledge test. It requires the organization and reorganization of a problem, i.e. finding the appropriate signals, cues and clues that will activate whatever knowledge is filled or stored.

2. Comprehension represents the lowest level of understanding. It is the ability to grasp the meaning, explain and restate ideas by means of translation and interpretation. An individual knows what is being communicated and can use the idea communicated without relating it to the other material.

3. Application is the ability to use the abstractions (learned material) in new situations. The abstractions may take form of general ideas, rules of procedures, generalized methods and technical principles.

4. Analysis is the ability to separate material into component parts and show relationships between parts. This is useful for clarifying the communication and indicating how it is organised. There are analyses of elements, relationships and analysis of organizational principles.

5. Synthesis is the ability to put together the separate idea to form a new whole. It is the process of working with pieces, parts and elements and arranging them in a way as to constitute a structure or pattern.

6. Evaluation is the highest order thinking skill defined as the ability to judge the worth material against the stated criteria, quantitative and qualitative judgments about the extent to which material satisfy criteria. There are judgments in terms of internal criteria (those determined by the student) and external one (criteria given to him or her).

At the turn of the 21st century, the Bloom's Taxonomy was slightly revised by Bloom's former student L. W. Anderson and D. R. Krathwohl.[2] Unlike Bloom's original taxonomy where each category is described as a noun (the categories being arranged in increasing order, from lower order to higher order), Bloom's Revised Taxonomy from 2001 uses verbs rather than nouns for each of the categories (see Figure 2).

The first thinking skill (Knowledge) is now called Remembering (the process of retrieving, recalling and recognizing knowledge from memory). Comprehension is substituted for Understanding, i.e. the process of constructing meaning from different types of function (written and

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2 For detailed analysis see Anderson & Krathwohl, 2001.

graphic). Application becomes applying, *i.e.* carrying out or using a procedure through its executing or implementing. Analysis turns into Analyzing, *i.e.* breaking the concept into parts, determining how the parts relate to one another or to the overall structure.
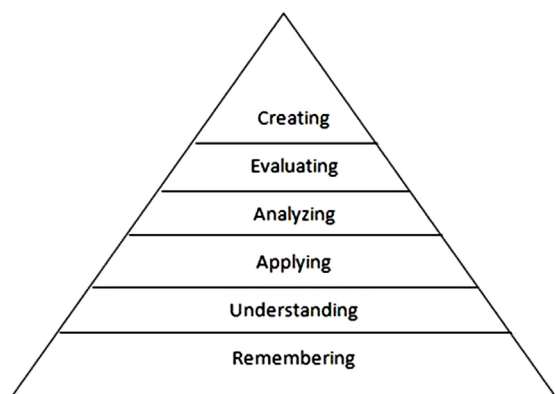
Figure 2. Bloom's Revisited Taxonomy
(L. W. Anderson and D. R. Krathwohl)

There is also a rearrangement of the sequence within the taxonomy. The most striking changes are made to the last two higher order thinking skills (Evaluating and Creating being the revised positions in Bloom's Revised Taxonomy). That is to say, the highest order thinking skill in the Bloom's Taxonomy (Evaluation) is now at the fifth place and is entitled Evaluating (making judgments based on criteria and standards through checking and critiquing), whereas the fifth one (Synthesis) is exalted to the highest place in Anderson and Krathwohl's taxonomy and is entitled Creating (putting the elements together to form a coherent or functional whole).

3. BLOOM'S TAXONOMY IN DIGITAL CONTEXT

Even though Bloom's original taxonomy and revisited taxonomy by Anderson and Krathwohl are the key tools for teachers since they are providing actions and learning opportunities emerging as technology advances, they do not address new processes and objectives that appear as the result of technological advancement and integration of ICT into the everyday life of a student. Thus, the need for dealing with this deficit gave rise to Bloom's Digital Taxonomy. It refers to both the cognitive domain and methods and tooling. In 2008, Andrew Churches devised a model for Bloom's Taxonomy for the emergence of digital tools that are often used integrated into classrooms and deployed by students. The verbs belonging to each category are presented on two levels: traditional and *digital*:

1. Remembering, recognising, listing, describing, identifying, retrieving, naming, locating, finding/ bullet pointing, highlighting, bookmarking, social networking, social bookmarking, favouriting/local bookmarking, searching/googling;

2. Understanding: interpreting, summarising, inferring, paraphrasing, classifying, comparing, explaining, exemplifying/ advanced and Boolean searches, blog journaling, twittering, categorizing and tagging, commenting, annotating, subscribing;

3. Applying: carrying out, using, executing, implementing, showing, exhibiting/ running, loading, playing, operating, hacking, uploading, sharing, editing;

4. Analysing: comparing, organising, deconstructing, attributing, outlining, finding, structuring, integrating /mashing, linking, validating, reverse engineering, cracking, media clipping;

5. Evaluating: checking, hypothesizing, critiquing, experimenting, judging, testing, detecting, monitoring /blog commenting, reviewing, posting, moderating, collaboration, networking, refactoring, testing;

6. Creating: designing, constructing, planning, producing, inventing, devising, making/ programming, filming, animating, blogging, video blogging, mixing, re-mixing, wiki-ing, directing, broadcasting.

In this model, the elements coloured in black are already existing verbs, while the elements coloured in blue are new digital verbs.[3]

However, digital verbs are used in digital environment very frequently with the use of various educational online tools. The first Digital Bloom's Taxonomy Pyramid was first published in 2007 by Samantha Penney (Roberts, 2012). There are two problems that can arouse in this context. First, this kind of classification implies distribution of tools according to the appropriate level of their use. However, a great number of those tools can be used for various purposes, *i.e.* one tool can be used to engage different levels of thinking. The second problem is the popularity of the tools, *i.e.* a new list of educational online tools is published annually.[4] (see Hart, 2015)

4. APPLICATION OF BLOOM'S DIGITAL TAXONOMY MAP AND ONLINE TOOLS: A CASE STUDY

After providing the theoretical framework for Bloom's Taxonomy in digital context, in this section we will discuss the effects and benefits of its implementation in the course of Applied Linguistics and Language Teaching II during the

3   For detailed explanation of all new digital verbs see Churches, 2007.
4   http://c4lpt.co.uk/directory/top-100-tools/

academic year 2015/2016. As a part of the course, a model for earning extra points after the completion of each chapter/topic was developed. Students were assigned a task to be performed with the use of the specified online tool that was to be mailed to the professor for the assessment within the five-day time period. During that time they were free to contact the professor via e-mail or Facebook for any further questions or clarification. The special group on Facebook had previously been created for teaching purposes. The purpose of the tasks assigned to students was to give them the opportunity to activate higher levels of thinking, to learn to navigate in the digital world and to individually and collaboratively apply theoretical knowledge in practice and in digital world. In this paper, the students' performance for three tasks will be presented.

For each task, the organization of students' tasks along with the employment of Bloom's Digital Taxonomy verbs and online tools will be provided. First, the chapter and the task related to the chapter in the textbook as well as the online tools used to perform these tasks will be stated. Second, the usage of traditional and digital verbs in Bloom's Taxonomy (Churches, 2007) that correspond to the tasks performed will be exemplified.

The tasks were chosen from three chapters from the course textbook: Discourse Analysis, Pragmatics and Corpus Analysis.

Discourse Analysis: Task I

Task: Provide a visual presentation of the features of spoken (formal/informal) and written (formal/informal) discourses.

Online tools: Popplet, Facebook, Trello

Traditional verbs usage:

    C: planning, designing

    E: experimenting

    A: comparing, organizing,

    A: showing, exhibiting,

    U: summarizing, classifying, exemplifying, comparing, exemplifying,

    R: listing, describing,

Digital verbs:

    E: posting, moderating, validating

    A: mashing, linking

    A: running and operating, uploading and sharing, hacking

    U: categorizing & tagging, subscribing

    R: searching, googling, bullet-pointing, social networking

After completing the chapter on Discourse Analysis, the students had to provide a visual presentation of key features of the following four categories: informal spoken discourse, formal spoken discourse, informal written discourse and formal written discourse with or without provided examples of discourses. The online tool they were requested to use for this purpose was Popplet (www.popplet.com) (Fraizer, 2015). Popplet is a free, collaborative web tool that allows you to organize interactive multimedia graphics. It is an excellent tool to create mind-maps and diagrams. After they had completed the task, they were supposed to send it via e-mail for assessment. Having satisfied the requested criteria, they were approved to upload it on Trello board Applied Linguistics and Language Teaching II in the card Discourse Analysis. Trello is a project management or a task management tool that works with cards and columns. This organizational principle provides a visual representation of tasks. The columns can be freely defined, and the cards can be moved around or re-ordered (www.trello.com) (Lytle, 2012).

As we can see, the students had to employ the verbs at all levels of the taxonomy. They had to make a list of all the features in order to describe various discourses they had provided as examples. Afterwards, they had to summarize the features and distribute them to four categories at the same time comparing the categories and exemplifying. Having completed this stage of the task, they were inclined to find the way how to show/exhibit these categories in Popplets. During the process of Popplet creation they were expected to compare the categories and think of the ways of organizing them in accordance with the conclusions they had drawn. While doing this they were experimenting with the online tool. Finally, they made a plan how to design their Popplet.

In digital context, in order to find various presentations of different extracts and samples describing various discourses, they had to do some searching/googling. The students used social networking in order to communicate with their colleagues as they have a Facebook group created for this purpose (Munoz & Towner, 2009). In order to use the online tools (Popplet and Trello), they had to subscribe. Along with learning how to use these new applications, they also had to run, operate and hack the tools, upload their work and share it. In the Popplet creation they had to do some mashing and linking. After posting their work, it was validated by the teacher and moderated by the rest of the class.

Pragmatics Task II

Task: Analyze and comment on the dialogue the professor uploaded on VoiceThread.

Online tools: VoiceThread

Traditional verbs:

    C: producing, inventing

    E: hypothesizing, judging, detecting

    A: deconstructing, attributing

    A: carrying out, showing, using

U: interpreting, explaining, exemplifying, inferring

R: finding, describing

Digital verbs:

C: videocasting

E: monitoring, commenting, posting, collaborating

A: mashing, tagging, validating

A: uploading, sharing, editing, annotate

U: categorizing & tagging, subscribing, commenting

R: searching, googling, social networking

After completing the chapter Pragmatics, the dialogue Silly Job Interview by Monthy Pythons[5] was uploaded on VoiceThread (www.voicethread.com) (Rodesiler, 2010). VoiceThread is a totally web-based application that allows you to place collections of media such as images, videos, documents, and presentations at the center of an asynchronous conversation. The application enables students to post their comments in five different ways: as a text comment, an audio comment, a video comment, an uploaded comment and a comment left via phone.

In this process they used all six levels of thinking in the taxonomy. They had to find and describe the dialogue. On a higher level they had to interpret and explain the dialogue, carry out an analysis and choose the way to show their opinion. They had to deconstruct the dialogue to its main segments and attribute the features to its participants and argument their illocutionary force. In doing that, they had to detect references, hypothesize the participants' intentions and judge their behaviors. All their comments were visible to other students, so they often challenged the opinions of the colleagues and elicited a kind of discussion. In the end, they 'invented'/produced something completely new as a result of their collaborative work.

In the digital context, they had to follow the link and enter the VoiceThread. They used Facebook group for any misunderstandings or questions they had. In order to be members, they had to subscribe so that their comments can be tagged. In this meshing process they were uploading, sharing, annotating and commenting. Furthermore, they were collaborating, monitoring each other's work and posting their comments. The final result was videocasting the final product.

Corpus Linguistics: Task III

Task: British National Corpus Search (KWIC) and the analysis of the hits.

Online tools: Google Search

Traditional verbs:

C: Planning, Producing

E: Testing, Detecting

A: Comparing, Attributing

A: Carrying out, Using, Showing,

U: Interpreting, Inferring, Classifying, Explaining, Comparing, Exemplifying

R: Listing, Finding,

Digital verbs

C: publish

E: commenting, detecting

A: validating

A: categorizing, commenting, hacking

U: advanced searching

After completing the chapter Corpus Analysis, the task set to students was to carry out an analysis of whichever word they chose from the British National Corpus[6]. More specifically, they had to mark the type of analysis as KWIC and choose the context for the word (spoken, written, meetings, letter *etc.*). They were provided with a list of key words in various contexts with specific number of hits. They were expected to analyze the word from grammatical and semantic/lexical aspect. They used the online tool Google Search to perform this task. Upon the assessment, they uploaded it on Trello.

The students used the first two levels by finding the website and understanding how to use it. Afterwards, they carried out the search and tested the software. In this process, they had to compare the words in different contexts and to detect typical and exceptional cases. In the end, they had to plan the manner of presenting the collected data and 'produce' a unique piece of work with their own hallmark.

In digital context, they used the verbs from four levels. They used advanced searching because they had to navigate the search to find the page where they can type the word and conduct the analysis. They had to hack the software in order to know how to use it. They categorized the keywords according to the words that were in its vicinity and commented on the search results. They had to consult the theory in order to detect the existing patterns and comment on them. In the end, they published their result and posted it on Trello.

5. CONCLUSION

An urgent need for exploration of Bloom's taxonomy in digital context has emerged from the fact that both, the original Bloom's taxonomy and the one revisited by Anderson and Krathwohl, were not able to address new processes and objectives that appeared as the result of technological advancement and integration of ICT into the everyday student's life. We presented the Bloom's Digital Taxonomy Map by Andrew Churches via a case study of three tasks, performed by the use of online educational tools within the courses conducted at the Faculty of Philology, University of Sinergija. We showed that the students' performance of these tasks

5   https://www.youtube.com/watch?v=zP0sqRMzkwo

6   http://www.natcorp.ox.ac.uk/

proved to be efficient and effective, since it enabled them to activate higher levels of thinking, learn to navigate in the digital world and individually and collaboratively apply theoretical knowledge both in practice and digital world. Furthermore, the application of this method brought the following benefits to the teaching and learning process within this course: (1) the homework concept in the students' digital environment is being set; (2) the collaboration among students via the Facebook group is being provided; (3) the students' creativity and freedom to choose the manner in which their tasks are going to be presented via online tools is being exercised; (4) a greater level of engagement and devotion is being displayed by students due to their awareness of the fact that their work would be in the public eye and (5) students' literacies and fluencies are being developed in this manner. The overall process just opened the door to new ways of teaching and learning at the Faculty of Philology in Bijeljina and generated the implementation of many innovative ideas in the upcoming time.

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NECESSARY STEP FROM "ICT" TO "LTK" IN FOREIGN LANGUAGE TEACHING AND LEARNING

Maja Veljković Michos,
Lora Petronić Petrović

[1]Singidunum University
32 Danijelova Street, Beograd, Serbia

[2]Singidunum University
Faculty of Business Valjevo,
Valjevo, Serbia

Abstract:

When we speak about new technologies and education, the first thing that comes to our mind is information and communications technologies or ICT. Technological progress and development of information systems have inevitably led to the incorporation of ICT in the teaching-learning methodologies. With the use of new digital educational content in our classrooms, temporal and spatial boundaries of those two processes have been transcended. However, teachers of foreign languages face the fact that the incorporation of ICT in the teaching procedure doesn't imply necessary improvement of knowledge and language skills of students. Therefore, it is essential to develop digital competences of both teachers and students, which will further ensure adjustment of teaching-learning process to modern circumstances. Hence, it is necessary to introduce and apply a new concept in the teaching methodology - "LTK - Learning Technologies Knowledge", which emphasizes the application of digital or virtual materials for the enhancement of teaching, learning and assessment. In this paper, we will propose certain useful guidelines and tools that can ensure proper application of ICT in our educational environment, thus improving students' knowledge and skills while learning a foreign language.

Key words:

ICT, LTK, teaching and learning, foreign language, Web tools.

1. INTRODUCTION

Technological innovations have provided creation of new educational environments and new learning experiences. In this sense, computer skills of teachers should be developed according to technical and educational progress. Moreover, our role as teachers is fundamental in this process, since we have to be those who know how to apply ICT in order to help our students learn a foreign language using modern technology.

On the other hand, our students are mainly more proficient than us in using the Internet and they carry out different online activities daily (surf, chat, download videos and songs, communicate with friends on social platforms, read magazine or newspaper articles *etc*). Consequently, teachers should consider this advantage and make our students more responsible for their own progress by putting it to work for learning (Gonzalez Romero 2007: 161).

Nevertheless, not all activities performed with use of ICT are valuable for the teaching and learning process. It is clear that new technologies alone can neither produce educational innovation, nor the fact that we are using them makes us better teachers or students. For that reason, the role of the teacher

Correspondence:

Maja Veljković Michos

e-mail:
mveljkovic@singidunum.ac.rs

in the teaching process is essential – not in the way to teach our students to use technology (since, as we previously said, they do that even better than we do), but to teach them how to use it properly in order to learn a foreign language.

2. ICT OR LTK?

Our main objective in using technology as an improvement in teaching and learning process is to make our students better and more independent learners, as well as to ensure that they acquire or improve both learning and language skills. At this point, we start talking about LTK - Learning Technologies and Knowledge, as, so far, the final stage of teaching in digital era. First the teaching was about ICT, and then through ICT, until we arrived to LTK, where our goal is that our students learn language with technology (Vivancos: 2008).

Hence we can say that from the Society of Information where we began to handle ICT, with the intention to manage and collect generated information, we turned to the Society of Knowledge, where the significance of technology is not anymore just gathering and using information. Its importance is now transformed into knowledge – using it in the proper way. This means that technologies provide access to knowledge and learning, and it leads us to technologies of Society of Knowledge which are the LTK (López 2013: 3).

Once this distinction is done, teachers need to evaluate every new tool they find in order to determine how it fits into their curriculum and their didactic methodology. Before incorporating ICT in the process of teaching and learning, it is essential to understand their purpose, not just their form. In achieving this, teachers should ask themselves the following useful questions:

1. Will ICT encourage learning?
2. Will ICT bring new possibilities and improve the efficiency of procedures that we are already using?
3. Do they fit into our didactic methodology?
4. Have we considered the possible risks?
5. Do they fulfill the needs of our students?
6. Do we know how to use them properly?
7. Do we need trainings, seminars and courses to learn how to use them properly?

If the answers to these proposed questions (or others that teachers may consider appropriate) are positive, we are referring to ICT that can be incorporated into the process of teaching and learning, or LTK. It further means that it is necessary to determine the most appropriate methodology to be incorporated in our classroom, in order to develop

digital competences of both teachers and students, and thus diminish the existing gap between teachers, considered digital immigrants and students, considered digital natives (Prensky: 2001).

One of the appropriate methodologies that we found very helpful was designed by Mishra and Koehler in 2006, a model known by its acronym TPACK (Technological Pedagogical Content Knowledge).

According to this model, the way to improve a good use of ICT and LTK in educational environments is based and depends on the knowledge of the teachers. Therefore, language teachers should not focus exclusively on the educational and linguistic contents to be developed and learnt, but should also have knowledge about technology, which will allow them to select and manage the Web tools and resources in order to create the content they want to exploit in the classroom. This, of course, presumes that teachers have already acquired and implemented knowledge in didactic methodologies which is appropriate for teaching a foreign language in their lessons, those of learning by doing, experimenting, of collaborative and cooperative nature, which allow that the classrooms become shared learning spaces for building up skills and knowledge.

3. INTEGRATION OF ICT IN CURRICULUM (TPCK MODEL)

The idea of TPCK (Technological Pedagogical Content Knowledge) was developed by professors at the University of Michigan and it became a tool that prepares teachers to successfully implement technology in classrooms (Mishra and Koehler 2006:1017-1054).

According to this model, expertise in smart adoption of technology by teachers and students is required in order to accomplish effective teaching and learning process. Moreover, it is primarily aimed at teachers and demands more specific skills from them, especially because they are sometimes faced with barriers that discourage them from using ICT in the classroom or creating additional materials with them. In that sense, there are seven combinations of analysis offered by TPCK model.

These different combinations allow planning different teaching strategies in order to improve the process of language learning, taking into consideration more aspects: content-pedagogy-technology:

- ◆ CK (Content Knowledge)
- ◆ PK (Pedagogical Knowledge)
- ◆ TK (Technological Knowledge)
- ◆ CPK (Pedagogical Content Knowledge).

- TCK (Technological Content Knowledge).
- TPK (Technological Pedagogical Knowledge)
- TPCK (Technological Pedagogical Content Knowledge)

The next table presents UNESCO ICT Competency Standards for Teachers (ECD-ICT), which represent a reference model for integration of ICT in curriculum (url: UNESCO ECD-TIC).

4. WEB TOOLS FOR LEARNING TECHNOLOGY KNOWLEDGE

Considering the previous table of Standards of ICT skills for teachers, as language teachers at university, we asked ourselves what the best way would actually be to use web tools in our teaching and how we should use them to make our students, as we previously stated, better and more independent learners. The answer laid in the fact that there

	Basic ICT knowledge	Knowledge Deepening Approach	Knowledge Application
Pedagogy	Integrate ICT, "knowing" where, when (also when not) and how to use (ICT) digital technology activities and presentations in the classroom	Solution of complex problems. Structuring tasks, guiding the comprehension and supporting collaborative projects.	Self-management. Forming learning processes, structuring situations in which students apply their acquired skills and helping students to acquire new skills and knowledge
Teacher Professional Development	ICT literacy. Gaining ICT skills and knowledge from web sources, in order to use ICT in acquiring additional knowledge about their subjects, besides pedagogy, contributing to their own professional development.	Management and guidance. Create complex projects, collaborate with other teachers and make use of networks in order to have an access to information, colleagues and experts, to support their own professional development.	Teacher in the role of a student. Show willingness to try, learn continuously and use ICT in order to create professional knowledge communities.
Curriculum and Assessment	Basic knowledge. Have solid knowledge of curriculum standards (study plan) from their subjects as well as the ability to integrate the use of ICT by students and these standards in the curriculum.	Application of knowledge. Have exhaustive knowledge of their subject and be able to apply it flexibly in a variety of situations.	Competencies of the XXI century. Know the complex cognitive processes, know how students learn and understand the difficulties they can face.
Organization and Administration	Standard lecture rooms. Be able to use ICT during activities with the entire class, small groups and individually. Ensure equal access of students to ICT.	Collaborative groups. Being able to create flexible learning environments in classrooms. In these environments, teacher may integrate student-centered activities and flexible application of ICT, in order to support collaboration.	Organization of learning. Being able to play a leading role in the formation of their colleagues, as well as to promote development and implementation of the vision in their school as a community based on innovation and lifelong learning, enhanced by ICT.
Use of the IKT	Basic tools. Know the basic function of hardware and software, as well as productivity applications, the Internet browser, a communication program, a multimedia presenter and management applications.	Complex tools. Knowing a variety of applications and specific tools and should be able to use flexibly in different situations based on problems and projects.	Widespread technology. Ability to create knowledge communities based on ICT, and capacity to use them in order to support the development of students' skills in both ways: creation of knowledge and permanent and reflexive learning.

Table 1. Standards of ICT skills for teachers (Adapted from UNESCO, 2008).

existed such abundance of web tools that we could search for those matching each type of intelligence, as well as with different strategies for learning a foreign language.

Being a skill, comprised of four subskills (listening, speaking, reading and writing), learning a foreign language implies practicing these skills on a regular basis. In this fact we found our next directive – to look for a web tool that would support everyday practice of a language. At the beginning there were plenty of them we could choose from; those that were not meant for teaching at all, such as blogs, wikis, even social networks, such as Facebook, Twitter or Instagram, until appearance of the one specially developed for teaching/learning purposes, MOODLE platform. It is based on pedagogical principles, and it offers us possibilities of adjusting teaching and learning methods from our classrooms to virtual world. It means that it not only helps us continue communication with our students after classes, but it helps us continue interaction (individual, pair or group work) among themselves even though they are not sitting in the same room. The only pitfall of this tool that we had to overcome was to make our students "visit" it regularly.

The best way to match content and technology was found in creating different activities and exercises that implement strategies needed for successful learning. In presenting different web tools for this purpose, we would start with those used for learning vocabulary, as we consider vocabulary the basis for foreign language learning.

In order to make our students good vocabulary learners, we enlivened strategies for learning and integrating it in already existing knowledge, such as using word/ flash cards with QUIZLET (http://quizlet.com/), mnemonics with MIXBOOK (http://www.mixbook.com/), word searchers with PUZZLE MAKER http://www.puzzle-maker.com/WS/, crosswords with CROSSWORD PUZZLE GAMES http://www.crosswordpuzzlegames.com/create.html, LISTEN AND WRITE (http://www.listen-and-write.com/ for practicing spelling and dictations, as well as VOKI http://www.voki.com/ for practicing pronunciation (or speaking and listening skills).

Furthermore, we propose tools that can be used for improving all four language skills, as well as strategies for their learning. In the first place we put WORDLE http://www.wordle.net/, which can be used for creation of warm-up, lead-in to wrap up activities. Then, there are several tools for creating mind maps, of which we will mention https://www.text2mindmap.com/, http://www.wisemapping.com/ and https://bubbl.us/. For creating posters we suggest using GLOGSTER http://edu.glogster.com/, POPPLET http://www.popplet.com/ or SMORE https://www.smore.com/. One of the very useful tools is http://www.eslvideo.com, a

site where interactive quizzes can be created, as well as KAHOOT https://getkahoot.com/, for creating online quizzes, discussions or surveys.

5. CONCLUSION

When we refer to advantages of applying ICT into the process of teaching and learning foreign languages, we consider the fact that this is a complex procedure of developing the language skills of reading, listening, writing and speaking for which the foundation is teh knowledge of vocabulary and grammar rules. With ICT integrated properly in curricula, it has become possible to create exercises for practicing all previously mentioned. In addition to doing exercises created by teachers, students also participate in creating exercise themselves, and in such a way become responsible for their own learning and are able to follow their own progress.

The importance of ICT is now transformed into knowledge – using it in proper way. This means that technologies provide access to knowledge and learning that lead us to technologies of Society of Knowledge which are the LTK.

Web-tools have become very useful and necessary LTK strategy in the process of teaching and learning a foreign language, completely integrated in the demands of modern didactic methodology.

If used properly, ICT or LTK become powerful tool for encouraging students for autonomous and effective learning. In this paper, we presented examples from our own practice, as a brief review of different activities we are using them for, with the aim of making our suggestions basic guidelines for some future work and research.

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THE IMPACT OF ICT USE ON FLL
IN DIFFERENT PERSONALITY TYPES

Marija Stanković,
Milica Čolović

Singidunum University
32 Danijelova Street, Beograd, Serbia

Abstract:

This paper concerns the effects of ICT use on the process of foreign language learning, specifically English for different personality types of learners. Our aim is to test whether the use of ICT in English classes, or at home, during students' primary and secondary education, has had an impact on students' language proficiency and whether and to what extent that impact has been influenced by students being introverted or extroverted. This small-scale research was carried out at Singidunum University, Centre Niš, with the first year students whose knowledge of English ranges from A1 to B2. Based on the results obtained, it can be noticed that there is a significant correlation between the personality type and teaching methods in relation to language learning. Furthermore, in terms of frequency and purposes of ICT use, and what they perceive as a good possibility for language improvement, there are differences between male and female students. Most students would not opt for a replacement of a traditional face-to-face contact with ICT. However, since young adults increasingly use ICT for non-educational purposes, it would be irresponsible not to take advantage of that and encourage and teach students to become ICT-oriented when it comes to education.

Key words:

ICT, FLL, personality type, traditional methods, gender.

1. INTRODUCTION

With the rapid technological advancement and increasingly growing amount of knowledge, the importance of ICT in the learning process is no longer questionable. Not only is its implementation in classroom recommendable, but it seems to be the only way to respond to the ever growing demands on knowledge acquisition. In other words, since traditional learning methods seem to be failing to meet the needs of a modern society, learning environments should rely on more contemporary methods, thus offering a variety of learning activities based on efficient knowledge acquisition strategies. The benefits and potential of ICT are especially prominent in FLL (Foreign Language Learning) and FLT (Foreign Language Teaching), which, being both skill-based and knowledge-based, differ from most other subjects (Fitzpatrick and Davies, 2003). With learning becoming more autonomous, a teacher's responsibility is to grasp individual behaviour and find ways to cater for each individual's needs, interests and learning styles, providing personalised learning environments. However,

Correspondence:

Marija Stanković

e-mail:
mstankovic@singidunum.ac.rs

a question frequently posed is: can ICT equally support and nourish all four language skills, irrespective of an individual's personal traits and preferences? This paper attempts to examine whether students' knowledge of the English language has been influenced and navigated by the teaching methods used in primary and secondary education and whether such methods were or were not in accordance with an individual's personality type.

Overview of ICT use in education

In order to gain a better understanding of ICT in teaching/learning processes, its origin, the entire process of implementation from a modest towards a widespread use, its benefits and limitations, as well as its future potential and changes it brings and demands from both teachers and learners, we should begin with a brief overview of the topic and the accompanying concepts in the relevant literature.

Although the use of computers in FLT and FLL began in 1960s, it was only in the mid-1980s that computers became all pervasive and thus easily accessible (Fitzpatrick and Davies, 2003). Nowadays, ICT permeates all spheres of a globalised society, redefining the ways of conducting business and commerce and with an emerging impact on education and training. There are three stages of the so called CALL (Computer Assisted Language Learning), each of them corresponding to technological developments and pedagogical advancements, as well. When behaviouristic approaches to FLT began to be frowned upon, there appeared communicative approaches, only to be soon replaced by constructivist/integrative approaches (Fitzpatrick, 2003). Each of these brought about important changes in the roles of not only the teacher and the learner, but the computer, as well. Firstly, the Internet represents a vast resource of authentic linguistic materials, which enables teachers to step out of the classroom boundaries and, improving their own knowledge, learn to tailor materials to meet the needs of any learner, regardless of their age, level of knowledge, or other. Therefore, implementing ICT in learning processes, teachers abandon their traditional roles and become guides, mentors, facilitators, mediators, researchers, conscientious designers of learning scenarios, collaborators, orchestrators, evaluators and self-evaluators (Fitzpatrick, 2003). Instead of pouring knowledge into the heads of curious and information-hungry students, they are to facilitate the learning process, to guide and enable students to interpret the information they are given and relate it to their prior knowledge and experience. Secondly, the role of the learner has undergone some crucial

changes, most important of which is that the learner is no longer an object, but rather a subject, not only with their own needs, interests and cognitive abilities, but also with responsibility for their learning. Like teachers, they also have access to online materials, and instead of being passive recipients of a language, they actively and independently participate in exploring, learning and creating a language, sharing it with their peer learners via ICT. Finally, the role of the computer has changed: originally a tutor, then a tool, now a stimulus in language learning, a data source, a communication facilitator, a tester and, in a way, a teacher (Padurean and Margan, 2009).

Overview of personality types

Pedagogy and methodology have always relied on psychology, which, on the one hand, has been trying to grasp the general principles underlying the human mind and, on the other, to fathom the uniqueness of the individual mind. Individual differences become especially prominent the moment we claim that the role of the teacher has evolved to that of a tailor of the available authentic material.

Learners differ from each other. Research has shown that individual traits may be the most consistent predictors of L2 learning success, which, unlike L1 acquisition, can range from zero to native-like proficiency (Miyake & Friedman, 1998). Therefore, language aptitude and motivation are not enough to ensure that the learning process goes smoothly. Due to individual differences, which come in terms of personality, learning styles, anxiety, self-esteem, creativity, willingness to comunicate and other (Dörnyei, 2005), individualised learning techniques are required. According to Carl Gustav Jung, the father of analytical psychology, there are three bi-polar concepts: extraversion–introversion, sensing–intuiting, and thinking–feeling, with each person having a preference for one of the two cognitive functions. A fourth dimension was added by Myers-Briggs in 1970s: judging-perceiving. Nowadays, a very popular model for determining individual differences is the so-called Five Factor Model (FFM), or the Big Five personality traits, which focusses on five dimensions: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism (Dörnyei, 2005). Even though there are some doubts as to whether and to what extent individual differences have an impact on learning, extensive research has shown that at least two of them – openess to experience and conscientiousness – do have, indeed.

2. METHOD

Participants

The research was done at Singidunum University, Centre Niš, with the first-year students. Immediately upon the admission, all students were required to do an online placement test due to the fact that they came from different towns and different schools and, as a result, were on different level of English proficiency. Based on the results, the students were divided into two groups, a group A consisting of those whose results showed they were either on B1 or B2 level, and group B, who were on A1 or A2 level. Fifty students were recruited for the research, 25 students from group A, and 25 from group B, 25 male and 25 female. All students were 19-22 years old.

Procedure and instruments

Firstly, the participants were asked to complete the questionnaire created for the purposes of this research, and afterwards to complete a free online personality type test, with previously given oral instructions. Furthermore, the students' scores on the initial online placement test were taken into consideration.

The questionnaire was comprised of ten questions, which can be grouped into three categories. The first category focuses on the participant's exposure to English: how many years the participant has been studying English, whether they have learned it mainly at school, from private teachers, film, music, or video games, and what materials they have been exposed to in their English classes (ranging from a textbook only, to a combination of a textbook, CDs, other audio, video and the Internet material). The second category refers to how often and what for the participant uses a computer and a mobile phone. The third set of questions was aimed to elicit the participant's opinion on whether ICT has improved or can improve their knowledge of English, whether they feel more comfortable learning English online or in a traditional classroom setting, what can improve their knowledge (studying within a small group of students and with a teacher, studying regularly at home, the use of ICT and the Internet, spending some time in an English speaking country, or a combination of at least two previously mentioned methods.

An online free personality test[1] was used in the experiment. The test consists of 60 questions to which the participant should provide an answer on a seven-step

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1 https://www.16personalities.com/free-personality-test

scale, from totally agree to strongly disagree, trying to avoid the neutral (middle-step) answer. The test takes 10-15 minutes to complete. The 16 personality test used in this research, is based on the three models - Jung's, Myers-Briggs' and the Five Factor Model, and analyses individual traits in terms of five personality aspects, which, when combined, result in a certain personality type. Those five aspects are: Mind (introverted-extroverted), Energy (observant-intuitive), Nature (thinking-feeling), Tactics (judging-prospecting) and Identity (assertive-turbulent). There are sixteen possible combinations, or personality types. However, since the number of the participants is relatively small, we decided to analyse the results not in terms of every single type, but in terms of four main categories: Analysts, Diplomats, Sentinels, and Explorers. The role layer determines one's goals, interests and preferred activities.

3. RESULTS

The data obtained via personality type testing was emailed and later analysed using SPSS software, together with the data obtained via the questionnaire and the placement test scores. The values were presented as mean values. P values of less than 0.05 were considered significant.

The results obtained can be analysed from three aspects. One part of the questionnaire focused on the participants' exposure to English: how long they have been studying it, whether they have learned it mainly at school, from private teachers, or films, music and video games, and what materials they have been exposed to in their English classes. The results showed a correlation between a personality type and learning from the school teacher ($x^2 = 9.36$, $p < 0.05$), where Explorers are most prominent ($MR = 30.50$), then Analysts ($MR = 28.50$), and Diplomats and Sentinels, respectively ($MR = 19.30$, $MR = 18.97$). Also the statistical significance was reached in terms of a personality type and learning from textbooks, with Explorers, Diplomats and Sentinels having the same preference ($MR = 22.50$), and Analysts the smallest one ($MR = 16.50$), where ($x^2 = 28.82$, $p < 0.01$). Furthermore, the analysis of the scores on the online placement test has also shown that there is some correlation between the scores and a personality type ($x^2 = 15.54$, $p < 0.49$): Architects/Analysts ($MR = 33.38$), Entertainers/Explorers ($MR = 25.50$), Campaigner/Diplomats ($MR = 22.20$), Protagonists/Diplomats ($MR = 21.14$), Entrepreneur/Explorers ($MR = 20.50$).

Secondly, the analysis confirmed that Jung's first variable, Extroverts-Introverts, bears considerable significance. As expected, Introverts are more likely to use the Internet for: searching information ($t = 2.35$, $p < 0.05$), communicating with teachers ($t = 2.99$, $p < 0.01$), studying ($t = 2.67$, $p < 0.05$), and playing video games ($t = 1.29$, $p < 0.01$). On the other hand, Extroverts are more likely to use the Internet for watching films ($t = -0.90$, $p < 0.05$), and listening to music ($t = 1.29$, $p < 0.05$). Moreover, Extroverts feel more comfortable studying traditionally, from textbooks ($t = 2.91$, $p < 0.05$) and combining textbooks and CDs ($t = 1.98$, $p < 0.01$).

Thirdly, a statistical significance is also evident from the perspective of gender. It is females, slightly more often than males, who use the Internet (4.84 *vs.* 4.65), look for online information (1.04 *vs.* 1.00), spend more time on social networks (1.12 *vs.* 1.03), play video games and learn English by playing video games (1.64 *vs.* 1.19 and 1.84 *vs.* 1.38), think that their English would improve by spending some time in an English-speaking country (1.40 *vs.* 1.15). However, it is males, rather than females, who communicate with teachers via email more often (1.23 *vs.* 1.08), learned English from school teachers and teaching material such as textbooks, CDs and videos (1.30 *vs.* 1.16 and 1.88 *vs.* 1.76), and think that their English would get better if they study regularly at home (1.84 *vs.* 1.60).

4. DISCUSSION

From the results obtained in the research, we wanted to see whether using ICT in FLT/FLL has had any impact on the students' proficiency and whether and to what extent one's personality traits are responsible for that impact. We opted for the first-year students, who are on different level of English proficiency, which was confirmed by the online placement test they did immediately upon the admission. Their background data concerning their L2 learning experience was collected via the questionnaire, along with the data referring to their use of ICT and their views on the best ways and means for possible improvements. These two sets of data were compared mutually, as well as with the personality type test results of each student. The objective was to see what correlation, if any, there is between the personality type, the teaching methods, more precisely the use of ICT and the current knowledge of the English language.

When communicative approach was replaced by constructivist approach in the late 1980s, both on theoretical and pedagogical level, there also appeared a need for a more systematic use of ICT in the teaching/learning process. What began to be emphasised was the socio element of learning and thus, until that moment, a pure cognitive view turned into a socio-cognitive view (Fitzpatrick, 2003). The objetive was to create authentic social contexts which would enable the learner to use a language rather than studying about it, an environment which would be fertile for each of the four language skills and which would simultaneously promote, integrate and take advantage of the rapidly growing technology.

What was extremely important was the assumption that each learner is an individual with their own features and preferences, while simultaneously, on the other hand, it was claimed that good language learners share a common set of most prominent personality features, which proved to be consistent in various studies. According to a questionnaire survey by Lalonde, Lee, and Gardner (1987), success in language learning is guaranteed if the learner is meticulous, persevering, sociable, inquisitive, independent, organised, active, involved, flexible, assertive and imaginative. When the door to psychological research was widely opened, it was confirmed that individual traits may be quite reliable predictors of L2 learning success. Among many, the two traits pointed out by most renowned psychologists were conscientiousness and extroversion. Whereas conscientiousness has shown consistent results, extroversion has not always produced positive results in school learning process, which is accounted for by introverts' tendency and ability to consolidate learning, by not being so distractible and by having better studying habits. On the other hand, in formal situations and pressurised environments, extroverts feel more comfortable, they do not feel they are under pressure and they speak more fluently and accurately. Therefore, when it comes to second language learning, it does not necessarily mean that being introverted will inhibit the learning process, or that being extroverted will enhance it. Both extroversion and introversion can be positive, depending on the context.

This was confirmed by our results as well. Those students whose mind was assessed as introverted on the online personality test said that they used the Internet for communication with teachers, searching information, studying and playing video games, whereas those whose Mind was assessed as extroverted said that they used the Internet for watching films and listening to music, and that they preferred studying from textbooks and CDs. However, the Explorers, who said that they had learned language mostly from school teachers and from textbooks, did not have the best scores on the placement test.

Finally, some of the results obtained in terms of gender are somewhat surprising: the female students use the Internet more often, they play video games, and believe their English would improve if they were to spend some time in a foreign country, unlike the male students, who had learned mostly from school teachers and textbooks, CDs and videos, and who said that they would rather communicate with their teachers via email.

Nowadays, when traditional methods do not seem to be enough to respond to the growing demands for knowledge the use of ICT in education is more than advisable. Learning is becoming more and more autonomous and the teacher is expected to fathom each learner as an individual and to provide personalised learning environment, responding, on the one hand, to individuals needs and learning styles and, on the other hand, enabling students to respond to the needs of society. The teacher has the responsibility to take advantage of the all-pervasing ICT and encourage and teach students to become conscious of the benefits and necessities of ICT in a life-long educational process.

5. CONCLUSION

The aim of this paper was to examine the effect of ICT use in the process of foreign language teaching and foreign language learning in relation to personal traits. In order to do so, firstly, we had to establish the current level of students' English proficiency, which had been done by students doing an online placement test; secondly, we had to obtain the information about whether students had been using ICT in the process of learning during their primary and secondary education, *i.e.* how often and what for they used the computer, which was done via the specially created questionnaire; thirdly, it was necessary to find out each student's personality type by asking them to do an online personality type test. This small-scale research included 50 first-year students at Singidunum University, whose English knowledge ranges from A1 to B2. The results obtained in the study show a certain correlation between being extroverted or introverted and the teaching methods used in FLT, thus confirming numerous previous studies which claim that whether or not one will learn successfully a second language indeed depends on what type of person he or she is and, consequently, whether or not the teaching material and methods are designed to satisfy one's needs, interests and learning habits. Given that this was a smale-scale research, further research is needed to definitely confirm this and, possibly, establish additional correla-

tions between the degree of ICT exposure, personality type and the proficiency.

ICT has already modified the culture of learning and yet it is going to bring about even more changes. Nowadays, the positive aspects and the necessity of implementing ICT in language teaching and learning processes are unquestionable. Just as the computer has evolved to revolutionise our social life, so has it altered both the teacher and the learner. Once the objective of language teachers was to ensure that students spend endless hours trying to memorise grammar rules and vocabulary. This was then replaced by the one which insisted on encouraging and motivating learners to develop communication skills. A 21st century language teaching goal is to enhance the human and social development of students and community (Warschauer, 2002), not only by trying to simulate the atmosphere of an authentic environment, but rather by finding one and introducing students to it. Mastering language skills should not be separate from mastering technology, or other areas of interest. Encouraged to satisfy their own needs and interests, whether in self-directed and independent activities, or in interactive, cooperative work, learners take on teaching roles and, consequently, the responsibility. Nonetheless, with the increase of responsibility on the part of the learner, the teacher's responsibility does not decrease; quite the contrary, having to assume multiple roles and functions instead of only one, the teacher has gradually turned into a learner himself.

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GAME-BASED LEARNING IN ENGLISH FOR PROFESSIONAL PURPOSES

Tatjana Marković

Belgrade Business school
– Higher education institution
for applied studies,
Belgrade, Serbia

Abstract:

This paper aims to explore the potentials of introducing game-based learning in English for Professional Purposes course at the tertiary level of education. It considers the possibilities of integrating an online business game in a task-based experiential syllabus using simulation as its core technique. Simulations are seen as a viable, dynamic, communicative and learner-centered approach that enables creating the learning experience that resembles real-world professional experiences. By integrating language, content and skill development in meaningful and purposeful tasks that replicate workplace target tasks, simulations create an immersive and stimulating environment that fulfills the needs for competence, connectedness and autonomy, thus increasing learners' motivation.

Key words:

simulation, task-based learning, game-based learning, ICT.

"People learn a second language more successfully when they use the language as a means of acquiring information, rather than as an end in itself…

…People learn a second language most successfully when the information they are acquiring is perceived as interesting, useful, and leading to a desired goal" (Richards and Rodgers, 2001: 207; 209).

1. INTRODUCTION

The new Conceptual Age (Pink, 2005) requires the possession of complex competencies and skills for the integration in the contemporary globalized and competitive workplace arena. It asks for a critical consideration of existing teaching practices and a search for imaginative and innovative solutions for preparing students to become functional and successful participants in their future professional communities.

In the field of English for Professional Purposes, the 21st century challenges necessitate the acquisition and development of complex communicative, language, cognitive, social and affective capabilities relevant in terms of workplace requirements. At the same time, there is a pressing need for learning to take place in a stimulative, enjoyable and exciting environment, as a critical element for awakening the motivation of the new game generation digital natives (Prensky, 2001:65).

Correspondence:

Maja Veljković Michos

e-mail:
mveljkovic@singidunum.ac.rs

One of the emerging trends in general education at all levels, including the tertiary level, is game-based learning, an innovative, action-based approach, relying on experimentation, self-discovery and exploration, often advocated as the future of education.

The first part of this paper will describe the rationale for the use of game-based learning, with simulation at its core, in teaching English for Business Purposes. The second part will be devoted to the presentation and review of an online business simulation and exploration of the pedagogical potential for its integration with the existing non-digital simulation in a task-based syllabus.

The simulation format has been found to be a viable, holistic, learner-centered and meaningful instruction choice, well-adapted to the needs of language and professional communication in the future workplace (Huhta *et al* 2013).

It is believed that such an approach effectively prepares students for operating in the professional environment and leads to the acquisition of the pertinent jargon, a set of professional skills and a repertoire of language skills used in everyday informal interactions with colleagues (Gatehouse, 2001).

Using game-based techniques enables:

a) creating a learning experience that is closer to the world and the way digital natives think and act, including a strong fun and game element, offering excitement, challenges and cooperation;

b) bringing teaching and learning closer to real-world professional experiences, by integrating language, content and skills development in meaningful and purposeful replicas of target tasks.

There is strong evidence that game-based approaches increase motivation and lead to deeper and more comprehensive learning results, as will be shown in the next sections.

2. GAME-BASED LEARNING – AN OVERVIEW

It is beyond the scope of this paper to explore the intricate classification of games and the complex relationship between games and simulations. For our purpose, it is sufficient to note that simulations have been traditionally considered as types of games, that the earliest simulations were in fact war games, and their relationship remains close to this date (de Freitas, 2006:10). As the author de Freitas (de Freitas, 2006:11) observes, through a more general educational lens, what brings games and simulations together is the potential they offer for learning through play, learning in immersive micro-worlds.

Games and simulations have been widespread in the field of amusement and entertainment for thousands of years, yet their use in education and training appears to be of a later date, somewhere at the end of the 18th century, primarily in the field of military training. In the 1950s they were introduced in management and business education, and from then on games and simulations have started gaining ground in a range of other disciplines (Ellington, Gordon, and Fowlie 2006::ix-x; Gredler, 2004:578; Klabbers, 2009:xi). Today we are witnesses of the massive development in the field of gaming and simulation and the growth in the variety of types and range of applications (Crookall 2010; de Freitas, 2006; Ellington, Gordon, and Fowlie 2006). Gaming and simulation is seen as "a promising, and rapidly expanding field of study", improving and evolving, "with new trends emerging, and new avenues of thought being explored" (USA Information Resources Management Association 2011: xxiv-xxv).

The potential of game-based learning is increasingly becoming appreciated based on numerous studies showing its effectiveness in cognitive development and curricular knowledge acquisition in new and innovative ways (de Freitas, 2006; Johnson, Smith, Levine & Haywood, 2011: 2011: 21-22; Whitton & Baek, 2013). Its positive effects also include affective and motivational outcomes, the development of perceptive as well as soft skills (Connolly *et al*, 2012:667; Wastiau, Kearney & Van den Berghe, 2009).

Games and simulations enable the creation of an exciting learning experience by fostering collaboration, problem-solving and procedural thinking, key competences for the 21st century (Johnson, Smith, Levine & Haywood, 2011:5). They cultivate creative thinking, experimentation and positive attitude towards intensive changes in our modern society. They are goal oriented, have an interesting story and enable learning while socializing (ibid.). At the same time, in the spirit of social constructivism, they create a space respectful of individual learning styles and strategies and multiple intelligences, increasing motivation and leading to longer-lasting learning (IGI Global & Felicia, 2011: x-xiii).

In higher education, they enable an integrated approach in acquiring content knowledge along with specific skills, such as decision-making, innovation, problem-solving and leadership (Johnson, Smith, Levine & Haywood, 2011, 2011:21-22). They offer the transformation of the learning process through direct experience in an immersive environment. As new generations of learners want interactive relationship with materials of different modalities (Prensky, 2001), the introduction of game-based learning is becoming increasingly popular. Finding ways to capture its motivational force in the field of education and use it to advance the

achievement of education goals has become the "holy grail" of teachers and practitioners (Garris, Ahlers & Driskell, 2002:442) [1].

GBL is gaining momentum and is increasingly becoming popular in the field of digital games, including so-called serious games, created solely for educational purposes, as well as in the area of long existing non-digital games.

In the domain of foreign language learning, games and simulations are not a recent fad and have been used since the 1980s and the emergence of the communicative approach (Coleman, 2002). The use of games and simulations in EFL, both digital and non-digital, has been widely documented (Crookall & Oxford, 1990; Dupuy, 2006; García-Carbonell, Andreu-Andrés & Watts, 2014; Levine, 2004; Magge, 2006; Naidu, 2007). However, they are coming into vogue again, as we are witnessing a rise in interest for using games in EFL, including adaptations of existing commercial games for the needs of foreign language courses.

Some studies explore the implementation of *Alternate reality games - ARGs*, such as *The Tower of Babel*, aimed at promoting foreign language learning in schools in a joint European project involving 300 students in 17 countries (Connolly, Stansfied & Hainey, 2011) and the use of interactive fiction in textual adventures (Pereira, 2013). Furthermore, the commercial computer game/simulation, the SIMS, which emulates everyday life and activities, has been used in several studies that looked into its impact on vocabulary acquisition of university students, showing its positive effect as a complementary activity in lexical acquisition (Miller & Hegelheimer, 2006; Ranalli, 2008).

In their analysis of vocabulary acquisition and retention using lexical games among students of engineering, Yip and Kwan (2006) have demonstrated not only increased student interest and motivation, but also improved success and effectiveness in reaching learning outcomes. At the same time, a growing body of research is being done on the use of virtual worlds, such as *Second Life*, *There,* and similar, synthetic immersive environments with possibilities of voice chat, which might be quite effective in foreign language learning (Ranalli, 2008:453).

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1 However, there are authors who believe that accurate results of game-based learning in the cognitive and subject matter sense are difficult to determine, as different studies use different methodological approaches, different classification of competences and skills and diverse terminological solutions. Furthermore, instruments for the precise measuring of learning outcomes of GBL are still inadequate, as it is much more complex than traditional learning (see Wastiau, Kearney & Van den Berghe, 2009 for a literature review on games in primary and secondary education, and Connolly *et al*, 2012 for a comprehensive overview of relevant studies dealing with games in higher education).

In the next section we are going to explore simulation as a technique, both in its non-digital version and the possibilities for integrating it with a digital format.

3. SIMULATIONS – OVERVIEW

Simulations are gaining high status in institutions of higher education. The main reason for their rising popularity in the field of foreign language teaching is the fact that they integrate both the communicative and the interactional aspects of language.

They create a micro-world mirroring and modeling multi-dimensional aspects of the real world and offering students pathways for discovering its principles and relations (Rieber, 1996). Simulations represent a safe ambience for learning and trying out different competencies and skills in a world that is imaginary, yet with functions that are realistic. The scenario-based opportunities encourage various social interactions and learning transactions, whereas role play and character identification make the learning experience in immersive environments effective and stimulating (de Freitas, 2006:44).

In terms of the linguistic methodological approach, they belong to the realm of TBLT, which is oriented towards the primacy of meaning in the completion of tasks and achieving non-linguistic goals related to real-life professional goals. Tasks have tangible outcomes, clear purpose and a real context (Skehan 1996:38).

Being a highly versatile and flexible technique, simulations can be easily adapted to the needs of English for Professional Purposes and they are particularly suitable for intermediate and advanced level students in activating, consolidating and reinforcing existing competences and skills. They create an extremely powerful environment for promoting the development of the students' verbal repertoire.

For these reasons simulation as a technique has already been implemented in our English for Business Purposes course at the Belgrade Business School, enabling us inter-curricular integration and the parallel development of communicative, content, interpersonal, social and cognitive competences and skills, while at the same promoting creativity, cooperation and teamwork as the key elements for professional success and performance. In addition, simulation as a technique enables the creation of a playful environment which results in a highly inspiring and engaging experience contributing to successful learning.

4. THE COMPANY SIMULATION – DESIGN, STRUCTURE AND IMPLEMENTATION

The Company Simulation, developed for our first-year students, revolves around tasks and subtasks related to some of the typical situations and experiences that may arise in the professional target culture and future workplace: setting up companies, dividing company roles and recruiting personnel, attending a trade fair. It includes different business interactions and transactions, such as exchanging telephone calls and e-mails, requesting information, making quotations, placing orders and socializing with foreign guests and associates.

It is an attempt to recreate a representation of the business world reality in which students act out their chosen business roles, in line with Jones'(1982:5) definition of simulation as "a reality of function in a simulated and structured environment".

The Company Simulation has six stages. Each stage of the simulation project begins with a briefing, and ends with a debriefing session. The briefing session provides an opportunity to introduce the tasks, bring attention to specialist vocabulary and useful expressions (Bullard, 1990:59-60), and to activate students' content, linguistic and socio-cultural background knowledge (Knutson, 2003:56-57).

The debriefing session, which is part of the reflection process, is an indispensable pre-requisite for successful experiential learning to take place, the key to the transformation of practical experience into knowledge (Kolb 1984:38). It is a reconstruction of the learning experience, its success and its challenges (Bullard, 1990; Jones, 1982; Knutson, 2003). It reinforces learning through meta-reflection and making connections between game activities and tasks with those performed in the real world and sets the stage for corrective work.

The tasks in the Company Simulation revolve around different communicative situations stimulating communication and information exchange. The tasks have tangible outcomes and clear and meaningful purposes that require information gathering, decision-making, knowledge sharing and negotiating of meaning in bridging information gaps and resolving problem-solving situations.

The first stage is devoted to the building of the conceptual framework for company set-ups, organizational structure and departmental responsibilities. Mixed-ability student teams fulfill the task of establishing their virtual companies, choosing their names and headquarters, business operations and business missions, along with the delegation of appropriate roles (general manager, marketing manager, financial manager, *etc.*). This stage ends in short company presentations aimed at engaging and sustaining student motivation in further work, and sets the stage for the phases to come.

Stage two is built around designing CVs and cover letters for the chosen company positions. In order to relax the atmosphere, boost creativity and imagination, students are allowed to either keep their own identity in the Simulation or create a new one, a role which will make them feel secure and free to experiment and communicate without feeling stress and anxiety.

In phase three students prepare for attending a business fair by practicing different business interactions, such as booking flights and accommodation, making contacts with prospective business associates, conducting formal and informal social interactions in establishing rapport with colleagues and clients, with the objective of closing business deals with other student teams. This is an introduction to phase four were companies exchange e-mails and phone calls in the process of developing and finalizing the business deal.

The Simulation project closes with oral presentations of all the companies, exhibiting all their activities and transactions, and the submittal of a portfolio containing the documents generated throughout the simulation: CVs, e-mails and planners, as well as the students' journals registering their progress in the execution of tasks.

5. COMPANY SIMULATION REVISITED – AN INTRODUCTION TO VIRTONOMICS

The next step in enhancing the learning experience using the simulation technique lies in enriching the non-digital Company Simulation by integrating it with an online business simulation.

We believe that in ESP the biggest promise of GBL lies in the use of digital games and simulations originally developed for educational purposes in the professional subject areas. To be more precise, in teaching English for Professional, Business and Computer science Purposes, using business and entrepreneurial simulations such as Virtonomics (www.virtonomics.com) or Entrepreneurship Simulation: The Startup Game[2] may be most appropriate as complementary parts of the existing syllabus.

As the Virtonomics simulation is available for free use over the Internet we have decided to explore its learning potential and appropriateness with respect to the acquisition of language and content knowledge.

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2 https://cb.hbsp.harvard.edu/cbmp/product/WH0001-HTM-ENG

Virtonomics has managed to combine the educational and leisure aspects of game playing and having fun along with learning. It is a web-based online business simulator, a business strategy game, providing a framework for creating and developing a business. It represents a simulated virtual economy, based on real world economy and its business and managerial principles. It brings together more than one million players worldwide, creating a real business-oriented community with participants coming from all walks of life, businessmen, entrepreneurs, university and college students.

The aim of the game is to create a profitable and competitive enterprise. At the outset each player receives startup capital and is helped out during the initial period with different bonuses. However each virtual business owner is free in the choice of how to use and spend this money and which business goals to pursue.

Being a flexible and creative game, players are not limited to a single scenario; there are a variety of options to explore, each within a different realm, different industry, different strategic approach. From the outset, as a player, you build and manage your startup in an industry chosen among a variety of diverse options, both in terms of field of operation and type of enterprise. You can opt for retail business, manufacturing, medicine, automotive industry, oil refinery, sport equipment production, or something else, in Russia, Saudi Arabia, Argentine, you name it.

The games unifies 17 interconnected main business processes, 141 subsidiaries, 5 macro industries, 203 products, 33 countries, 300 cities. As a non linear environment, it allows each player to follow his or her own business path. Yet at the same time, he/she is a "part of a rapidly growing economy" with all the actions interconnected and created by real people, whether it is developing a business, forming partnerships, trading, purchasing or selling enterprises (virtonomics.com). Although the game is virtual, people and their interactions and transactions are real. Just like in real life you can try out different scenarios, and depending on your knowledge, persistence and experience, you can prosper or go bankrupt. The success of the business relies on your game actions. This involves making strategic and tactical decisions on a daily basis and judging the effectiveness of your campaigns, diversification, choice of suppliers, field of operations. It asks for constant market research, hiring, training and managing employees, investing in marketing, introducing technological innovations, improving the product quality, choosing the right partners, providing client satisfaction in order to start making a profit and rise to the top, so picking your niche and staying on edge is a must.

6. LEARNING BENEFITS OF VIRTONOMICS

Virtonomics is an excellent online environment for developing both hard and soft business skills, for making connections and communicating while still having fun.

It is a collaborative community, an environment with people willing to share their knowledge, experience and business acumen in helping newbies implement business strategies and develop their companies. Despite an essentially competitive nature of the game, players are willing to help each other out with advice. Furthermore, the game provides helpful resources such as forums, wikis- help files, guides, videos *etc*.

Its learning value lies in the fact that you can see results of your business decisions very quickly, much faster than in the real world. This enables you to adjust your moves daily in the struggle for a bigger market share and higher profit.

However, the important question remains and that is whether you can learn to do business by playing a game.

The authors of the game believe you can improve your entrepreneurial skills, and that playing a game where you can explore the consequences of making pricing, marketing and managerial decisions in a realistic environment in terms of competition and market conditions in a risk-free environment, can contribute in many ways in testing out your strategies and improving your business skills. You can also improve decision making in complex situations, analytical thinking, administrative skills and so on.

By combining the classroom Company Simulation with Virtonomics, where students could set up their companies in the virtual business community and follow their enterprises' progress based on managerial decisions and insight, we could take this English for Professional Purposes project one step further ahead, both in the area of professional competences and English competences development.

7. CONCLUDING REMARKS: CHALLENGES AND OPPORTUNITIES OF GBL

Language-wise, the Simulation leads to the practice, development and integration of all language skills through negotiation and cooperation in conquering different communicative challenges posed by various situations and interactions. The presence of non-linguistic outcomes that take the focus away from the language, inspires natural interactions and the use of different communicative strategies in overcoming communication barriers and information gaps, which has proven to be an effective pedagogical approach.

Interactional authenticity, relevance and pertinence for the future workplace make simulations a method of choice in English for Professional purposes. Tasks in simulations are contextualized, meaningful and purposeful, mirroring real life communicative challenges and they enable developing and consolidating both linguistic and professional competences. In terms of language development, adding the business simulation accelerates the lexical acquisition process, with important specialist vocabulary acquired in context.

Both the classroom and the digital version of the simulation are interactive formats, fostering cooperation and leading to the development of social and interpersonal skills, as well as affective ones. In other words, simulations activate analytical and creative, intellectual, social and emotional potential of learners (Crookall & Saunders, 1989; Oxford & Crookall 1990). Teamwork, collaboration and cooperation, tenets of social constructivism (Vygotsky 1978/1997), enable peer learning, and a shared experience of discovery and exploration (Breen & Candlin 1980:95), in both the digital and the non-digital simulation environment.

The classroom atmosphere in a simulation is safe and risk-free, lowering the affection filter and encouraging risk-taking, an important element in language learning. The setting is relaxed and light-hearted, reducing shyness and self-consciousness. Fun and excitement, creativity and imagination, with all the attention focused on the task and complete involvement and immersion in the game world, create a sense of flow, the optimal learning experience that arises in the delicate zone between boredom and anxiety (Csikszentmihalyi, 1975:35-36). This state, a pre-requisite for successful learning (Goleman, 2008:89), is important for ESP as well, since, albeit a practical approach, ESP should also include elements of "enjoyment, fun, creativity and a sense of achievement" (Hutchinson and Waters 1987: 48).

As an active pedagogical approach, the Simulation cultivates learner autonomy and independence, enabling students to make their own decisions and take control of their learning process. The format respects individual learning styles and strategies in planning and evaluating learning, thus giving students the sense of responsibility, achievement, self-efficacy and self-esteem. It raises the students' interest, stake, engagement and investment in their work, instills inspiration and motivation, promotes deeper learning (Crookall 1990:157), and thus epitomizes many aspects of the holistic and humanistic approach in learning.

In a psychological sense, games fulfill the requirements for awakening intrinsic motivation, as they satisfy the need for competence (the sense of ability), the need for autonomy (independent decision-making) and the need for connect-edness in a social sense (Przybylski *et al.*, 2010:155-157), the so called key elements of PENS- *player experience of need satisfaction.* This type of project would enable a) the development and application of competences, linguistic and specialist; b) the freedom and flexibility in decision-making and choice of strategies for reaching the desired goal; c) connectedness with other "players" through cooperation and competition, with an additional added value, and that is immersion into the world of "game".

In a professional sense, simulations bridge the gap between theory and practice, knowledge and action which is one of the cornerstones of education aimed at preparing students for the workplace arena. Using simulations, students at the tertiary level of education are given an opportunity to practice "the various multi-faceted, work-related skills that they will require once they enter employment" (Ellington, Gordon and Fowlie 2006:107). They practice the communicative skills and the professional knowledge and skills acquired in economic and business subjects through a simulated and accelerated "first-hand experience", offering skill transfer and developing lifelong learning skills.

Yet, still "a key challenge for designers" is how "to get the correct balance between delightful play and fulfilling specified learning outcomes" (de Freitas, 2006:5), how to integrate educational elements in the natural course of the game without killing the game, on the hand, and on the other hand, how to include the reflective element which would lead to a purposeful and learning game, and not just remain on the behavioral level where tasks are solved through trial and error (Kiili, 2005:14).

In foreign language learning this translates to the following: mirroring successful classroom techniques often does not result in an interesting gaming format, and on the other hand, a fun and entertaining game with no tutoring elements does not lead to effective learning and ends in the entertaining experience (Purushotma, Thorne, & Wheatley, 2008; Whitton & Baeck, 2013: xiii-xiv).

How we learn through play is still an open question, and the results of empirical studies and their meta-reviews are often inconclusive. The pressing question is what exactly is learning and how can learning outcomes be specified and measured in a valid and reliable way. As learning in immersive environments is complex and sophisticated, based on experience, interactions, and interchanges of various sorts, the learning outcomes are more wide-ranging and cross-disciplinary and much more difficult to assess and evaluate using standard procedures. However, at the same time they are potentially more rich and applicable to real world experiences (de Freitas, 2006:18), and having in mind all the potential educational opportunities offered

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by game-based learning, we strongly believe simulations deserve a highly prominent place in teaching English for Professional Purposes.

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E-GLOSSARY AS A LEARNING RESOURCE

Katarina Milosavljević,

Dalibor Marijančević,

Tijana Gajić

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

In the present information era, it is almost unthinkable not to use the Internet in business, teaching and everyday life. In this paper, the use of the Internet in foreign language teaching and learning is being discussed. As an example, e-glossary is used. E-glossary is developed through students' own effort. The students learn English as L2 and German as L3 at Singidunum University in Belgrade. The glossary is compatible with curriculum and with the vocabulary level taught during the three years of study. This glossary is a bilingual one used to translate words and phrases from German to Serbian and vice versa. It consists of the vocabulary needed for A2 level of competence according to the European Framework of Reference for Languages https://www.coe.int/t/dg4/linguistic/Source/Framework_EN.pdf. The fact that this glossary has been fully developed by students should be particularly emphasized.

The first part of this paper is dedicated to the development and programming of the glossary itself using JAVA programme. E-glossary of this kind is a synthesis of philological and IT skills. A few generations of students have been using it mainly because it is practical and can be easily installed.

Key words:

e-glossary, foreign language teaching, foreign language learning, the German language.

1. INTRODUCTION

It is impossible to programme e-glossary without a programming language knowledge. E-glossary usage and new words addition are both impossible without the German language and grammar knowledge. This paper is intended to be a unique combination of informatics and philology. Advantages and disadvantages of the e-glossary will be described, as well as the reasons for its development. Furthermore, we will offer some useful examples, taken from the German course, held at Singidunum University, as well as a detailed explaination for using this kind of e-glossary, followed by pictures. The second part of this paper is dedicated to JAVA programming language and reasons for the choice.

E-glossary is only one example of using the Internet in foreign language teaching. Additionally, Moodle platform, specialized websites and youtube channels especially created for foreign language learning are being used. According to the questionarre results Ferčez got, students of technical faculties recognize the importance of learning English and they realise how helpful it is in using the Internet. Almost all manuals and warnings are in English (Ferčez, 2006:118) English is very important

Correspondence:

Katarina Milosavljević

e-mail:

kmilosavljevic@singidunum.ac.rs

not only in everyday communication but also in IT field. Computer programmes are being changing so fast that literature and manuals which are originally in English cannot be translated at that speed. Some of the words or phrases within IT field are often untranslatable, so they remained the same. At Singidunum University, Faculty of Informatics and Computing, students, except for English, learn second foreign language. The results of a survey conducted by Šimunović show that approximately 60% of students recognize the importance of learning two foreign languages and 40% of them are either reticent or they think that learning two foreign languages is of minor importance to them (Šimunović, 2013:221). They learn language traditionally, at school or faculty, but also at home, using the Internet. The research done by Gabrilo and Rodeka shows that majority of students consider traditional lecture learning more efficient than the so-called Internet learning (Gabrilo and Rodeka, 2009:297). The combination of various learning techniques is considered to be the best. The Internet usage in language teaching should primarily depend on the group itself and students' learning styles.

2. ELECTRONIC AND TRADITIONAL GLOSSARIES

At the very beginning, the difference between the concepts of glossary and dictionary will be explained. The glossary is a small dictionary which offers explaination/translation of the word or phrase, but it does not offer grammatical, phonetic and phraseological explainations. The comparison between traditional end electronic dictionary is emphasised here. The aims are the same but the usage is quite different. This comparison is similar to the comparison between traditional and e-book. E-book has lots of advantages: it saves our time and space, it is easily portable, it cannot be easily damaged, it is easily searchable by keyword *etc*. Jeremić V. stresses the fact that e-book also means equality because of knowledge availability via the Internet (Jeremić, 2010: 68). On the other hand, e-book has also its disadvantages, such as sight damage, there is no possibility of a dedication of a book, there is no spiritual value as in the case of traditional or paper book. It is the same with dictionaries. E-dictionary is easily portable and searchable, mostly free of charge and exremely systematic. Traditional dictionary can be heavy, word search takes more time, it is usually expensive and unavailable. If we conducted a survey about the students' usage of dictionaries, we would reach to the conclusion that e-

dictionary is a lot more used. There are bilingual and monolingual dictionaries. *Google translate* is probably the world-renowned bilingual dictionary. This dictionary is very useful but we should also bear in mind that it often ignores the context, grammmatical and other characteristics of the words. As an example of a monolingual dictionary, we offer the most famous online German dictionary DUDEN http://www.duden.de/. As a result of a word search in DUDEN dictionary, we have not only translation (descriptive explaination in German), but also word's grammatical characteristics, synonyms, the main collocations and the frequency of its usage. In addition to DUDEN, DWDS- Das Digitale Wörterbuch der deutschen Sprache http://www.dwds.de/ is also an excellent monolingual dictionary. This dictionary is intended for advanced learners of German. The main disadvantage of monolingual dictionaries, generally speaking, is the fact that beginners or pre-intermediate learners find very difficult to use them. Dictionary compiling is extremely difficult process which takes years and participation of variety of experts to finish. One word can have lots of meanings and it can be used in various contexts. In order to be considered competent for dictionary compiling, lexicographers should have extensive knowledge related to syntax, phonetics, phraseology *etc*. It is also desirable that lexicographers should be bilingual. Dictionaries are an important part of national heritage because they keep less frequent words from forgetting.

To summarize, our e-glossary is mainly based on words translation and does not include grammar characteristics and different contexts a word can be used in.

3. ELECTRONIC GLOSSARY DEVELOPMENT

This glossary has been fully developed by students of the Faculty of Informatics and Computing at Singidunum University. While writing down variety of new German words, students came to an idea of keeping all those words in an electronic form. E-glossary of this kind is a unique synthesis of philological and IT skills. E-glossary programming is impossible without not only JAVA knowledge but also the appropriate level of German language knowledge. By searching words in this glossary, students can learn a lot and by adding new words, they make their own contribution to its development. Since German has been studied at Singidunum University for two years and students have been learning language from the very beginning, the glossary consists of the vocabulary needed for A2 level

of competence according to the European Framework of Reference for Languages. Vocabulary is in accordance with the book - Berliner Platz 1 NEU, Langenscheidt, by Christiane Lemcke, Lutz Rohrmann and Theo Scherling. The students of the Faculty of Informatics and Computing are not very keen on writing, so they prefer typing instead. Sometimes, they even type new words into their smart phones or ask for a permission to photograph the blackboard with words written on it. This method is also used by students of other study programmes, not only students of Informatics and Computing. This fact tells us that students nowadays learn languages in a different way. The e-glossary mentioned above is the most useful in tests preparation to the students who developed it. It does not include grammar. Also, it does not include plural form of nouns which is very important in German, because it is mainly learnt by heart. The issue which is raised here is whether students should learn difficult words before they learn simple ones; for example, should students learn animal or plant species before they learn the word animal or plant (das Tier, -e which means animal, die Pflanze, -n which means plant). The same sentence can be finished in at least ten different ways, without major change in meaning. This is one example of it:

- Ich komme nicht, weil ich keine Lust habe.
- I will not come because I don't feel like coming.
- Ich komme nicht, weil ich schlecht gelaunt bin.
- I will not come because I am in a bad mood.
- Ich komme nicht, weil ich schlechte Laune habe.
- I will not come because I am in a bad mood.
- Ich komme nicht, weil ich gelangweilt bin.
- I will not come because I am bored.
- Ich komme nicht, weil ich nicht fit bin.
- I will not come because I am not fit.

The sentence can be changed grammatically and subordinate clause can be used instead of two simple ones.

- Ich komme nicht. Ich bin nicht im Stande.
- I am not capable of coming.
- Ich komme nicht. Ich fühle mich schlecht.
- I will not come. I do not feel very well.

Conjuction can also be changed.

- Ich habe keine Lust und **deswegen** komme ich nicht.
  I don't feel like coming and that's why I won't come.
- Ich habe keine Lust und **deshalb** komme ich nicht.

I don't feel like coming and that's why I won't come. (The translation is the same but the conjuction is not.)

- Ich komme nicht, **denn** ich habe keine Lust.
  I don't feel like coming and that's why I won't come. (The translation is the same but the conjuction is not.)

While learning a foreign language, students develop their own system of memorising new words and learning style as well. They have opportunity to role play, talk in front of the group, understand the importance of context, revise Serbian grammar, do pair work or group work (emphasis is on team work) and consequently, they are prepared for real life situations and their future careers. E-glossary is just one example of motivating the students to learn a foreign language. The advantages of e-glossary of this kind are: simple usage, maintainance and new words addition as well as search. It can be easily multiplied, moved, printed, depending on user's needs. There are various ways of keeping the data in electronic form. Some of them are conventional, widespread and usable on different platforms or operating systems. It can be simple textual, MS Excel or MS Word file. The development of this kind of e-glossary requires IT skills that an average computer user has. Also, the tools mentioned above, which are used for maintaining these kinds of files contain functionalities which can help while searching. Although we are more that aware of the fact that there are great number of various glossaries and dictionaries on the Internet, this e-glossary is likely to be the most useful to us, because it is unique in a way that it is compatible with curriculum and the vocabulary level taught at the faculty at the moment. The glossary consists of approximately 1000 words and phrases, but the new ones are being constantly added.

Writing on a piece of paper includes making inevitable mistakes. Sometimes, those mistakes can improve the process of learning itself. Mostly, if we write in a traditional way, on a piece of paper, mistakes corrections will remain as a reminder for us, in order not to repeat the same mistakes. That reminder is usually missing in electronic form.

If we use glossaries and dictionaries available on the Internet, we may search the same word or phrase more than once. There are some expressions we simply cannot memorise. If we keep our own records, when we repeat the action for the first time, we will immediately notice that we have already did the action and that certain word or phrase is difficult to remember. These were the initial reasons for creating our own glossary. The other reasons will be described later.

JAVA PROGRAMME

As we have already said, two common electronic ways of keeping or searching words, files and the Internet dictionaries/glossaries are portable, that is to say, they can be used on almost all platforms. So, we also needed the programming language which can be used on most platforms for the purpose of creating this glossary. Java programming language has been a logical choice.

Java programming language is one of the most commonly used programming languages. One of the reasons is portability. Every programme has to be translated into machine language which is understood by computer processor. The job of translating is done by translators or interpreters, depending on the option language producers want. Translators translate complete programming code into machine code, whereas interpreters translate line by line. Consequently, special version of these programmes is needed for each processor. That fact inspired Java creators to develop combined solution. They introduced the layer which is located between the programme and processor. „Programmes written in Java are still being translated into machine language, but that machine language is not the real processor name but imaginatory computer called Java virtual machine (JVM). Java virtual machine language is called bite code" (Živković, 2012:6). Java virtual machine interprets that code into appropriate processor machine language of our computer. In that way, Java bite code data file can be performed on any processor type, supported by Java virtual machine.

The important part of every application is the way we keep the data. There are two reasons for choosing text files. The first one is portability and the second one is the type itself-they can be read even without the application. As a structure used for data processing, the list is used. According to Živković, the list as an abstract data type has advantage in regard to data chain in practice where the related elements are being manipulated but the number of those elements is unknown (Živković, 2010:88). Considering the fact that we do not know how many words are going to be used, the list is more than suitable.

In users interface designing, we also go for Java programming language and *Swing/AWT* libraries. These libraries graphic components communicate with the operating system and take systematic appearance for windows, events management *etc*. „Actually, complete graphic programming in Java is based on JFC library

(Java Foundation Classes), which consists of Swing/AWT and much more than that" (Živković, 2011:165).

HOW TO USE

Data entry file creation: By clicking on the button „add new source" the window is being opened and folder with the application in it should be found. New file name should be typed then.

Similarly, an existing one can be added, if chosen in the dialogue offered (picture I and II).
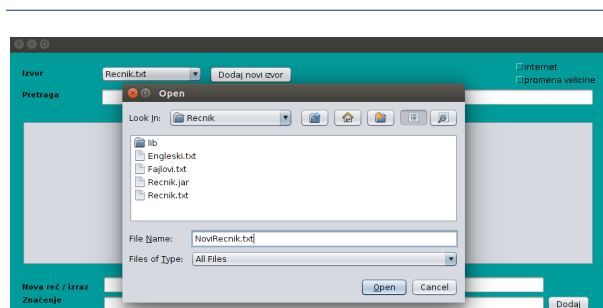
Picture 1.

Now we can access two options „New word/ Phrase" and „Meaning" and then click on „Add" button (picture III).
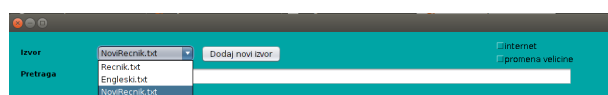
Picture 2.

In case we do not know the meaning of a word, by typing that word and searching it in the „Internet" option, web page with the word typed will be opened on Google Translate service from where we can take the meaning. The size change will reduce the window height so that the suggestions offered by Google can be seen (picture IV). Glossary can function without the Internet. The option of finding the word needed on the Internet can be also used.

Picture 3.
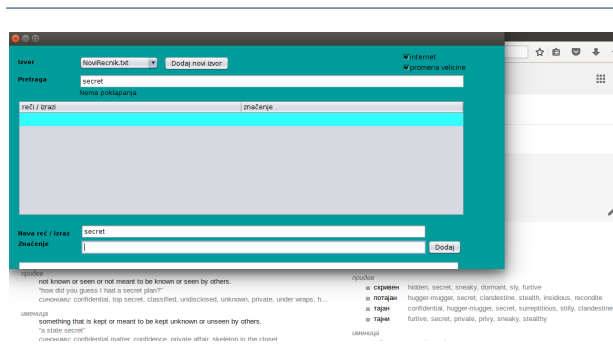
Picture 4.

The search of existing phrases is quite simple. Any character chain is searched in both columns-phrase and meaning (picture V).

Picture 5.

Editor, located below the search option, include feature which can be activated by shortcut CTRL+SPACE. As picture VI shows, the list with the same result as in the search option, is activated. In that way, the user can choose the term he/she wants which will then be entered by using word search option, so „Ich misl" will become „Ich denken" which can be furher improved in order to get the correct grammatical form. If we enter all the persons forms, singular and plural form, of a verb, there will be no need for corrections. The shortcut mentioned above activates the feature in the mode so as to use the left term from the list while entering. If we activate the shortcut by using F1, the right term will be entered instead the left one.
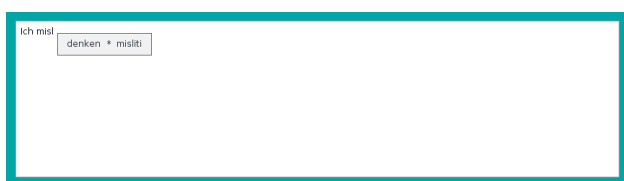
Picture 6.

4. CONCLUSION

The goal of electronic glossary development is a synthesis of philological and IT skills, programming and spoken languages and students' own initiative support. On one hand, this glossary motivated students in an original way and on the other hand, it proved to be very useful to them. Our glossary is not perfect, but it's goal has been fulfilled. Young generations add new words to it and offer some new solutions. This glossary has been a pioneering work and we expect lots of similar projects in the future.

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E-BUSINESS RELATED RESEARCH

HUMAN-COMPUTER INTERACTION IN E-NEGOTIATION

Gordana Dobrijević,
Jelena Đorđević Boljanović,
Ivana Brdar

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Even though we think about negotiation as an essentially human activity, there are many negotiation support systems and automated agents developed for helping human negotiators. They can support or completely replace human negotiators, and serve as intermediaries for individuals or organizations. Some of them can even take into consideration cross cultural differences between people. In this paper, we address some of the issues related to interaction and synergy between human negotiators and automated negotiation agents.

Key words:

e-negotiations, automated negotiation agents, human-agent interaction.

1. INTRODUCTION

Extensive use of the Internet has radically altered the way we use computers. Today, it is common for people and computers to work together, including over great distances in time and space. For instance, we can see computer systems as parts of military systems, online auctions, emergency response systems ("Colored Trails", n.d.) and negotiations. Although we think about negotiation as a predominantly human activity, there are many negotiation support systems (NSS) and automated agents developed for helping human negotiators, *e.g.* INSPIRE, Virtual Human Agent, or Diplomat. Software can also be used in human-to-human negotiation analysis to predict negotiation outcome in early stages of the process.

Since the 1990-ies, two-thirds of the research of the NSSs have focused on operational level problems, NSS technologies, processes and methods (Pervan and Arnott, 2013). On the other hand, comparatively little research has been dedicated to the interaction between negotiation agents and human negotiators (Lin and Kraus, 2012). Human-agent interaction is especially important, because negotiation agents can play different roles in electronic negotiations. They can support or completely replace human negotiators, serve as intermediaries for individuals or organizations, *e.g.* bidding in online auctions (van Wissena *et al.,* 2012), or as a training tool (Dobrijević and Đorđević Boljanović, 2014).

Negotiation is a process that happens to all of us, almost daily, and sometimes we are not even aware of it. Designing an efficient automated agent could relieve people of the tasks that can be performed by machines,

Correspondence:

Gordana Dobrijević

e-mail:

gdobrijevic@singidunum.ac.rs

e.g. brokering agents. Some of the benefits of using fully automated agents instead of human decision makers are: better outcomes, fewer conflicts and lower costs, because less work is done by humans (Yang *et al.*, 2012) and normally negotiations take less time. However, semantic and emotional issues involved in negotiations make human negotiators indispensable when negotiating about more important or complex matters, so a human-agent cooperative system is needed (Hindriks and Jonker, 2008).

2. AUTOMATED TEXT CATEGORIZATION IN HUMAN-TO-HUMAN NEGOTIATIONS

The study of Kesting and Smolinski (2013) showed that in e-negotiations people have less trust towards the other party, that the relationships are on a lower level than in face-to-face negotiations, and that people are more prone to hard and distributive negotiation style. This is probably due to perceived informality and anonymity, and the lack of nonverbal communication. That is in accordance with several earlier studies (2010) which showed that communication media have important effect on negotiation process and outcome. Researchers tried to determine how the communication process during negotiations actually influences the effectiveness of negotiations. Those analyses were performed manually, which is laborious and time-consuming.

Social Information Processing Theory (Walther and Parks, 1992, ac cited in Körner and Schoop, 2013) proposes that social cues (responsible for building trust and understanding between the parties), in the absence of nonverbal communication while communicating via email, are transferred directly through words. In order to facilitate this analysis, Sokolova and Szpakowicz (2007) used text mining (Statistical Natural Language Processing and Machine Learning techniques) to find general tendencies in the text. They performed their research based on the data acquired from the negotiation support system INSPIRE during several years. The outcomes were labeled either as successful or unsuccessful, and the participants were either buyers or sellers. They focused on the words that show negotiator's desire to come closer or to move away from the other party, as well as the words showing power (or the lack of it). More than 1,500,000 words were used during the analysis. They concluded that language symbols can predict negotiation outcomes early in the process.

The subsequent study of Sokolova and Lapalme (2010) confirmed those findings and showed that successful

e-negotiations contain more positive language and emotions than the unsuccessful ones (although the analysis of negative emotions did not have conclusive results). This study also showed that informativeness (the amount of provided information) of the messages between the participants corresponds to the negotiation success. However, Körner and Schoop (2013) were not able to reproduce these results in a later experiment. As the authors said themselves, it is probably due to the nature of the negotiation data and methodological problems.

3. SOME ISSUES IN HUMAN-AGENT INTERACTION

Since people come from different backgrounds, and have different characteristics, efficient agents should be able to take these variables into consideration when **ne**gotiating with different people. People make mistakes; human behavior is varied and is influenced by cultural, social and cognitive factors (Lind and Kraus, 2012). For this reason, automated agents are increasingly using heuristic methods (rules of thumb that allow for deviations of human behaviour, which produce adequate results, and not the best possible) (Dobrijević, and Đorđević Boljanović, 2014). Some other models used for creating negotiation strategies are Bayesian models, generic algorithms, and estimation algorithms for multi-issue trade-offs (Yang *et al.,* 2012).

Shahmoradi *et al.* (2014) proposed a new agent-based model for simulating negotiations. They included a cultural parameter of time sensitivity in order to help intelligent agents in cross-cultural negotiations in B2C e-commerce context. The seller's offers are based on the buyer's predicted time sensitivity in product delivery. The simulations are based on different cultural data sets of five countries. Their results showed that this model could decrease the number of negotiation rounds and the total time spent.

Also, it is difficult to design generic automated negotiation agents that can negotiate in various areas. Sometimes it is because of the characteristics of the area itself, and sometimes it is because there are many preferences negotiators can have as well as various strategies and tactics they can use. That is why many agents are created as area-specific and cannot be used in other domains (Lin *et al.*, 2014).

Another issue is evaluating agent-human interaction. It is a critical part of the designing process, because it shows how successful the automated negotiating agents are (Lin at al., 2012). As system and agent behaviour is

impossible to anticipate, this evaluation is normally done through simulations and observational analysis (Baarslag *et al.*, 2010). Since that process requires time and effort, Lin and Kraus (2012) have devised two environments to make it easier and more manageable: GENIUS (which stands for "General Environment for Negotiation with Intelligent multi-purpose Usage Simulation") environment and Colored Trails game environment. They can be used for testing automated agents, as well as evaluating human-human, agent-human, and agent-agent interactions. Genius can also be used to prepare human negotiators through negotiations against other people or software agents, and to train software developers to create generic automated agents (Baarslag *et al.*, 2010). Colored trails ("Colored trails", n.d.) environment enables exploration of human decision-making as well as computational strategies. They can be studied in groups consisting only of people or in mixed groups of humans and computer systems.

In their experiment of agent-human negotiations, Vahidov and Kersten (2012) paired different types of agents with humans in negotiating a product sale. The results were quite interesting: the majority of participants were not sure if they had been negotiating with agents or humans, while very small number of participants guessed accurately that they had been negotiating with software agents. Even in the case of human to human negotiations, 2 out of 30 participants thought they had been negotiating with a computer (!). The answers actually depended on the type of strategy used. If distributive and then integrative strategy was used (more complex pattern of concession making), then the majority of participants thought they were negotiating with a human. In this experiment software agents performed better than humans, in both utility and number of agreements reached.

Experiments with human subjects are needed to evaluate how successful automated agents are in negotiating with people. That, as we said, can be expensive and it takes time. Seeing that automated agents and humans behave differently, the issue is whether other sorts of computer agents can be used to evaluate automated negotiators. One method of this evaluation is the use of Peer Designed Agents (PDAs), created by human subjects (Lin *et al.*, 2012). The design of the PDAs involves human subjects to state their preferences for all sets of information in the game (and not only those that can appear during the game). Some previous studies (Chalamish *et al.*, 2008, as cited in Lin *et al.*, 2012) showed that agents designed by human subjects can sometimes be used instead of humans in some games.

Lin *et al.* (2012) carried out bilateral negotiation simulations with more than 300 human negotiators and 50 PDAs in two different environments: one was simulating real-life transactions and the other was Colored Trails game. In order to make situations more life-like, other party's preferences were not disclosed. People negotiated with other people, with PDAs, and with negotiating agents (KBAgent and QOAgent).The authors investigated whether PDAs behaved like humans and whether they can be used instead of people in the evaluation of negotiating agents. They found out that automated agents were more successful than PDAs in the same negotiation scenario where they were more successful than humans, and that generally they were equally generous to the other party. They also showed that, although a bigger part of the evaluation can be done without humans, they are still necessary in the final evaluation.

4. THE LATEST ADVANCES

Automated agents are getting better in various respects. Many of the current agent strategies consist of different modules. The strategy is an outcome of various combinations of these modules, with different success of each module. For example, an agent could have a module that has excellent results in predicting preferences of the other party, but still have bad results because it concedes too fast. So far, there is no way to determine which of the components is crucial in reaching negotiation success. In order to examine the efficiency of the individual factors of negotiation strategy, Baarslag *et al.* (2014) proposed an architecture that differentiates three elements which together create negotiation strategy, namely the bidding strategy, the opponent model, and the acceptance condition (BOA). They claim that the existing agents are compatible with the proposed architecture. Based on *e.g.* target sum, time, and discount, the bidding strategy establishes the concessions that could be made. An opponent model shows preferences of the other party; while the acceptance condition says whether the opponent's bid is acceptable or not. Separating the individual components, the authors were able to recognize some opponent models that are more efficient than others; and to replace existing opponent models with others, in order to improve their performance. Recombining the components enabled them to considerably improve the negotiating agents' performance.

Since 2010, there have been five competitions of automated negotiating agents. The aim of this competition is to improve the "research in bilateral multi-issue

closed negotiation" ("Tudelft Negotiation", n.d.). Closed negotiation happens when parties do not disclose their preferences, and it takes place quite often in life. Here we see the importance of using heuristic models, because negotiation agents do not have sufficient information about the other party. This competition is based on the GENIUS environment (Baarslag *et al.*, 2010). This competition should help create more proficient negotiating agents, test bargaining strategies, examine opponent models, and especially gather negotiation agents, domains and preference profiles, so that researchers and academics could use them widely (Baarslag *et al.,* 2010).

Artificial intelligence can help human negotiators in many ways, *e.g.* implementing search techniques or using strategic reasoning. On the other hand, it cannot help with the issues such as small talk that humans engage in during the process, and obtaining common knowledge related to the field in question. The idea is to reach synergy between negotiation agents and humans, neutralizing each other's weaknesses and taking advantage of strengths. While humans can understand emotional tone and context of negotiation, they need support in neutralizing emotions and focusing on their interests (Jonker *et al.*, 2012).

According to Hindriks and Jonker (2008), in order for humans to cooperate with machine, they need to share an abstract model of a particular task (*i.e.* negotiation), detailed models of a specific domain (*e.g.* salary negotiations), the user model, and the opponent model – jointly called the DUO models. They can be shared only if they imitate cognitive models of the humans. Hindriks and Jonker (2008) proposed a task division between the human user and the machine, based on strengths and weaknesses of both. They developed a negotiation model matching human perception of negotiations, called Pocket Negotiator. It can work on a handheld device or a computer to help human negotiators (Figure 1-3). Pocket Negotiator can help humans with some of the most prominent challenges in negotiations, namely ignoring a potential for a win-win deal, making too big concessions, rejecting a better offer, and settling for an outcome worse than the best alternative (BATNA). It supports human negotiators during all four stages of negotiations (preparation (Figure 1), exploration (Figure 2), bidding (Figure 3), and closure). Through this human-software synergy, some usual mental errors can be prevented and user's cognitive tasks can be easier to perform.
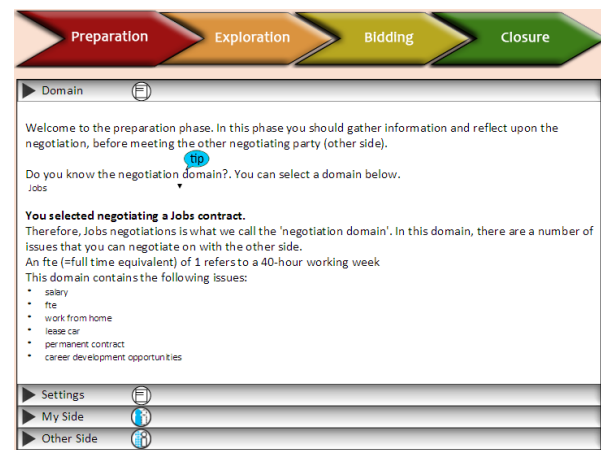
Figure 1. Pocket Negotiator software, preparation phase

Source: Pocket Negotiator (n.d.) retrieved from http://ii.tudelft.nl:8080/PocketNegotiator/index.jsp February 9, 2016
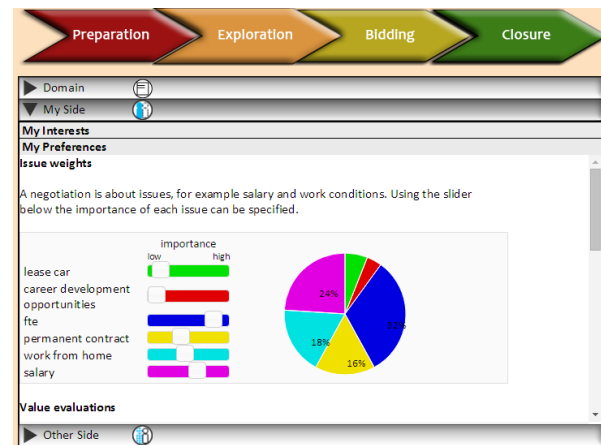
Figure 2. Pocket Negotiator software, exploration phase

Source: Pocket Negotiator (n.d.) retrieved from http://ii.tudelft.nl:8080/PocketNegotiator/index.jsp February 9, 2016
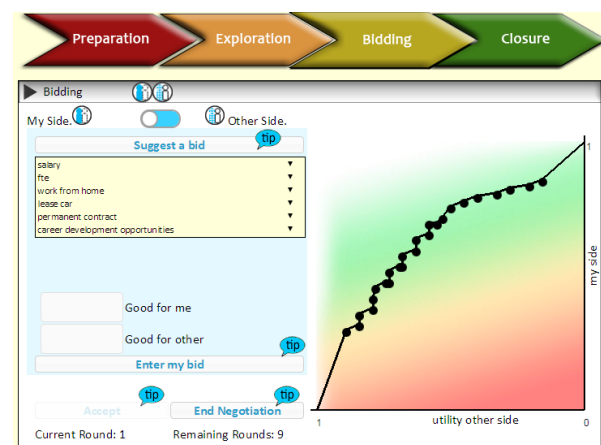
Figure 3. Pocket Negotiator software, bidding phase

5. CONCLUSION

What lies ahead is difficult to predict, but we can definitively envision some new breakthroughs in the design and use of artificial intelligence in negotiation, namely automated agents and negotiation support systems. Some of the important issues in human-machine interaction were addressed in this paper, together with some contemporary solutions to the challenges of this interaction. Negotiation is an emotional process, and computers can help human negotiators cope with its complexity.

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THE ROLE OF ERP SOLUTIONS IN MANAGING CORPORATIONS FROM THE ACCOUNTING PERSPECTIVE

Marko Milojević,
Ivica Terzić,
Dragan Miletić,
Saša Stamenković

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Contemporary method of doing business requires that managers have at their disposal at all times information about the results achieved both by the company as a whole and by its individual organizational units or its products and services. In the circumstances characterized by globalism and unhindered movement of capital, monitoring business operations would be unthinkable without integrated business solutions. Activities and processes carried out within an organisation are mutually interconnected and interdependent, and therefore must be synchronised in order to maximise available resources and obtain information in a timely fashion. The implementation of integrated business solutions is precisely what facilitates efficient management of companies that are geographically dispersed and that carry on complex and multiple business operations. The objective of this paper is to analyse the roles and functions which enterprise resource planning (ERPs) solutions have within the business organisation and on improving organisation's efficiency and quality in terms of its business operations and decision-making process.

Key words:

accounting information systems, ERPs, costs, investments, resource management.

1. INTRODUCTION

The last decade of the twentieth century witnessed the successful implementation of a long-lasting ideal of using a single integrated software package for managing, supervising and controlling all business processes within a legal entity. This software solution was named ERP (Enterprise Resource Planning) or business resource planning system. The ERP structure comprises information subsystems *i.e.* information modules which deal with individual functional activities (parts) of the company, such as: production, accounting, warehousing, marketing, sales, planning, procurement, finances, human resources, legal affairs, client relationship, *etc* (Barjaktarović *et al.*, 2015). Individual software applications which process transactions within a business unit or a business process regardless of the company's overall activities are not suitable for planning resources on the level of an entire organisation (Ganesh *et al.*, 2014). Such applications do not meet the needs of modern organisations. Activities and processes of a single organisation are interconnected and interdependent and therefore must be synchronised in order to ensure optimisation of available resources and to obtain timely information (Milojević *et al.*, 2014b). This clarifies

Correspondence:

Marko Milojević

e-mail:

mmilojevic@singidunum.ac.rs

why the information system must be based on a new, integrated and interconnected concept. The complexity of such system and diversity of organisational functions was precisely what made companies and organisations discard the idea of creating and maintaining their own information system.

Prior to the introduction of ERPs, companies generally owned information systems for each business process and function. It was not a rare case that the company owns one information system used for accounting purposes and the other one for logistics, production and marketing. Such information systems were mainly introduced:

- At different times,
- Often by using different programming tools, and
- Procured from different vendors (Marjanović and Milojević 2012).

This leads to complications and more expensive maintenance of systems implemented in this way. Data and business transactions are frequently recorded more than once, information is unreliable and their exchange made difficult. Reports generated by such systems are often inconsistent and defy comparison. The role and the tasks performed by ERP, and this paper too, are to describe the manner in which ERP integrates data from all company's functional units and converts them into unique and reliable information which is adapted to serve the company's specific needs, in accordance with international business standards.

Today, information is a crucial business resource and each company's efficiency and productivity is directly dependent on possession, analysis and use of information. Modern information and communication technologies (ICT) play a vital and important role across entire globalised market (Marjanović *et al.*, 2014). Tha majority of job positions in modern organisations require the use of computers and IT resources (both software and hardware). Computer literacy of company's employees and the extent to which information technologies are applied within a company is one of the most important factors for the companies to opt for the introduction of ERPs.

The concept of an ERP system implies that individual transactions are parts of an integral set of business processes which are comprised of the company's operations and data generated by such transactions do not pertain only to certain parts of the organisation but can and should be used for diverse purposes by different users dispersed within the organisation. ERP is therefore a multi-modular strategic asset and software tool which enables integration of organisational segments as well as synchronisation of individual business functions into mutually connected business process via a unique information system. In this way, ERP ensures control and optimal use of all company resources and meeting the needs of all information system users (Tumbas 2008; Njeguš 2009). To enable greater flexibility for business operations and modelling of organisation, ERP systems rely on the use of client-server technology, relational databases, Windows and Unix OS and advanced programming languages.

Company's ERP system is comparable to a human central nervous system. If it is healthy *i.e.* functional, ERP transfers information about supplier, buyer and employee status to the management in an understandable manner. ERP also assists management, the "brain" of the company, in adequately responding to such information and in coordinating company's resources in the manner which can attract new users, defeat the competitors and reduce expenses. For these reasons, the implementation of ERP system can be viewed as the best possible investment. The objective of this paper is to analyse the roles and functions which ERPs have within the business organisation and their effect on the improvement of efficiency and quality of business operations and decision-making processes.

2. EVALUATION OF ERPS

The development of integrated information systems started in the 70s of the last century with the introduction of information systems for production planning purposes and which primarily dealt with material resource planning (MRP). Somewhat later, the production operations became linked with the clients' requirements and necessary capacity with the intention to close the circle of orders, procurements, production and sales. Such business systems were closed-loop MRPs. The improvement and development of this system resulted in the so-called MRP II systems in 80s (Nuković 2011). These systems enabled planning and managing all resources required for the production process not just material but also human and financial resources as well. At the beginning of 1990s, the interconnection of all business processes within a single organisation with its suppliers and clients gave rise to the implementation of enterprise resource planning system (ERP). For years, ERP solutions were reserved almost entirely for manufacturing companies but today they are used by all types of organisations. Technological advancement which brought about mass production inspired more careful attitude towards buyer's needs and requirements. Monitoring such requirements resulted in the development of information systems for customer

relationship management which served to support the production and sales according to clients' needs and requirements. Successful functioning of the abovementioned business process was dependent on the business process performed with the supply chain causing the need to connect to the supply chain information system (SCM – Supply Chain Management) with ERP and CRM. ERP II was a new term launched by the Gartner Group referring to the next generation ERP tools which are expected to provide high quality support to specific business requirements, internal and external communication and human resources management.

ERP systems continuously upgrade their web interfaces to ensure better support to e-trade and company portals and to ensure more simple data exchange via internet. Application Service Providers will play an ever increasingly important role in outsourcing of often very expensive ERP modules. Even though the implementation of ERP is very expensive and time-consuming activity, majority of global companies introduced and applied ERP system. This stresses the actual need for connecting all processes and functions within a company into a unique information system and circumvents the inefficiency resulting from non-integrated data and isolated applications.

3. REASONS IN FAVOUR OF ERP INTRODUCTION

There are numerous reasons speaking in favour of introduction of ERPs. Factors and motives which have effects on the decision to invest into ERP are commercial and technological in nature.

Business reasons are the following:

- Optimisation of the use of resources,
- Reduction of operating expenses,
- Increasing productivity and efficiency,
- Synchronisation of planning, management and control.
- Improvement of business cooperation with the clients (buyers) and business partners,
- Improving the decision-making process.
- Technological motives are the following:
- Improving the quality and availability of information,
- Standardisation of business processes in accordance with the best business practices,
- Integration, optimisation and improvement of business processes,

- Introduction of the system which enables the growth and development of business operations in contemporary environment,
- Replacement of non-integrated and outdated systems.

In modern business environment, the speed of organisation's response to market demands is of vital importance. With its unique database and integrated modules, ERP system enables an organisation to make faster and more efficient decisions based on accurate and up-to-date information. An alternative to ERP implies keeping large number of unintegrated business applications and systems which support different business functions and processes. Maintaining such systems is very expensive as each of them requires different support and maintenance. In such an unintegrated environment, data must be entered separately into each of those systems. Different systems may require different formats which incurs data conversion costs. Multiple entries also imply more employees to perform them, which only results in higher costs while posing a potential hazard for data integrity and safety as well.

4. GOALS OF ERP SYSTEMS

Basic goals of ERP systems may be formulated as follows:

- Integration of financial information (accurate and up-to-date representation of income and expenses);
- Integration of data about clients' orders;
- Standardisation and optimisation of business processes (automation and unification of business process, shorter duration);
- Reduction of inventory (optimal level of supplies with minimum storage costs);
- Standardisation of human resources data (up-to-date and accurate) (Petrović *et al.*, 2016).

ERP should be viewed as advancement of previous good business processes. The goal of ERP is to create synergic effects. The most important thing is to adequately perform re-engineering business processes, eliminate no-longer-needed activities and ensure improvement of others as such attitude will enable easier, faster and successful implementation of ERPs (Lečić and Kupusinac 2013). Generally speaking, companies choose an ERP package based on the following factors: functional capabilities, technical characteristics, manufacturers' reputation and implementation costs. The decision regarding the selection of ERP is also affected by the possibility of

fast implementation, user-friendliness, the scope and extent of necessary adaptations, the level of integration between ERP modules and IT infrastructure support. The most important matter is that ERP solution must meet the requirements of the company/user and it must be actually put to application and be user friendly to the employees and management.

Introduction of ERP changes the decision-making process. However, this does not imply that all activities and processes will be improved "overnight". Whether an ERP will function well depends on the degree of the system's and company's compliance. ERP system provides particular benefits in providing integration of data and exchange of information related to production process, distribution and financial sectors (Milojević *et al* 2014a).

We have already defined ERP as a complex, integral and comprehensive software solution for business support. However, ERP does not mean only having a unique solution and integration of all business processes, ERP must also have other important characteristics, some of which stand out: flexibility, modularity, openness, independence, comprehensiveness, adaptability, experience and localisation.

Flexibility refers to the system's capability for development in accordance with market changes within the company's organisation, technology and production systems. Modularity refers to the benefit of the company to choose its module and thus dictate the complexity of the applied software solution. This means that not only large, but small companies as well, can use ERPs. The openness enables adapting the ERP to different hardware and software platforms, usually legacy systems *i.e.* existing systems and also openness for establishing connections with other applications and systems. ERP is not dependent on the company's business processes and organisational structure and on its IT resources (hardware, OS, database management system). The comprehensiveness of ERP means that it supports all business functions, all company's business activities carried out in all industries as ERP is applicable in industry, trade, tourism, banking sector, education, healthcare, transport... Adaptability of ERP arises from its modularity, openness and comprehensiveness – it is adaptable to company's needs and requirements. This characteristic is crucial for the successful ERP implementation in all cases. The experience comes from long-term development of ERP, its solutions were tested in practice many times and are based on the "best business practice". Localisation refers to the "translation" of the software into the local language but also to the adaptability of the domestic law regulations which are often subject to changes.

5. ERP'S ARCHITECTURE

ERP is a unit which is comprised of modules which refer to all company's business functions. The modules are interchangeable, modifiable and adaptable and subject to combination in accordance with the company's actual needs and requirements. ERP system, through its modules, manages and controls all company's resources. One of most important information is the management of large quantities of information generated for individual business activities. It is very important that all relevant information is made available to all company's business segments. Decisions are made based on such information, for example: when the activity should start and end, who should perform such activity, which resources should be used and to what extent, *etc.*

Typical ERP system uses diverse software and hardware components to establish integration of business processes and activities. Key elements of majority of ERP system are their unique databases where data are stored for processing in various modules. The concept of development of ERP system includes the following stages:

- ◆ Planning,
- ◆ Analysis of requirements;
- ◆ Design;
- ◆ Implementation;
- ◆ Maintenance.

ERP integrates the operation of all organisational units within the company into a unique information system which serves individual needs and requirements. It facilitates data exchange and communication between different business sectors. Each ERP module works separately with its specific function for processing relevant data.

Some of the most significant modules of ERP system are the following:

- ◆ Finances & Accounting,
- ◆ Planning & Budgeting,
- ◆ Procurement,
- ◆ Warehousing,
- ◆ Logistics,
- ◆ Human resources,
- ◆ Sales & Distribution,
- ◆ Controlling,
- ◆ Materials Management,
- ◆ Production Management,
- ◆ Service Management.

Additional applications which use ERP resources may be:

- CRM – Customer Relationship Management,
- SCM – Supply Chain Management,
- BI – Business Intelligence.

6. ADVANTAGES AND DISADVANTAGES OF ERP

When implementing ERP, every company should become familiar with its advantages and disadvantages and use such knowledge to assess what is the most lucrative course the company should take. The advantages of ERP may be generally classified as organisational, managerial, infrastructure-related, operational and strategic. Here we present the most important advantages and opportunities:

- Single entry of data into the system,
- Data integration,
- Improved information flow,
- More efficient business processes,
- More efficient resource management,
- Improvement of business processes,
- Built-in best business practices and experiences,
- Higher quality planning and decision-making processes,
- Reduction of IT costs;
- Improvement of business skills,
- Improvement of customer relationships.

In addition to its obvious advantages, ERP can also have significant disadvantages such as:

- Implementation is long and expensive and requires large initial investments,
- Requires re-engineering of business processes and organisational changes,
- ERP is a very complex set of tools,
- The ERP implementation project might not bring expected benefits (may even result in company downfall),
- Adaption process may be complicated,
- Errors are replicated (multiplied) through the system,
- Renouncing application which worked well (change of corporate culture),
- Dependence on the supplier (vendor) in the future but also on expert consultants during the implementation,
- High consultancy and license renewal fees,

- Requires permanent training of employees (Manojlov 2013);

ERP market is one of the fastest growing markets in IT industry. The largest and most renowned global vendors of ERPs are SAP, Oracle and Microsoft.

SAP (Systems, Applications and Product in Data Processing) is a German company founded in 1972 and it is currently the industry leader with an estimated 30-60% share in the global ERP market. Their current product is SAP R/3 ERP system. SAP enjoys a special place among ERP manufacturers due to the fact that its modules were developed internally. Oracle offers Oracle Applications ERP solution which relies on the famous Oracle system for relationship database management with the most popular module being Oracle Financials. Microsoft Dynamics NAV is a mid-size enterprise ERP II class product created by the largest global software vendor – Microsoft, which pursues an adamant strategy of overtaking SAP's leading position. ERP products of all three global leaders are characterised by fast implementation, easy adaptation to user's needs, user-friendliness and efficient interconnection with other systems. All these advantages also come at a (high) price.

The most renowned domestic manufacturers of ERP solutions are companies: AB Soft, Digit, BisERP and (Slovenian) Datalab (ERP Pantheon). We note that there are also so-called open-source solutions, the most famous of them being: Compiere, Openbravo, Open for business – OFBiz, ERP 5, WebERP and Tiny ERP. Basic advantages of open-source ERP solutions are the following:

- Possibility of gaining access to source code in which the program was written;
- Free exchange and modification of open code for the purpose of improving program solution,
- The possibility of change and adapting source program,
- The possibility of connecting it with other programming solutions.

Depending on the scope of its business operations and according to its financial possibilities, each company can find an ERP solution suitable for its purposes and a vendor whose product will meet its needs.

7. COSTS OF ERP

The cost of ERP system is a central financial issue. Typical cost of ERP ranges between $400,000 to $300 million EUR. It is estimated that the total average cost of the system per user amounts to approx. $53,000. The cost of ERP implementation includes the cost of training,

consultancy, data analyses and conversion, integration, testing and adaptation. In addition to the price of ERP software, which is rather high, average maintenance costs on annual level amount to about 20% of its price. This includes software upgrades, expert support and user education through their access to knowledge base.

The structure of costs for introducing ERP is as follows:

- ERP software license costs;
- ERP system maintenance costs;
- Consultancy fees (usually the highest!)
- Costs of adaptation;
- Costs of infrastructure re-engineering;
- Internal associated costs.

The fact that ERP implementation requires large initial financial assets means that small and medium-sized companies are forced not to entertain the thought of ERP implementation at all. However, due to Cloud Computing technology, this issue may be easily circumvented (Jeremić *et al.*, 2015).

Ideal candidates for Cloud ERP service are companies operating in multiple locations. This solution enables the user to access the system from any location and to enter changes to the system which will be immediately recorded in all business processes. Thereby, the system ensures that the current status is always up-to-date as well as fast response to any changes.

Advantages of Cloud ERP are as follows:

- No initial capital costs like those incurred by ERP projects (hardware, software, licenses);
- Monthly payment for resources that you actually use;
- Entitlement to the most up-to-date software versions and software "patches";
- Simple and flexible increase/reduction of the number of users and their access rights (limited access costs less);
- Savings made in respect of time needed for system implementation and adaptation.

Table 1 presents the analysis of costs to be incurred by using ERP on your own IT infrastructure and the use of EPRs on a rented (Cloud) infrastructure. Data clearly show that the rental of Cloud ERP (PaaS – Platform as a Service *i.e.* SaaS – Software as a Service) is as much as 3.5 times cheaper, plus no initial investments only the costs of monthly subscription.

8. CONCLUSION

In recent years, huge changes occurred in the way companies do business. Particular contributors to these circumstances include the following factors: market globalisation, digital economy, growth of ICT sector (cloud computing) and development of e-commerce and e-trade

ERP on your own infrastructure	Investment costs (€)	Monthly operating costs (€)
Server room costs (12 m²)	61,200	200
Cost of IT infrastructure and personnel	48,976	781
Cost of operating system and database	5,340	172
ERP license costs (30 users)	64,615	1,231
Electricity cost	0	220
Cost of system administration	0	2,950
Total costs	(A) 180,051	(C) 5,554
Equipment renewal every 5 yearsa	(B) 72,430	
Total costs for the period of 10 years (A+B+C*120)	918,961	
Cloud ERP	Investment costs (€)	Monthly operating costs (€)
Cost of infrastructure rental		455
Cost of rental for ERP licenses (30 users)		1,650
Total monthly costs		(D) 2.105
Total costs for the period of 10 years (D*120)	252,600	

Table 1: ERP Implementation Costs Analysis and Comparison (Source: Author's example.)

through new models and new sales channels used in order to offer products and services. The degree of innovation is such that it increasing requires from the companies to replace their old information-business systems which no longer cope with the modern way of doing business. Old business applications regularly turn out to be obstacles to developing and introducing of new products and services. Despite plenty of advantages which ERP solutions offer in comparison to partial business applications, each company must analyse in depth their organisational and managing requirements, financial and personnel capabilities and assess their alternatives.

Each business system expect ERP to bring huge benefits: increased productivity, reduced operating expenses, improved business performance, shorter duration of business processes, higher quality and faster information flow, increased customer satisfaction.

To ensure company's survival in the times of harsh economic crises, management must have at its disposal accurate and timely information regarding business performance of each segment of the company. ERP integrates and supports all business processes within a single company through a unique database. Contemporary ERP systems are used by an ever increasing number of employees. The reason is very clear – in addition to financial and accounting operations of the company, information system cover also procurement, sales, human resources, customer relations, *etc.* Integrated ERP solutions cover and imply regulation of company's business processes, complete control over its business activity, readiness to compete in the market, widening the scope of its business activity, company growth and development.

Both domestic and international markets offer a wide array of high quality ERP solutions which enable businesses and other organisations to make an adequate choice, to select the product which will meet their current needs but will also be adaptable to future changes. Market openness and global digital economy imply the implementation and use of ERP solutions, particularly by large businesses and organisations.

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E-BUSINESS

THE APPLICATION OF TRANSFER PRICING BETWEEN RELATED PARTIES

Danica Rajin[1],
Tijana Radojević[2]

[1]Singidunum University,
Faculty of Economics, Finance and
Administration - FEFA,
Belgrade, Serbia

[2]Singidunum University,
Faculty of Business in Belgrade,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The aim of this paper is to provide examples of good practice in the field of transfer pricing for the fiscal year of 2014, in accordance with the Republic of Serbia regulations and the OECD guidelines on transfer pricing. The study analyzes the AB Belgrade company and it shows whether the transactions that the company AB Belgrade performed with related parties in 2014 are in accordance with the "arm's length" principle in order to fulfill the requirements related to transfer pricing under the Corporate Income Tax Law in the Republic of Serbia.

Key words:

transfer pricing, related parties, corporate income tax, return on sales.

1. INTRODUCTION

The strategic orientation of a company is defined by creating value for capital owners, where prices emerge as an important factor that is used for the exchange of products and services between its branches *i.e.* transfer prices. In order to define the financial strategy of a company, it is necessary to establish the method of determining the transfer price that is mainly determined by a company's orientation towards short-term or long-term objectives in the conduct of business activities. Income tax is one of the most significant government revenues, where evasion endangers the state budget Transfer prices gain importance in both theory and practice as used in the function of moving profits between countries in order to minimize profits.

Increased globalization resulted in transfer pricing becoming one of the main areas to be used by multinational companies in the future in order to deal with their economic benefits, while tax administration will be dealth with from the tax aspects (Perić, 2006).

2. TRANSFER PRICES

Transfer prices are determined as the prices at which goods or services are exchanged between two entities within the same company. Transfer price can be defined as "opportunity cost for a product or service, *i.e.* ignored value of not using transferred products in their following best alternative usability"(Figar, 2007).

Correspondence:

Danica Rajin

e-mail:

drajin@fefa.edu.rs

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Closely inspected, transfer-pricing represents the pricing of an organizational unit *i.e.* the segment of an enterprise dealing with the product, service and the semi-finished product which is internally transferred and implemented in the internal market. (Tomasevic *et al.*, 2012). Due to this internal feature, transfer-pricing is also referred to as the „internal cost". Current interest in transfer-pricing is mirrored in modern finances which focus on research results placing transfer-pricing as one of the areas of highest interest to international accounting (Sands and Pragasam, 1997).

According to Gajic (2007), transfer prices represent informative basis for important decision making processes of the parts and the entire enterprise, which emphasizes the need for their real identification, especially from the aspect of the scope and structure activities and overall business success.

In order to define the boundaries among which transfer prices can move, it is necessary to start from the level of utilization of the existing capacity. When branch offices sell products to the level of full capacity utilization, the opportunity cost of product units is the market price. It represents the upper limit transfer price because it is not in the branch offices' that buy the products interest to pay for products at a price that is higher than the market value. In case the branch offices are working on a level lower than full capacity utilization, the opportunity cost of the unit of production is equal to its marginal cost. The marginal cost is the lower limit for the determination of transfer prices because the branch would not be paid off to sell products at prices that are below marginal costs. (Denčić, 2011)

In the Republic of Serbia, transfer-pricing is regulated by the Transfer-Pricing Rulebook as well as articles 59, 60, 61a and 62 of the Corporate Income Tax Law and articles 5 and 6 of the Tax balance Rulebook as well as the Rulebook on tax information registration which all manage the assessment of transfer-pricing. In addition to the tax balance, the related party is required to state their business' income and expenses as well. Unless a full analysis of transfer-pricing according to the "arm's length " principle is enclosed, a set of fees amounting from EUR 1,000-2,000 and additional payments related to income tax and default interest have been established. The principle of "arm's length" implies that the taxpayer is required to enclose any data reflecting the value of those transactions which would be realized on the market if they were not associated to the related party.

3. ANALYSIS OF THE COMPANY AB BELGRADE

AB Group is a leading company specializing in products related to the use of electricity and data, where the network technology, optimization and security in the use of electricity as well as the data protection are key priorities in business.

A business enterprise purchases products from partner manufacturers who produce them according to the specifications and technical requirements set by the company, where the products are distributed under the brand AB Group.

Companies operating within the AB Group distribut the goods to the specified group of customers:

1. Manufacturers of electrical panel (35% customers)
2. Electricians and electrical engineers (35% customers)
3. Industrial companies (20% customers)
4. Energy companies (2% customers)
5. Other (8% customers)

Indicators	2011	2012	2013	2014
Return on sales	438,648	580,815	441,293	465,560
EBITDA	32,754	49,081	12,471	15,786
EBITDA margin	7,5%	8,5%	2,8%	3,4%
EBIT	29,153	44,572	7,506	11.154
EBIT margin	6,6%	7,7%	1,7%	2,4%

Table I. Financial indicators in the AB company (in 000) for the period 2011-2014.

Source: Serbian Business Registers Agency

Indicators	X	Y	Z	AB
Return on sales	1,903,134	1,363,808	583,347	441,293
EBITDA	54,626	85,343	20,221	12,471
EBITDA margin	2,9%	6,3%	3,5%	2,8%
EBIT	24,885	71,362	18,331	7,506
EBIT margin	1,3%	5,2%	3,1%	1,7%

Table II. Financial indicators for 2013 of major local competitors in Serbia

Source: Serbian Business Registers Agency

Table 1 and Table 2 present the major financial indicator (EBITDA) as one of the most important measurement of a company's operating profitability. EBITDA is essentially net income with interest, taxes, depreciation, and amortization added back to it, and can be used to

analyze and compare profitability between companies and industries because it eliminates the effects of financing and accounting decisions. The relevance of EBITDA reflects, as a way of comparing companies within and across industries. This measure is also of interest to a company's creditors. In general, EBITDA is a useful measure only for large companies with significant assets, and for companies with a significant amount of debt financing.

Major factors that may directly or indirectly have an effect on the level of prices in the industry in which the taxpayer operates:

- ◆ Reputation - the main factor in determining prices and market strength in the industry, as well as the quality that accompanies this name.
- ◆ Competition - regions where there is a high level of competitiveness have lower prices for their services.

The economic environment represents a major business risk which can strongly influence the scope of a company's business and profitability, which has especially been difficult in Serbia due to unfavorable economic circumstances.

No. transaction	Transaction	Company	Amount (RSD)
A. The transaction costs based on the Company			
1	Goods supply	AB Austria	283,713,670*
2	Over-invoicing costs - licenses	AB Austria	1,878,968.96
3	Controlling	AB Austria	977,380.55
4	Goods supply A	AB Zagreb	21,934.56
5	Goods supply B	AB Slovenia	146,681.26
		Total costs:	286,738,635.33
B. The transaction revenues based on the Company			
6	Education	AB Bosnia	28,215.17
7	Over-invoicing costs - transportation	AB Bosnia	69,277.14
8	Education	AB Zagreb	56,430.34
9	Goods C	AB Zagreb	159,812.92
10	Selling goods D	AB Slovenia	14,785.60
11	Marketing	AB Austria	403,333.68
		Total revenue:	731,854.85

Note: In 2014, the Company had a transaction relating to the purchase of goods from AB Austria in the amount of RSD 265,299,245.96.

Table III. Transactions overview with related parties

Functional analysis is conducted to identify the functions performed by the Company in relation to the activities which it provides for its related parties or which it receives from them. This is essential for the development of policy on transfer pricing because the functions assumed by the related parties are usually correlated with the risks taken or tangible or intangible assets created. Functions, risks and assets have an important impact on their profitability related to the operations of affiliated entities.

4. DESCRIPTION OF TRANSACTIONS WITH RELATED PARTIES

In 2014, AB Company did have transactions with related parties. According to article 2 sections 3 and 4 of the Transfer-Pricing Rulebook and the methods of the "arm's length" principle applied in the process of cost establishment for related party transactions ("Official Gazette of RS", no. 61/2013 and 8/2014), the following table shows data on the transactions the company had with related parties in 2014 and according to which the income and the expenses of the company have been recorded.

No of transaction	Type of transaction	Related parties	Amount (RSD)
1	Goods supply A	AB Zagreb	21,934.56
2	Goods supply B	AB Slovenia	146,681.26
		Total costs	168,615.82
3	Providing educational services	AB Bosnia	28,215.17
4	Over-invoicing costs - transportation	AB Bosnia	69,277.14
5	Providing educational services	AB Zagreb	56,430.34
6	Goods C	AB Zagreb	159,812.92
7	Selling goods D	AB Slovenia	14,785.60
8	Marketing	AB Austria	403,333.68
		Total revenue	731,854.85

Table IV. Transactions overview with related parties in 2014

According to the Corporate Income Tax Law ("Official Gazette of RS", no. 25/2001, 80/2002,80/2002, 43/2003,18/2010, 101/2011, 119/2012, 47/2013 and 108/2013) and the Transfer-Pricing Rulebook and the methods of the "arm's length" principle applied in the process of cost establishment for related party transactions ("Official Gazette of RS ", no. 61/2013 and 8/2014), the company has disclosed essential information on each individual related parties transaction realized in 2014.

The search of the database, conducted purposefully for this research, identified a vast number of companies that were potentially comparable and among which taxpayers who did not meet the minimum required criteria of comparability were removed. The operating loss was selected as a qualitative criterion for two or more years, which eliminated 36 companies. We performed a manual selection, by examining the description of the business in order to establish an independent comparable company. Based on the results of the manual exclusion, seven companies were selected for comparative search.

5. INDICATOR ANALYSIS

In order to achieve the reliability of analysis, we used an interactive range of financial indicators to determine the out of reach margin transaction which is the subject of the research.

Profit level indicator (PLI) is a financial indicator that is used to analyze the profitability of comparable companies. PLI which is used for research purposes of the comparative study of transaction purchases of goods from related entities and the sales to unrelated parties represents the sales revenue (Return on sales - ROS), which is defined as operating profit divided by operating revenues generated in the test transaction.

No	Company	Return on sales (ROS) 2011	Return on sales (ROS) 2012	Return on sales (ROS) 2013	Return on sales (ROS) 2011-2013
1	N1	6,73%	2,87%	7,89%	5,35%
2	N2	2,25%	1,76%	1,48%	1,82%
3	N3	4,79%	3,24%	2,14%	3,46%
4	N4	4,48%	4,00%	1,21%	3,16%
5	N5	17,41%	15,28%	13,41%	15,21%
6	N6	6,67%	6,28%	5,08%	6,04%
7	N7	0,19%	0,22%	0,27%	0,23%

Table V. The financial result for the seven selected similar independent companies

The summary table shows the financial results for the years 2011-2013 and the average ROS for the period of three years for a final sample of seven selected similar independent companies for tested transaction. Final sample of similar independent companies shows the average overall range. The final sample of comparable companies provides the full range of the average ROS of 0.23% to 15.21% and interquartile range from 1.82% to 6.04%, with a median of 3.46%. Interquartile range of realized net margins for comparable third parties is between 1.82% and 6.04%, which indicates a range of comparable margins. Return on sale for AB Group at 2.40% was realized in the transaction of goods procurement from related parties and the sales to unrelated parties in 2014, as part of interquartile range based on margins of comparable companies, ranging from 1.82% to 6.04%.

6. CONCLUSIONS

Transfer prices are used with the aim to shift profits to the countries called "tax havens" in order to minimize tax profits and increase profit after tax at group level, allowing multinational companies to strengthen their competitive advantage compared to the local ones. Hereby, they have direct impact on government revenues causing the state to introduce legislative solutions for the control of the sales transactions between subsidiaries. Additionally, the state introduced a rigorous independent audit of financial statements and prescribed the requirements for more detailed disclosures on transfer pricing in the notes to the financial statements.

Based on this research, we can conclude that transfer prices implemented in the intercompany transaction of goods procurement by the AB Group in 2014 are in accordance with the principle of "arm's length". Therefore, operating in accordance with "arm's length" principle which are required by Serbian law, managers in the given company do not have implications for the current business operations because there is no need of correction taxable profit in purposes of calculating the tax on corporate profit. The guidelines of this paper is to indicate the significance of treatment of transfer pricing in Serbia with the aim of potential accession to the European Union which demands harmonization of the Serbian law with the EU law.

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PRIVACY, PROPERTY AND ETHICS REGARDING THE USE OF COMPUTERS AMONG THE YOUNG

Ivan Nikčević[1],
Elena Marković[2],
Vesna Jokanović[3]

[1]Singidunum University,
Belgrade, Serbia

[2]Boarding School,
Zaječar, Serbia,

[3]Belgrade Business School,
Belgrade, Serbia

Abstract:

The problem of privacy on the Internet, threat to property and other implications of violation of ethics have gained importance as a consequence of social networks and various Internet sites. Intensive influence of virtual reality into lives of young people brings controversial circumstances and unpredictable outcomes. The paper presents research of education influence on ethical upbringing of students in the process of acquiring digital competencies. The research included high school students from first to fourth grade, who are living in school lodging.

Key words:

threat to privacy, property, computer ethics, adolescents.

1. THE INTERNET AND THE YOUNG

The Internet is characterized by a huge technical and social complexity, as such it stands for gigantic but almost invisible universe which encompasses thousands of nets, millions of computers and billions of users round the world" (Greenfield & Yan, 2006, p.391). There is a growing impact of the Internet on various aspects of people's lives and development. This is the case with the role of Internet and computers in the process of socialization, education, entertainment, various kinds of purchase and access to information. Present generation of the young have greater access and greater consumption of information than the previous. Today, the young may get online through various media including cell phones, TV and radio. The number of users is getting bigger every day, including children and adults. As a complex medium of communication, the Internet enables users quick and easy access to information, not only from big cities but also from small and distant settlements. The teenagers from New York, Berlin and those from the remotest settlements in Africa or Asia may be online at the same moment.

Worldwide research has shown that the Internet enables numerous users from impoverished and deprived regions to get necessary information and medical knowledge such as characteristics and symptoms of various diseases, ways of cure and many other information and medical help that could not be obtained before (Cassell *et al*, 2006).

Correspondence:

Ivan Nikčević

e-mail:

inikcevic@singidunum.ac.rs

Information on many socially sensitive topics, on marginalized groups, human relations, and political activities is accessible through the Internet (Suzuki and Calzo, 2004).

In the process of growing up every child goes through several phases of maturing which end by a stage of abstract thinking in the period of adolescence. At that time, the capabilities of understanding emotional experience of others as well as the skills of empathy are developed (Trnavac and Djordjevic, 2002). Today, the young spend more and more time on the Internet, exposing their brain to digital technology which influences the normal growth of the frontal cortex. This part of the brain is responsible for the process of thinking, so the growth of traditional communication skills is inflicted and success in school and social life as a whole are also influenced (Long & Chen, 2007).

We may say that presently the young are living in two worlds. One of these worlds is a real world with real, face to face interaction. In that world, real action and success are ways of competing for the social position, and there are rules and principles one has to adopt and follow for common good and mutual respect. Another world, the online world is a place with no sanctions for disrespect of moral principles, where immediate needs are not being postponed, where the young may create their identity just following their own, where they may be what they would like to be in the real life but without any conditions to fulfill or self-confirmation to carry out.

According to one research, the knowledge about ethical principles is poor among the individuals aged between 14-18. The answers show that most of the students in some way agree with the statements proposing some kind of neglect of ethical principles (Nikcevic, Markovic, 2015).

2. RESEARCH

Aside from many benefits of the Internet use, because of the lack of knowledge and experience necessary for bringing right decisions, the young often find themselves in risky situations, when facing ethical issues. Taking into consideration the amount of time spent on the Internet, it is necessary for the young to be aware of its influence on their behaviour and their growing-up process. Aside form its positive effect on modern society, easy access to the Internet constitutes greater risk and danger for the young and causes, through various virtual communities, different social problems, such as intrusion of privacy, security and ownership and also cyber crimes, pornography, *etc*. The young are free to visit any Internet site and to communicate with anybody. That kind of free

access and the exposure to all kind of information may have negative effect on growing–up for the young that haven't reached full maturity. It may negatively affect their real social interactions and make problems in their emotional development (Johnson, 2006).

On the basis of the above mentioned problems, the object of our research is the invasion of privacy and ownership and disregard for ethical norms on the Internet.

3. OBJECTIVE AND HYPOTHESES

On the basis of the above mentioned problems and subject of research, the objective is to examine the extent of respect for privacy, ownership and for ethical code that the young have on the Internet. The main hypothesis is that the young are inexperienced and do not have adequate respect neither for their own nor other people's privacy. On the Internet, they also lack respect for ownership and ethical principles. There are differences regarding privacy, ownership and ethical principles depending on the school students attendance and their success. The main hypothesis is followed by special ones:

1. On the Internet the young do not have adequate respect neither for their own nor for other people's privacy.
2. On the Internet the young do not have adequate respect neither for their own nor for other people's ownership.
3. There are differences regarding privacy, ownership and ethical principles between students depending on their success.
4. There are differences regarding privacy, ownership and ethical principles between students of different schools.
5. There are differences regarding privacy, ownership and ethical principles between boys and girls.

4. RESEARCH METHODS AND TECHNIQUES

Descriptive, so called "survey" method has been chosen as a research method. It is the attitude according to which researcher does survey, measures, compares, makes statements, analyses and presents (in our case), certain attitudes and social processes but without any change in practice.

The technique used in research is of making scales. Comparison of arithmetic means between different groups of respondents has been performed by the use of T-test and ANOVA. For the purposes of research, an instrument was designed in the form of a scale of Likert type, on four levels, through which the participants expressed their

views, namely the degree of agreement or disagreement with the proposed statement. Independent variables were gender, success and different school a student attends. The test consists of 21 statements supporting the examined dimensions. Cronbach-alpha test was used in order to examine the reliability of the scale. We got total inner consistency α=0, 74 confirming reliability of the whole test (Cortina, 1993).

5. PATTERN

The research sample consists of high school students of all grades and educational profile of tenants of high school dormitory in Belgrade. It included 542 male and female students, which indicates representativeness of the sample. On the basis of that, it is possible to conduct some detailed research and draw some generalizations.

6. RESULTS AND DISCUSSIONS

The first hypothesis is that the young do not respect enough their own privacy and privacy of others on the Internet. Based on the stated positions that the students presented, which are related to the dimension of policy we received frequencies that are presented in Graph 1.
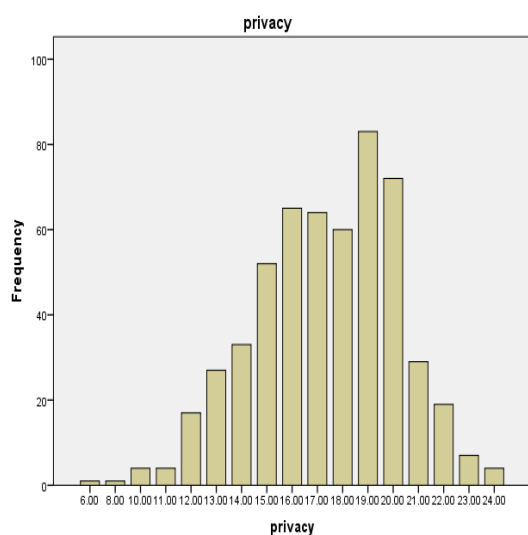
Graph 1. *Respect of privacy on the Internet for adolescents*

On the basis of the frequency response, we can conclude that our hypothesis is confirmed and that students do not sufficiently respect the privacy on the Internet or do not recognize it indicating lack of experience and lack of understanding of certain institutions (Greenfield &

Yan, 2006). Understanding and comprehension privacy among the young is one of the debatable topics. They "share and like" almost everything on social networks, publish their and their friends photos their feelings, thoughts, *etc.*, without thinking about the consequences (Long & Chen, 2007). The research of professor Sarah Jayne at the University College in London suggests that today's obsession with the Internet for many teenagers interferes the proper development of the frontal lobe and thus aggravates their social skills and damages the ability of reasoning (Smol and Vogan, 2011).

The second hypothesis is that the young do not respect sufficiently their ownership on the Internet, and the ownership of others. The frequencies of answers to questions relating to the ownership dimension are presented in Graph 2.
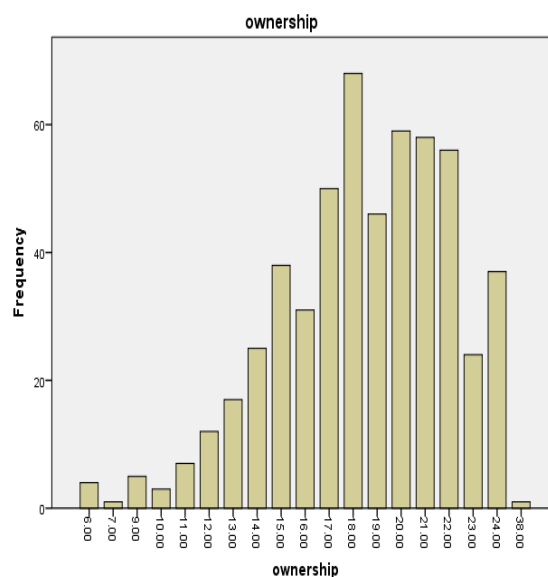
Graph 2. *Respect of ownership on the Internet for adolescents*

In Graph 2 we can see that the answers are concentrated in the bottom of the graph, which indicates low esteem of ownership. Researches show that excessive use of the Internet among the young leads to improper development of abstract thinking and understanding of the impact of their decisions for the benefit of another person (Smol and Vogan, 2011). Our hypothesis is confirmed by this.

The third hypothesis is that there are differences among students with different success in terms of privacy, ownership and ethical standards. Method ANOVA which determines differences among multiple categories has been used for examining this hypothesis. In order to determine differences among groups, Post hoc was done.

Dependent variable	(I)Success	(J)Success	SumM (I-J)	p
success	excellent	very good	0,62	0,015*
		good	0,60	0,33

[1]Differences are significant on the level 0,05

Table I. *Differences among the students in the examined expression size regarding to the success of students (Post hoc)*

Table 1 shows the results of comparing the arithmetic means at examined dimensions of privacy because there was statistically significant difference. There are differences both in terms of ownership and respect of ethical norms but there is not a statistically significant difference. It was found that students with excellent grades have a more positive attitude toward privacy in relation to students with very good success. This hypothesis is partially confirmed.

The fourth hypothesis is that there are differences between students from different schools in terms of privacy, ownership and ethical norms. To test the difference of arithmetic means, factor analysis of variance Post hoc was used to determine differences among groups.

Dependent variable	(I)School	(J)School	SumM (I-J)	p
school	medical	grammar	0,57	0,37
		musical	-0,80	0,63
		legal and economics	1,11	0,11
		tourism	0,53	0,79
		civil engineering and technical	0,18	0,014

[2]Differences are significant on the level 0,05

Table II. *Differences among students in expressions of examined dimensions regarding the school they attend (Post hoc)*

Dependent variable	Sex	N	M	SD	t	df	p
privacy	Boy	260	17,00	2,99	-0,67	516,19	0,027
	Girl	282	17,17	2,61			
ownership	Boy	260	17,67	3,70	-5,09	529,67	0,210
	Boy	282	19,24	3,49			
ethical	Girl	260	15,51	2,57			
standards	Boy	282	16,13	2,54	-2,82	535,39	0,931

[3] Differences are significant on the level 0,05

Table III. *Differences among students in expression of examined dimensions regarding the sex*

Table 3 shows the differences of arithmetic means between students of different sexes. It can be seen that significant differences exist between students of different sex only regarding the privacy, by which our hypothesis has partially been confirmed. Female examinees have more positive attitude toward privacy than male examinees.

7. CONCLUSION

The paper presents the results of research which aim was to examine how much the young respect the privacy and the ownership on the Internet and how much they are willing to follow the ethical code of behaviour. This study is the third in the series of studies on the behavior of adolescents on the Internet. (Nikcevic and Markovic, 2014, Nikcevic and Markovic, 2015).

The study is based on the assumption that the young do not have enough experience and do not sufficiently respect their own privacy and privacy of others, as well as ownership and ethical standards on the Internet.

The first and the second hypotheses were related to respect of privacy and ownership. The answers of our examinees show the low level of respect of the examined dimensions, indicating the need to involve parents and professionals to transform the existing strategy and forming new to influence the behavior of the young on the Internet.

The third hypothesis is related to the connection between success and privacy, ownership and ethical codes of behavior on the Internet. Statistically significant differences were found only in the connection between success and privacy, which can be explained by the conditions they live in. In fact, life in the dormitory means constant monitoring and control of students and their free time by the teachers. Coexistence with their peers involves joint decision-making in a variety of situations and respect of personal assets and assets of the institution they live in.

The fourth hypothesis examines the connection of schools of different modules with privacy, ownership and ethical code of behaviour. Statistically significant differences are, as in the previous hypothesis, found only in terms of privacy, which can also be described by the conditions they live in.

The fifth hypothesis examined the connection of the examined dimensions with the students' sex. The differences are, as in the previous two, found only in terms of privacy. The girls showed greater respect of privacy in relation to boys, as was confirmed by the previous research (Nikcevic and Markovic, 2014).

Simple and continuous access to the Internet provides tremendous opportunities for adolescents and their socialization, enabling them to connect with their peers all over the world. It is clear that the Internet transforms the social world of adolescents, and it is necessary to point out the potential benefits and risks and to ensure safe strategy of communication and interaction.

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E-BUSINESS

THE IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY ON HUMAN RESOURCES

Snežana Lj. Lazarević,
Jelena M. Lukić

Singidunum University,
Faculty of Physical Culture and Sports
Management,
Belgrade, Serbia

Abstract:

Information and communication technology (ICT) has penetrated all the areas of our lives and work and has become their integral part. The success of modern organizations, regardless of their size and activity, is increasingly becoming molded by ICT. Thereby, numerous researches have attempted to identify what determines the success of using this technology. The conclusion is that the employees, as the most important resource of every organization, along with human knowledge, skills, potentials and abilities, are one of the crucial factors which determine the success of ICT application. The subject of this paper is the analysis of the impact of contemporary ICT on human resources. Along with the positive effects, the paper also presents negative implications of ICT on employees, which have started to appear in practice.

Key words:

human resources, information and communication technologies, employee knowledge and skills.

1. INTRODUCTION

One of the main change in organizations over the last couple of years is the growing use of information and communication technology (hereinafter ICT) [1]. Corroborating this is the fact that until recently, managers took no notice of decisions about introducing and applying ICT, while today this is not viable [2]. Until the 1980s, the primary role of technology was reflected in the automatization of business processes and reduction of their execution time. In the last decade of the 20th and during the first two decades of the 21st century, the impact of ICT, as a significant factor for designing an organization, has become the fundamental topic in both managerial and ICT literature [3, 4]. Research has shown that ICT has generated new competencies, positions as well as a new nomenclature of positions [6]. Consequently, organizations are faced with numerous challenges and issues regarding the way of applying contemporary ICT, while the greatest changes are in the human resources (hereinafter: HR) area, that is, to be handled by the employees working with new technologies. Thus, the topic of this paper is to present the significance of ICT for an organization, and to indicate the role and significance of HR in its application. Along with the advantages, the paper also points to the key disadvantages, that is, the negative impact which ICT has on employees, which is increasingly more noticeable in practice.

Correspondence:

Snežana Lj. Lazarević

e-mail:
slazarevic@singidunum.ac.rs

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2. THE SIGNIFICANCE OF ICT FOR CONTEMPORARY ORGANIZATIONS

With the mass recognizing of the significance of information and communication technology by organizations in the last few decades, there increasingly appears the question whether ICT really transforms organizations and in which way [7]. Many people see in ICT a "*magic wand*" which can solve all the problems of an organization, overlooking the fact that the key to success is in total organizational change [8], that is, in a new organizational design which would enable using all ICT potential advantages [9]. Numerous research has confirmed that it is necessary to adapt the design of the organization, i.e.., its strategy, structure, processes, culture and HR, for successful application of technology [4]. Also, it is important that the organization has the developed and informed work environment which represents a good technological support for redesigning work, business and information processes (workflow management) [5]. Through time it is shown that one of the key factors which determine the success of applying ICT are human resources, that is, knowledge, skills and abilities of employees [20, 21]. In order to perceive the significance of ICT for the organization, it is useful to examine Table I which considers the strategic impact of the portfolio development by applying ICT and its strategic impact on the existing operating systems [10].

		Strategic impact on the development portfolio by applying ICT	
		WEAK	STRONG
Strategic impact on the existing operating systems	WEAK	*Support*	*Reversal*
	STRONG	*Factory*	*Strategic*

Table I. ICT strategic network

Source: Adapted according to McFarlan F. W., and McKenney J. L. (1983). *Corporate Information System Management: issues facing senior executives.* Homewood: Dow Jones – Irwin.

Within the organizations where ICT has a minor influence or it is likely that it will have a minor influence in the future, its key activity is in supporting the existing business processes and activities which requires an average or below average investment and intermittent attention of the top management. In the organizations in which ICT has an essential relevance for the current business processes and activities but the impact on the strategic position of the organization is still not visible, its activity is of a factory nature. However, in the organizations in which ICT is considered to be crucial for the future survival and growth of the organization, it has the features of a driving force. The greatest impact of ICT is seen when the functioning and survival of an organization is affected by its application, due to which ICT is considered a strategic resource and an integral part of the organization [10]. ICT has a strategic significance due to numerous indirect effects embodied in new possibilities. The organizations which are aware and react to these possibilities ahead of others can obtain a significant advantage. In order to achieve this, organizations must carry out innovations in business practices or else, if they mechanically implement technology without making changes in the existing practices and processes, their investment will be ineffective [11].

The influences of ICT on an organization are numerous and can be seen on the operational level, the organization itself and business strategies [12]. The impact of ICT on the operational level is reflected on the products and services which increasingly obtain the element of information, markets which become fluid categories and the economy of production which is characterized by changes in the planned structure of costs. On the level of the organization, the impact of ICT is reflected in the influence of the purchasers (transferring of costs and consumer information); the influence of the suppliers by reducing their powers (by undermining or partition); substitution of products/services through numerous innovations (new products and value adding); the appearance of new competition via creating or destroying obstacles for market entry; rivalry through changing its basis (competition or cooperation). The impact of ICT on the level of the business strategy is reflected through cost efficiency, differentiation of product and focus.

The process of formulating a business strategy requires taking into consideration plentiful information from different sources. The data which has to be mainly considered are data of purchasers, regulations, data on competitors, inputs, needs of the stakeholders, limits of resources, and trends in their given branch. Organizations must be aware that all the collected data is correlated and they need to schedule their processing [13]. Great support can be found in the use of ICT considering that its primary role is to improve the collection, processing and exchange of information.

The research of ICT impact on the competitve advantage of the organization started in the 1980s [14]. The widely accepted approach is that the application of ICT can lead to costs reduction, time reduction, the appearance of new channels of distribution, differentiating of products and services, as well as better understanding of purchasers' needs and desires [15]. Along with this, organizations can acquire numerous other advantages as ICT enables the following: collecting and processing of information at a significantly higher speed than in the past; making information accessible to all employees; enabling quicker access to information; stimulating the participation of staff in sharing and applying information and using information to adapt to the environment in a suitable manner [1].

It is very important for the organization to establish an ICT strategy which represents a set of decisions jointly brought by ICT and business management and which support and enable the realization of business strategies [16]. ICT strategy, along with the description of technology, must also include the connections and relationships between technology and business activities of the organization [18]. Thereby, it is obvious that formulated ICT strategy must be harmonized with the business strategy [17] and that the implemented ICT applications and infrastructure must support the strategic aims of the organization [19].

3. THE IMPACT OF ICT ON HUMAN RESOURCES

Contemporary organizations base their business success and competitive advantage on the strategic management of human resources. In that sense, it is noticeable that ICT turns out to be a strategic partner of human resource management (hereinafter: HRM), and the level of acceptance and implementation determines the structure of the e–HRM system. The application of the e-HRM concept implies a change in HRM activities [22], that is, with the development and introducing of new technologies in the organization, there occur relevant implications on HRM applied policies and practice in the organization. HRM activities such as planning human resources (through planning supply and demand) by applying contemporary quantitative methods and information systems, recruiting and selection of potential candidates via the Internet, social networks, the intranet and other (e-recruiting and e-selection), change of the nature of work – a more extensive designing of new jobs and redesigning existing ones, introducing new jobs,

acquiring new knowledge and skills through professional training by applying e-learning and computer simulations – these are just some of the forms of HRM activities which have undergone transformations by applying ICT. Table II shows some of the technologies and their impact on HRM activities.

Technology	Impact on HRM
Web portals	Employees can independently update their data, follow and manage their benefits package.
Mobile web and wireless access to the Internet	Used to help employees access the organization's HR activities.
Software for following activities on the Internet	Enables following employees to use the Internet for private purposes or monitors their work performance.
Data storage and analytical software	Assists HRM in monitoring HR systems and keep data accurate and updated.

Table II. The impact of ICT on HRM activities

Source: Adapted according to Dessler, G. (2007). *Human Resource Management.* New Jersey: Prentice Hall.

Certain authors stress that "*technology was never a scarce resource*" but rather a collection of managerial abilities needed to create a new value by applying this technology [24, p. 14]. Any organization which implements new technologies and new work processes must also have employees who can use them [25]. On the other hand, some consider that contemporary ICT will in the future lead to a radical work transformation and that the principle "*I think, therefore, I produce*" will prevail [26, p. 382], and that those employees with no ICT skills cannot expect respect from colleagues and supervisors [27, 28]. Also, with the influence of ICT, labor will become largely orientated towards teamwork, an increase of goods and services quality, meeting set deadlines, independence of staff, and a higher level of individual as well as team responsibility.

Research of the impact of technology on employees was carried out on various levels, starting from the entire organization, work groups and the level of the individuals. On the macro level, the key change was in the fact that top management came from technical science backgrounds or had substantial ICT skills [29] in contrast to the previous years, when social science degrees prevailed. A new work

position is formed in the organizations –Chief Information Officer (CIO), with the role of correctly implementing ICT within an organization [19]. ICT has a large impact on the professional commitments of managers by making some routine and simple decisions automatic, enabling the delegating of rights and obligations to the middle and low-level management, whereas decision making can also be made by staff not in managerial positions. Many managers claim that ICT has enabled them to leave the office and do field work, and that they have more time for activity planning [29]. Along with this, ICT enables employees at all hierarchical levels to access the information needed for a more efficient planning process, decision making, coordination and control [1].

ICT is a significant challenge for employees [30], but they are the ones who to a large extent determine the destiny of ICT within an organization [31]. Primarily, what is expected from them is a high level of education which will help to acquire technical skills but also business knowledge. Employees must have the abilities and motivation for continuous learning and knowledge acquisition as well as a high degree of self-control, various interpersonal knowledge and skills and the analytical approach to problem solving. The additional challenges appear from the following facts: 1) new ICT possibilities grow exponentially, something that human abilities cannot follow; 2) human capital and the labor market are specific as they consist of individuals who have expectations, needs and desires; 3) ICT experts have different motivation factors and needs in comparison with other experts [32].

Along with the fact that ICT is necessary for the functioning of any organization, research has shown that in practice ICT has a positive impact on employee productivity, as well as satisfaction, efficiency, autonomy and flexibility [33].

One of the most significant changes is that employment is not fixed to a certain place and time as ICT has enabled the occurrence of virtual organizations and the self-styled organizations without borders. Employees can work from anywhere where there is a telephone, fax machine, e-mail and Internet access [33] and the key positive effects for the employees are time free from commuting, as well as a greater freedom in organizing work time and balancing private lives and business careers. Also, there are some negative effects of working from home, such as the impossibility of quality assessment of staff performance, a feeling of isolation due to the lack of physical contact and no development of loyalty and identification with the given organization [34].

The expression "infoworker," put forward in 1957, underscored that in the future those employees who can create new values for an organization based on information would prosper [35], and today it is experiencing a real renaissance. The prediction is that by 2020, over 85% of the world population will be working as "infoworkers" [36, p. 77], and the hypotheses which [37] put forth in 1988 that employees will be forced to develop new skills and knowledge in order to work with new technologies as they imply a new way of thinking are totally confirmed today. Knowledge, which is increasingly permeating technological achievements, has replaced physical labor as a key component of economic development [38], while investing in human resources, human knowledge, skills and competencies is considered a key determinant of success and gaining a competitive advantage.

4. NEGATIVE IMPACTS OF ICT ON HUMAN RESOURCES

Certain weaknesses in ICT use have started to appear over time, along with numerous advantages. These weaknesses can be viewed from the aspect of technology, information security and work conditions [39]. The key negative consequences for employees are reflected via the influence of ICT on 5the a work environment. The ICT work environment may cause alienation and frustration of employees, as well as anxiety, stress, fear of job loss, and similar.

Many employees who use ICT to a large extent in their work place may undergo a loss of identity and the effects of alienation due to a specific feature of ICT – a lack of physical contact. Communication is carried out via e-mail without physical presence, and gives no possibility of viewing all the elements of non-verbal communication, gesticulation, or perceiving the tone of voice [1]. The reaction of the collocutor is unspecified until the message is answered, and even then there is no assurance that words have been chosen carefully and that the message replicates the essence [45].

Information technology and the Internet enable employees to be mobile, to work with co-workers from a distance and in all time zones, to do business in various forms and outside the traditional office environment [40]. In virtual organizations, employees are geographically dislocated and work from their homes without any physical contact, often worried that they are less valued and appreciated, that is, that they are "*out of sight, out of mind*" [41, p. 19]. Numerous research regarding those who

work from home (in virtual organizations) haa indicated some of the aspects of the negative mindset which can be encountered. Primarily, these are the feelings of isolation, a lack of appreciation and respect, non-inclusion in all relevant decisions, difficulties in keeping step with the changes in the organization as well as receiving feedback in real time.

Information anxiety represents the frustration of employees due to impossibility to keep pace with the enormous amounts of data. The human brain has a limited capacity for memorizing, processing and applying information – psychologists claim that individuals cannot work concurrently with more than 5 to 9 information segments [13, p. 8]. Computers and ICT have significantly spread the power of information processing, thus enabling organizations to overcome the problem of the limitations of the human mind [13], but at the same time they have led to information anxiety due to presence of information from various social networks, smart phones, blogs, and e-mail. Consequently, various health problems can appear, such as insomnia, insufficient or poor sleep, tension and apprehension, loss of concentration, frequent headaches, *etc.* [29].

ICT can be important support for an organization's downsizing strategy, which has to a large extent impacted on the eliminating of certain work places and reducing the number of organizational levels. These processes have caused the loss of some jobs and working positions [42] which is the greatest fear for employees who fear that they may lose their jobs due to new technologies. On the other hand, some employees may undergo stress at work due to an incapability to manage new technologies. Also, employees who largely work with ICT may begin to feel the symptoms of digital Taylorism – as they are aware that managers can monitor them constantly via e-mails, telephones, logs, files, *etc.* [43].

A great problem for organizations and management is also using ICT for private purposes during work hours which can lead to reduction of efficiency of employees [44]. Overcoming this problem via a limited or terminated access to certain ICT segments (especially private e-mails and social networks) can result in employee dissatisfaction.

All these negative impacts of ICT are perceived only after its application and it is almost impossible to foresee them. However, in practice there is often a total disregard of the negative impacts as the attention of the management is directed exclusively towards the advantages of ICT [45].

5. CONCLUSION

The world around us has been changing lately due to the effect of ICT. It is very likely that in the following decades ICT will have a great impact on all areas of life and work. Contemporary organizations are increasingly applying ICT and finding ways to acquire a competitive advantage. The actual application of ICT requires numerous changes in human resources. One of the most significant factors thet determines the success of using ICT are human resources, that is, knowledge, skills and abilities of employees. Principally, analogously with the development and introduction of new technologies in organizations, there is a need for new work places, that is, new knowledge and skills. Also, the job descriptions and commitments of the employees undergo changes, as they attain a powerful weapon – ICT, which enables working from everywhere where computers and the Internet are available. ICT has intensified employee learning processes through various training sessions, retraining, skills and career development. However, in spite of numerous advantages of ICT application that are primarily reflected in the advancement of productivity and employee efficiency, some negative aspects have been identified in practice, such as alienation, negative psychological influences, information anxiety, stress, and fear of job loss. All these influences represent new challenges and tasks for human resource management.

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INFLUENCE OF PEER-TO-PEER-BASED EXCHANGE ON CREATING NEW BUSINESS MODELS

Jelena Stanković,
Ninela Kordić,
Slavka Drašković

Singidunum University,
Belgrade, Serbia

Abstract:

One-to-one communication and business concepts which emerged in the period of introducing information and communications technologies (ICTs) in business in the dawn of the New Economy of the early 2000, quickly shifted to "many-to-many" and further on to "peer-to-peer" exchange and collaborative consumption, pushed by the expansion of social networks, and the strong influence of economic and social factors. The sense of urgency as a result of rapid population growth and resource depletion provoked the need for establishing savvy business models that will support clever resource use by utilizing peer-to-peer exchange. Moreover, the purpose of this paper is also to present and analyze new business models which support collaborative consumption as an important alternative for reestablishing customers' trust and loyalty in organizations. Collaborative consumption as peer-to-peer-based access to creation, production, distribution, consumption and trade of goods, services and information has become of high importance in business since it proved to bring lower costs of economic coordination within online communities, to speed up the pace of communication among reference groups of consumers, to contribute stronger communities, and to encourage sustainable development.

Key words:

collaborative consumption, economic factors, social factors, savvy business models, sustainable development.

1. INTRODUCTION

During the past twenty years, mass marketing has been replaced by „one-to-one" marketing approach, based on individual communication with target customers (Peppers *et al.*, 1999). Rapid use of information and communications technologies (ICTs) in business, enabled individual segmentation and building partner relationships with customers and clients (Rubin, 1997). Apart from ICT development, numerous market factors, especially economic and social factors escalated change in the way customers choose and consume products and services (Kotler & Keller, 2012): the goods have become „just a click away" from the potential customers; balance of online and offline access to information and communication with providers of goods and services; „24x7x367" has become the „code" for location and convenience of purchasing products and services. Furthermore, the development of ICTs contributed to development of many-to-many marketing (Gummesson, 2006) as well as establishing social media as many-to-many communication platforms

Correspondence:

Ninela Kordić

e-mail:
nkordic@singidunum.ac.rs

such as Facebook, Twitter, LinkedIn, followed by file sharing media (YouTube, Instagram), blogs, forums, and wikis. Based on that, the power of word-of-mouth (WOM) marketing has been empowered (Barak, 2016). The urge for establishing savvy business communication based on ITCs and personal characteristics of the existing and potential customers resulted in development of collaborative consumption and sharing economy, as a social and economic ecosystem built for the purpose of sharing human and physical resources in sense of common production, distribution, trade, and consumption of goods and services by different customers – individuals and organizations (Matofska, 2014). Economy of sharing has contributed to development of peer-to-peer (P2P) communication and exchange which has been present in all contemporary aspects of economic and social life.

2. PEER-TO-PEER COMMUNICATION AND COLLABORATIVE CONSUMPTION- RESEARCH OVERVIEW

Collaborative Consumption (CC) could be defined as „*the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online services*"(Hamari *et al.*, 2015, pp.1). CC projects are based on the use of online

services which enable easy connection of individuals (peer-to-peer) and creating peer-to-peer networks.

Visual presentation of Collaborative Economy in Fig.1. displays the economy organized into various groups, sub-positions and example companies.

Authors Hamari, Sjoklint and Ukkonen (2015) expect that CC, as an economic and social category, will contribute to slowing down and decreasing some societal problems such as hyper-consumption, pollution, and poverty by lowering costs of economic coordination within communities. Rapid population growth and resource depletion provoked the need for establishing models which will enable access to and consumption of goods and services. Peer-to-peer exchange has proved to be the way to put up with the above-stated societal problems. The authors emphasize that there is actually a lack of information and deeper understanding of why people would participate in collaborative consumption. The research (Hamari *et al.*, 2015) investigates customers' motivations to participate in collaborative consumption (CC). The study included 168 participants who were registered onto a CC site. It was discovered that the basic motivators are CC sustainability, personal enjoyment of the participants in the activities, and economic gains. In addition to that, the authors found out that people perceive the CC activity positively, but, at the same time, they

Figure 1. Collaborative Economy Honeycomb (Owying, 2014)

do not necessarily translate their attitude toward offerings into real action (Hamari *et al.*, 2015). The reason may be the lack of customers' understanding of the particular benefits of CC activities for them as participants, as well as for the society and the economy in general.

Another research (John, 2013) investigates the connection between CC and ICTs, in particular the internet, smart phones and social network sites (SNSs). The research included the analysis of 63 newspaper articles about CC, and argued that CC is a high-tech phenomenon which covers the main qualifications: (1) technology is described as the key driver of CC development; (2) technology is the driving force of CC, especially through use and development of social networks (*e.g.* Twitter and Face book); and (3) the terminology and metaphors used in CC can be easily connected with high-tech start-ups.

In 2010 Time magazine declared CC as one of the ideas with most potential to change business world (Walsh, 2010). CC has been included in some of the most popular services such as: AirBnB.com (space rental present in over 190 countries), FreeCycle.org (free exchange of presents and goods), Kiva.org (free lending money to alleviate poverty), Paperbackswap.com (free book exchange service).

According to Nielsen, in 2015 Airbnb was operating in more than 34,000 cities and 190 countries, with more than 25 million guests. Uber was available in 55 countries in the same year, with a presence in 150 cities in North America, 11 cities in Central and South America, 63 cities in Europe, Middle East and Africa, and 45 cities in Asia Pacific. Other services are only available in defined and smaller geographic areas, at least initially, such as one-hour delivery by Amazon in some parts of New York city (Van Welsum, 2016). The rise of the sharing economy is displayed in graphic (Nielsen, 2014)
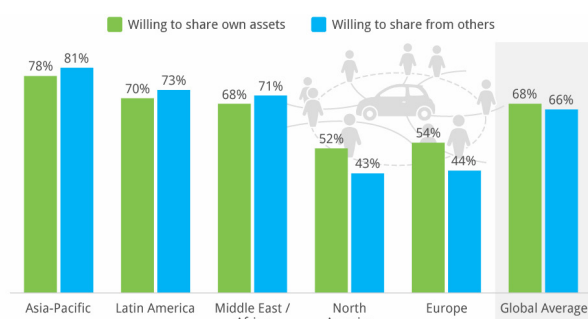
Figure 2. The Rise of Sharing Economy (Nielsen, 2014)

In his article in New York Times "Welcome to the 'Sharing Economy'", Friedman (2013) explains the core

of sharing economy based on the analysis of AirBnB.com i Vayable.com services. He concludes that the core of business change brought by CC and sharing economy is in building trust between companies and their customers. The purpose of CC and sharing economy can be seen in exchange of recommendations coming from the customers themselves (Friedman, 2013).

The development of sharing economy and peer-to-peer exchange depends on people's willingness to share. According to Nielsen survey (2014), 28% of global respondents stated positive when questioned about their willingness to share or rent their electronic devices for fee, 23% were willing to rent power tools, bicycles (22%), clothing (22%), household items (22%), sports equipment (22%), cars (21%), outdoor camping gear (18%), furniture (17%), homes (15%) motorcycles (13%) and pets (7%). When it comes to renting services, 26% of global respondents would rent lessons or services via the Internet, such as music lessons or dog sitting services.

3. BUSINESS ASPECTS OF SHARING ECONOMY

Sharing economy comprises different aspects of value sharing and creation in a way that economic, financial, ecological and social values are of equal importance. It also comprises alternative currencies, local currencies, time banks, *etc.*, as a way of "giving and receiving" to build supportive networks, strong communities and social equity. Developing and accepting new business models based on collaborative consumption and peer-to-peer exchange can also contributes to clever and savvy use of disposable assets.

Sharing economy encompasses different structures such as for profit, non for profit, barter and cooperative structures (Friedman, 2013). Corporations, governments as well as individuals take active part in different evolving organizational structures acting as buyers, sellers, creditors or debtors (Altimeter Group, 2013).

Our planet and its inhabitants stand in the center of an economic system in which value creation, production and distribution should be in synergy and in sync with disposable natural resources. CC and sharing economy contribute to development of peer-to-peer exchange of information with the purpose of protecting resources, saving living costs, and reducing the risk of making wrong decisions in exchange with customers and users of similar goods and services (*e.g.* Neighborgoods.net service).

As the time passes by, the number of industries which accept sharing economy services is on the rise. One of

the examples of sharing economy influence on classical economy is the increase of the number of web sites for fund raising (CrowdFunding), as well as the services for peer-to-peer lending such as Lending Club and Prosper (Berger, 2015). Such services have started to appear on the Serbian market.

Rachel Botsman (2010) points out that the mentioned development of trust by using peer-to-peer services will end up in creating a „currency" made up of reputation of the individuals and that will be used as a determinant for credit rating. In such a way, gaining trust in or/and of completely unknown people enables further development of CC and peer-to-peer exchange. From the individual measuring of influences of the individuals communicating on a distance, *e.g.* service Klout.com., researchers are now in the situation to classify the trust developed among distanced users as the key factor of success of the sharing economy projects conducted online and offline.

4. SHARING ECONOMY AND BUSINESS MODELS BASED ON TRUST

The analysis made in the European Union resulted in discovering new trends in business based on sharing economy, CC and peer-to-peer based communication and information exchange (Dervojeda *et al.*, 2013).

As opposed to conventional business models which imply activities to enable customer's approach to assets of the company, peer-to-peer based business models enable customers to approach other customers' skills and competencies. Online platforms and online markets support connection of customers who own particular resources with customers who are in need of those resources.

The start-up companies are the first to be considered as the driving force of sharing economy (Dervojeda, 2013). Their role can be found in matching customers who own particular resources, such as competencies, skills or know-how, with customers who are in need of such resources, in right moment and with adequate transaction costs. Customers can also offer their own resources and look for demands and needs of other customers. Most of the start-up companies in sharing economy belong to incubator programs, in which they are advised how to provide startup capital.

The development of ICTs and the increase of web 2.0 enabled development of online platforms which promote user content, sharing and collaboration among users and customers, as well as database sharing (Kaplan & Haenlein, 2010). There are also possibilities for peer-to-peer lending, such as platforms for micro lending *e.g.* Kiva,

and crowd funding services *e.g.* Kick starter, one of the world's largest funding platforms for creative projects. It is interesting that within this platform, among others, exists the proposal for funding the local films by individuals from around the world (Kickstarter, 2016).

Open source software, online collaboration, database sharing and peer-to-peer lending are considered to be different activities of sharing economy, since they are based on ICTs and Internet support and improvements which have facilitated and simplified sharing physical and nonphysical goods (Hamari, 2015).

The are some important economic factors which stimulated development of sharing economy (Dervojeda *et al.*, 2013):

- ◆ reduced customers' trust in business of the companies as a result of financial and economic crisis;
- ◆ increase of unemployment and decrease of purchasing power of customers which affected customers to develop the need to earn and save money.

The factors caused customers to be more sensitive to peer-to-peer business model, which are focused on customers and suppliers. In addition to that, the technology required for establishing and developing such models has become accessible at reasonable prices. The annual increase of sharing economy is estimated to be over 25% (Dervojeda *et al.*, 2013).

One of the greatest challenges of peer-to-peer platforms from customers' perspective is the lack of trust in online transactions and activities in general. Therefore, the companies that operate in sharing economy try to increase trust by establishing peer-to-peer rating systems, identity authorizations, and quality and safety requirements (Dervojeda *et al.*, 2013).

5. INSTEAD OF CONCLUSION – CHALLENGES FOR SUSTAINABLE DEVELOPMENT AND PEER – TO - PEER EXCHANGE IN SERBIA

The Commission of the European Union (EU) intensively analyses the effects of sharing economy on future personal, social, and economic development of its members (Mackay, 2015). Encouraging sustainable development should be one of the main goals, based on sharing economy development potentials which would be the following (Dervojeda *et al.*, 2013) :

- ◆ decrease of negative influence to local environment – *e.g.* decrease in emission of carbon monoxide and reduction in use of natural resources,

- build stronger communities, based on shared values and solutions,
- savings of lending cost and costs of raw material supply,
- help people use goods thay can not acquire easily,
- help creating minimal safety and quality standards for peer-to-peer markets,
- provide more training and education projects for programmers,
- make empleyment more flexible,
- help decreasing income taxes.

Based on previously mentioned, the examples of sustainable peer-to-peer activities can be found in Serbian economy. Peer-to-peer exchange services have been operating in Serbia for quite a while, although only a few of them are domestic. In June 2015, the first Serbian Car Sharing platform, Car4Use, started to operate. There are currently 57 active Car Sharing programs worldwide in all major cities. In all countries, other forms of transport are losing popularity, while the number of users of Car Sharing service is growing on a daily basis (Car4Use. com, 2015). Also, recent peer-to-peer project in Serbia is a platform whose establishment is underway and it should serve for exchanging goods and services in „helva" as a currency (alva.rs). Unlike national currencies which are based on central or federal reserve or digital currencies (bitcoin - based on mathematical functions of computers), helva bases its value on human resources or number of established network among customers. Helva stands for accounting and exchange unit of goods and services. Personal profile of consumers includes personal identification and all transactions made. By now, helva is the only alternative currency in the region, while globally there are alternative currencies functioning locally in the similar manner (Otvorena škola ekonomije, 2014)

One should take into consideration the fact that some of the companies, involved in sharing economy, are being investigated. For instance, Uber is the company currently involved in several trials in Spain, France, Italy, Belgium and Hungary (Ashok, 2016). The company famous for lending flats and rooms, AirBnB, gets involved from time to time into legal prosecutions, based on complaints from associations of hotels. The General complaint is that AirBnB is involved in activities of disloyal competition and that more taxes should be paid for service they deal with (Tuttle, 2013).

Still, the greatest advantage of sharing economy and peer-to-peer transactions can be found in creating new jobs for people under thirty-five who are currently mostly unemployed. Also, peer-to-peer commercial transac-

tions generate and encourage individuals to develop their skills that can be used in different industries which are important for developing more democratic economy and society (Dervojeda *et al.*, 2013).

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REVISITING FAIR VALUE ACCOUNTING
AS A MAGNIFIER OF FINANCIAL CRISES

Vule Mizdraković,
Nemanja Stanišić

Singidunum University,
Belgrade, Serbia

Abstract:

In an earlier paper titled 'Mark-to-market accounting as a magnifier of financial crises', we advocated that fair value or mark-to-market accounting magnifies financial crises by creating a feedback loop between figures from financial reports and financial markets. We proposed a simple method for assessing how overpriced the US stock market is, which included a comparison between fixed base indexes of the S&P 500 and nominal US GDP. In this paper, we reiterate the role that fair value accounting is expected to play in both the creating and bursting of financial bubbles, putting it in the context of theories of 'reflexivity' and 'almost self-fulfilling equilibria'. We reassess the level of the US stock market, showing that a substantial stock market bubble (the third in the last two decades) has been formed recently and that significant market corrections may happen in 2016.

Key words:

mark to market, reflexivity, equilibrium, financial bubble.

1. INTRODUCTION

An increasing number of recent accounting regulations (both International Financial Reporting Standards - IFRS and Generally Accepted Accounting Principles - GAAP) regarding the further implementation of fair value in financial reporting practices, might lead us to the conclusion that fair value accounting is a novel approach in assets/obligations valuation. However, fair value accounting has been around for quite some time, though it has expanded greatly over the last three decades. There are some indications that it had already been in use in 1910; it had been used through the 1920s and was abandoned approximately from 1934 to the 1970s (Fabricant, 1936; Stanisic *et al.*, 2012; Ramanna, 2013). It seems that at that time, implementation of fair value accounting had not been obligatory, and it did not have any legal introduction in financial reporting practices. According to Herrmann, Thomas and Saudagaran (2005), the newly established Securities Exchange Commission (SEC) considered fair value to be too soft as a measure to be used in practice. After 1940, fair value has been unofficially banned. The end of the Great Depression, its devastating effects and the termination of fair value accounting from official financial reporting practices might be just a coincidence. However, in our paper titled 'Mark to market accounting as a magnifier of financial

Correspondence:
Vule Mizdraković

e-mail:
vmizdrakovic@singidunum.ac.rs

crises', we have argued why that might not be the case. It is quite clear that we had a relatively peaceful period from the 1940s to the mid-1970s, without frequent financial crises. Incidentally/accidentally, that is the period in which the historic cost model of valuation was the only valuation option in the official financial reporting practice. The most probable reason why the fair value concept was revived once again is the idea that financial markets are efficient and their prevailing prices are reliable measures of value (Ramanna, 2013). Though, we will offer some other explanations in this paper. Up until now, the world economy has faced several financial crises, each one being stronger than the one before. It seems that there is yet another financial bubble on the US financial market ready to burst. Therefore, the main question is as follows: How is fair value causing all this trouble in financial markets? We will try to answer this question by analysing the principles of fallibility and reflexivity, defined by George Soros, in the context of fair value accounting. That will be the following part of this paper. The second one will refer to the divergence between basic accounting principles and fair value concept, with the possible explanation of the reasons why the standard setters have been astray from the common accounting sense when they reintroduced the fair value accounting. In the final part, we will present the results of the reassessment of the US stock market level, showing that yet another market bubble has been recently formed and that a significant market self-correction may take place during 2016.

2. THE THEORY OF FALLIBILITY, REFLEXIVITY AND HUMAN UNCERTAINTY AND FAIR VALUE ACCOUNTING

In his first published book titled *The Alchemy of Finance*, George Soros replaced the principles of rational expectations and efficient markets with the principles of fallibility and reflexivity (Soros, 1983). Those principles will serve as a basis for the explanation of how fair value magnifies the effects of a financial crisis and creates market volatility. The foremost principle refers to the human perception of the facts related to some event and his/hers perspective as a result. In the case of natural phenomena, the facts are, in most cases, observable, so there is no active function of the observer. For example, in determining how many lightning strikes occurred in a storm, the observer's opinion does not change the outcome of the experiment. On the other hand, in the social sciences, the observer's knowledge, opinion and perspective affect the results of the experiment. We believe that the same goes

for fair value estimation. For example, let us consider the valuation of a remote gas station[1]. An accountant/valuer plays both passive and active roles in the process of valuation. He/she will observe the market, take into consideration a very few facts and use his/her perception to estimate the fair value of the gas station. However, that is not the end of the process; the estimated value will enter the financial statements of that firm, and if not estimated correctly, it will cause further complications. If we presume that the firm is a subsidiary of another entity, the estimated value will have an effect on its financial statements, as well. It is important to realise that the price at which the gas station has been acquired is a fact, but estimated fair value is not a fact, it is the result of the cognitive and manipulative functions of the accountant/valuer. We will try to faithfully explain these terms, but we strongly suggest reading the above-mentioned book.

First of all, let us define where the equilibrium in fair value estimation lies. The price of a new asset can be defined as the equilibrium between the costs of production and the value to the buyer (Hulten & Wykoff, 1981). Apparently, it is difficult to obtain this equilibrium, but the price of the used asset is even harder to determine. That process includes the estimation of the present value of the asset by the seller and the estimated value for the buyer. Therefore, equilibrium is a moving target, since the opinions and perceptions of the seller and the buyer constantly change. Also, their actions will determine the final result. Clearly, valuation is a very complex and dynamic process because the participants interact with each other and the environment interacts with them, as well. This economic model is a feedback system of expectations, which maps individual beliefs into actions and market realizations, which in turn shape new market expectations (Hommes, 2013). The previous author claims that realized market price p_t depends on the individual forecasts $p_{j,t+1}^e$ for tomorrow of all participants:

$$p_t = F(p_{1,t+1}^e, \ p_{2,t+1}^e, \dots p_{H,t+1}^e) \tag{1}$$

The outcome of the valuation process will be affected by the knowledge, expertise and experience of the accountant. There is no such thing as perfect knowledge in the social sciences, and the definition of market value[2]

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1   International accounting standards do not proscribe that fair value estimation by a professional valuer is mandatory. Therefore, estimation for financial reporting purposes can be performed by an accountant.

2   Both the IFRS (International Financial Reporting Standards) and the IVS (International Valuation Standards) consider market value as a close equivalent to fair value. International Financial Reporting Standard 13 – Fair value measurement, does not even include the previous requirement in the definition of fair value.

supports that:

…the estimated amount for which a property should exchange on the date of valuation between a willing buyer and a willing seller in an arms-length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion (International Valuation Standards Committee, 2003).

Among other assumptions (willing, arms-length transaction, proper marketing, prudent and compulsion) that lead to the estimation of the fair value amount and not its determination, the key word is knowledgeable. International Valuation Standard 1 – Market Value Basis of Valuation considers the knowledgeable seller or buyer as the one who is reasonably informed about the property. Therefore, because of the absence of perfect knowledge, we cannot consider fair value as a fact. There are very few facts that the accountant can provide in the process of valuation; all other information he/she uses is based on his/her estimates and perception. We will name a few: current condition; physical, functional and economic obsolescence; the remaining age; residual value; adequate comparables; gross and net operating income; vacancy; capitalisation rate, *etc*. On the other hand, the structure of a human brain is very susceptible to fallibility because our consciousness can process only seven to eight subjects simultaneously (Soros, 2013).

Furthermore, before performing a valuation, the accountant will have to determine if the property is in its highest and best use (HABU). HABU is the fundamental premise in obtaining the fair value. It is defined as 'the most probable use of a property, which has to be physically possible, appropriately justified, legally permissible, financially feasible and which results in the highest value of the property being valued' (International Valuation Standards Committee, 2003). In some cases, this is a major assumption, which depends on the opinion of the valuer/accountant and his/her knowledge in the field of accounting, finance and law. Knowledge can be represented by true statements, which are based on facts. Price can be a fact, but estimation is not a fact: it is susceptible to our opinions and perception. Therefore, we can conclude that the valuer/accountant suffers from fallibility.

The process of fair value estimation might be comprehended as the cognitive function of a valuer. That is his/her attempt to understand, and most of all, to measure the value of the asset/obligation. This can be perceived as a passive function. The previous process is yet another attempt of social scientists to invent some kind of fixed relation between a participant's thinking and the actual

course of events (Soros, 2013). But, there is also a manipulative function. According to Soros, if the observer plays an active role in observing the phenomena, according to his/her interests, than he/she is influencing the final result of the process. That is what an accountant/valuer does when estimating the fair value of a gas station. He/she is influencing the market by estimating the value; his estimations and perception will be used as a fact in other valuations or as an exact value of the asset in financial statements, and the circle of fallibility begins. This is called the principle of reflexivity. The truth is that in the process of valuation, we only have dependent variables, but we are pretending that some of them are independent. As an example, a valuer uses comparable properties and their offered prices and makes corrections: usually lowering the value of the property being sold by using his/her perception of how much the owner will lower the value of the property. By doing so, the independent variable of one function is the dependent variable of the other; thus implying a circular relationship (the shoelaces theory). Even if the accountant/valuer does use contractual prices, he/she still makes the corrections needed in order to level the quality, age, location and other characteristics of properties. By doing that, the contractual prices as facts no longer serve as independent variables in the process of valuation. The interests of a valuer in the process surely exist, to some extent, whether he/she wants to admit it or not. Therefore, the valuer performs a manipulative function besides the cognitive function.

There is also a problem of uncertainty. We can divide reality into its objective and subjective sides, where thinking and perceptions belong to subjective reality. It is very hard to predict human reactions and responses to incentives; therefore, there is a high uncertainty of how a person will react. Human uncertainty exists in both functions, cognitive and manipulative. It is very important to notice that in the case of valuation, there are multiple participants who interact with each other and the system in which they operate. The reactions of buyers and sellers regarding the property being sold, or in any other market, are truly hard to predict. Therefore, a reflexive system exists. The necessary conditions of this system are defined by Beinhocker, and we will only name them here: environment, agent, goal (interest), cognitive and manipulative function, complexity and internal model (Beinhocker, 2013). The last condition requires further elaboration; to that end, we shall cite the author…: 'If I perceive state A (cognitive function) and take action X (manipulative function) then state B

will result, bringing me closer to (or further from) my goal G' (Beinhocker, 2013). This decision model updates itself in response to interactions between participants and their environment, which creates feedback between the perception of the environment and the participants' internal decision model.

We would like to finish this analogy of the theory of fallibility, reflexivity and human uncertainty and fair value accounting by adding that the implementation of fair value might create positive and negative feedback loops. Positive loops drive participants' views further away from reality. Only a small incentive is enough for valuers to perceive the value of the property as being much higher than it actually is. The negative feedback loops do the opposite: they correct participants' moves, and they do it much faster in comparison to positive ones. The link between the importance of self-reinforcing feedback loops and imperfect knowledge in the financial markets is considered to be Soros's main achievement (Bronk, 2013). Also, positive and negative feedback loops sometimes tend to even make participants' views pessimistic. Positive and negative loops are the basis of the boom and bust process, much like what happened in the 2008 financial crisis. The incentive in that crisis, and the main misconception, was 'easy credit'. The value of collateral (the gas station in our case) was perceived as an independent variable and the availability of credit as dependent, whereas in realty, a reflexive relation exists between the two (Soros, 2013). In the time of welfare, credit becomes cheaper, and real estate values rise; therefore, when the trend picks up, the valuer/accountant feels this as an incentive, which clouds his/her reasoning. That is how the value of the gas station could be inflated if fair value accounting is used for financial statement purposes, or it can be significantly deflated in the period of market contractions or recessions.

3. THE DIVERGENCE BETWEEN BASIC PRINCIPLES AND MAIN GOALS OF ACCOUNTING AND FAIR VALUE MEASUREMENT

Based on the previous section, it can be concluded that fair value is not an objective measure, and most of all, it is not reliable. On the other hand, accounting information has to have certain qualities in order to be used for financial reporting purposes. In this chapter, we will discuss whether fair value fulfils these prerequisites, and after that we will consider the main goals of accounting.

Basic accounting principles and fair value

General purpose financial statements should be prepared with the presumption that the entity will continue its business in the next, at least, twelve months from the end of the reporting period. This is the going concern principle. If the entity will cease to operate or liquidate its business, the statements should not be prepared according to the going concern basis and some other basis will be used. In that case, the value of the assets is estimated under force sale conditions (forced sale values). Let us recall that market value is the amount that can be obtained on a certain date with proper marketing (International Valuation Standards Committee, 2003). This period can vary according to market conditions and the asset characteristics. Therefore, this period is not strictly specified by valuation regulation. But, hypothetically proper marketing usually requires the period of six to twelve months (for liquidation values, the period is even less). On the other hand, the definition of fair value does not even consider proper marketing, and it is probably presumed[3]. The presumption period required by the going concern principle and proper marketing period do not collide. According to Herrmann *et al.* (2005), the predictive value of fair value over historical cost is particularly significant in situations when the entity is no longer a going concern (acquisition or liquidation). Therefore, if we use fair/market value for the estimation of an asset's value, do we violate the principle of going concern and prepare general purpose financial statements under some other basis?

The principle of reliability focuses on the level of neutrality of accounting information. Reliable information is free from error and bias and faithfully represents what it means to represent. Therefore, in order to be reliable, fair value has to be measured objectively without the personal prejudice of the accountant/valuer. That is very hard to achieve in the process of fair value measurement. Whenever personal beliefs are included in the process of measurement, manipulations can appear. By using Benford's Law and digital analysis, it has been found that examined fair values of marketable securities appeared to be manipulated upward, while historical costs of the various assets analysed exhibited no such signs (Jordan *et al.*, 2013). The possible explanation of the previous might be the accounting recognition of such upward revaluation, which is to be recognized as an increase of income. Also, in 2007 and 2008, the asset prices rose significantly,

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3   It is interesting to note that valuers do not have to develop exposure and marketing time when performing valuation for financial reporting purposes.

and the fair value gains on certain securitized assets were recognised as net income, which was used to calculate executive bonuses (Ramanna, 2013). The result of such manipulation will be boosted income. That can have further implications on the financial market, according to the previously explained principle of reflexivity.

The information presented in financial statements should be readily understandable by the users who possess reasonable knowledge of business and economic activities and accounting. The International Accounting Standards Board issued International Financial Reporting Standard 13 – Fair Value Measurement, which explains fair value, sets out a framework for measuring fair value and requires special disclosures about fair value measurements. Clearly, this standard is proof that further clarifications regarding the definition of fair value and its measurement are needed by professional accountants. But, aside from investors, are the other users of financial statements truly aware of the nature and different aspects of fair value?

The accounting information, such as the fair value of our gas station, has to be verifiable. Such information should have the ability to ensure through consensus among measurers that the information represents what it purports to represent. That means that some other valuer or accountant should be able to prove the disclosed value in the repeated process of valuation. Three different accountants will certainly agree on the original cost of the asset, but they will not give the same fair value. As we have already noted, the fair value measurement requires the use of different kinds of presumptions and is dependent on the accountant's/valuer's perception.

Neutrality is the request that accounting information is free from bias intended to acquire a predetermined result. The manipulative function of the accountant/valuer does not permit the neutrality of fair value. Some authors consider that the main disadvantage of historical cost regarding neutrality is that it allows write-downs if fair value is less than book value (in the case of impairment), but historical cost does not allow the same for write-ups (Dietrich *et al.*, 2000; Herrmann *et al.*, 2005). That is actually the sign that historical cost is in accordance with the principle of conservatism.

The accountant should be objective and neutral, as previously noted. However, if he/she faces two acceptable alternatives for reporting an asset, conservatism guides the accountant to choose the alternative that will result in the lower asset amount. An independent valuer aims to estimate the highest achievable amount that can be acquired for the asset being sold. Likewise, by using HABU, as a fundamental basis for fair and market valu-

ation, the result of the process is the highest value of the asset being valued. Therefore, it is arguable whether fair value accounting is in accordance with the principle of conservatism.

Finally, general purpose financial statements should be comparable. Their users should be able to compare business entities from the same industry and analyse their performance, for example. If one entity uses fair value accounting and the other historical cost accounting, both balance sheet and income statement will not be comparable between the analysed entities.

Main accounting goals and fair value

Financial statements should represent what really happened in the previous period of a certain business entity. Standard setters should always have in mind two main goals of accounting. The first goal is the calculation of the financial result and the second one is reporting on the value of the assets, liabilities and equity on the statement day. The financial result is a product of the use of all assets in the business of a certain entity. Since some of the assets lose their value gradually over a certain period of time, the depreciation and amortisation of those assets have to be calculated. The purpose of these values is to distribute the value of the assets used over their lifetime. In that way, we accomplish two main goals of accounting: accurate calculation of financial results, and on the other hand, calculation of the present value of the entity's assets.

The first value is shown on the income statement and the other on the balance sheet, which indicates the present value of the assets used by a certain entity. If we inflate the value of the assets, on the left hand side of balance sheet, we have to increase its right side as well. The increase of the value is the perception of the accountant/valuer: there is no clear source of that value (it is not equity and certainly not obligation). The equity increases if the entity creates value through its business by having positive financial results. That increase of equity is verified because the entity used its assets and created the value that is recognised on the market, *e.g.* a product has been sold or a service has been provided.

On the other hand, the positive results of revaluation are recognised as an increase of the revaluation surplus, which is a part of the entity's equity. That positive revaluation result appears when the fair/ market value of the asset is greater than its book value. We will try to elaborate on the previous statement. In this situation, the entity can sell the revalued asset and gain more value than by us-

ing it. Nevertheless, the entity continues to use that asset (again going concern), probably because it considers that it can gain more value from its use in regular business. That gain in the future will be recognised on the market and in income statement if the entity performs well. Only then, the result will increase the equity, if it is not distributed previously to the owners.

By using the fair value for financial purposes, we are prematurely recognising the results that the entity will earn in the future and prematurely increasing the equity. In that way, we are doubling and magnifying the entity's results. As previously noted, in a time of recession, the pessimistic views of valuers can decrease the value of assets unreasonably. Through asset valuation, accountants/valuers are actually performing business valuation. They are anticipating future transactions and events that will happen in the future (discounted cash flow method). The nature of that process is speculative, and if we add self-interest managerial decisions into the mix, the results of that process are questionable. Therefore, the concept of fair value is in a collision with the purpose of financial statements, which is to present financial transactions that occurred in the previous reporting period.

If we take into consideration the previous arguments, we are wondering: Why did accounting standard setters depart from the main purpose of accounting when they proscribed the valuation methods to be used? That could be due to the fact they were not accountants. Allen and Ramanna (2013) conducted research regarding the effect of the professional and political characteristics of the Financial Accounting Standards Board (FASB) members and SEC representatives on the reliability and relevance of proposed standards. They noticed that FASB members from financial services (investment banking/ investment management) are more likely to propose standards that decrease reliability in favour of relevance, and they tend to propose fair-value methods[4]. Also, it is interesting to note that not until 1993 did the FASB include any financial service veterans. The situation was far different in 2013, when those members constituted more than a quarter of the board (Ramanna, 2013).

We will recall once more that the purpose of accounting is the calculation of financial results and presentation of the value of total assets on the statement date. That information is intended for the general public, rather than some specific user of financial statements. The fair value of the assets is significant information for the investors; as it can help them in making the right decision. However,

specific requirements of the main stakeholders should not be fulfilled by the general purpose financial statements. Those statements should provide reliable information based on facts, which can be used for estimating future transactions. The accounting information should not be an estimation or speculation itself.

4. THE RELATIONSHIP BETWEEN THE S&P 500 AND GDP

In our paper from 2013 titled 'Mark-to-market accounting as a magnifier of financial crises', we have proposed a simple method for estimation when the US financial market is overpriced. We have assumed that the economy of a country creates the value that is measured by the gross domestic product (GDP) of that country. If business entities within that economy grow, the GDP will grow and *vice versa*. The successful business of those entities should be recognised by their investors, and therefore, the market value of those entities will increase.

We have assumed that business entities' earnings, GDP and the market value of those entities should align in the long-term. However, real life figures shows volatility, which started in 1995, the year in which fair value accounting was fully imposed (Stanisic *et al.*, 2012). Fig. 1 shows the gap between the nominal US GDP and S&P 500 returns in the period 1950–2016.

The two figures almost align until 1995; after that year, the S&P 500 values are extremely volatile. There were three peaks, in April 2000, October 2007 and July 2015. The lowest values in that period occurred in January 2003 and January 2009. It should be noted that the lowest values were recorded right after the year end, when financial statements were published. It is clear that the new bubble has been formed and that we can expect the burst effect as the market self-corrects itself. As we analyse fig. 1, we can recognise all of the phases of the positive and negative feedback loops explained by Soros. It takes time for the momentum to build up; it has one or a few crises when the belief in the misconception fades, but inertia is too strong and the bubble is created. The burst is much faster and much more violent, and the market participants even get pessimistic, which is documented by the decrease of S&P 500 values even lower than GDP in 2009.

5. CONCLUDING REMARKS

In this paper, we made our arguments regarding the implementation of fair value accounting as the basis for

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4   Interestingly, the authors did not find any connection between regulators' careers in auditing with reliability and/or relevance (Allen and Ramanna, 2013).
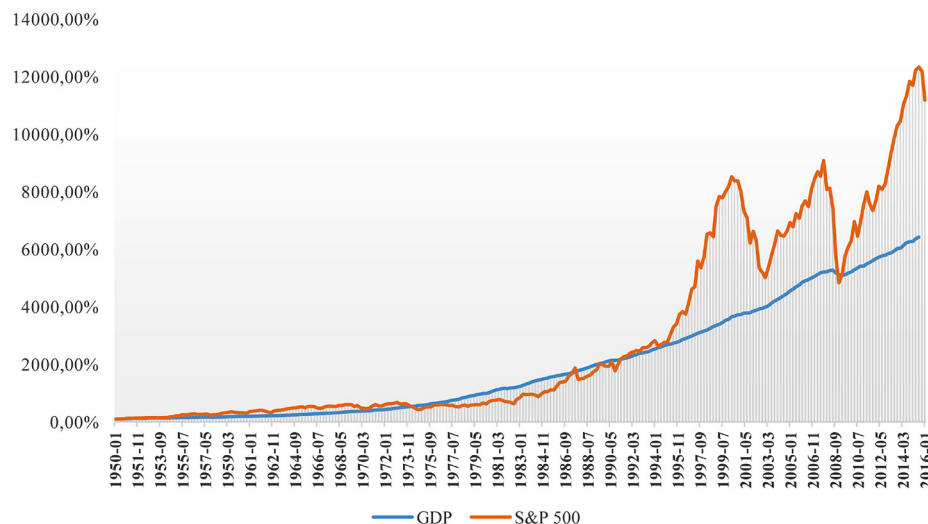
Figure I. The movement of nominal US GDP and S&P 500 from 1950. to 2016.

asset valuation. By using the theory of fallibility, reflexivity and human uncertainty principles, we have explained why fair value is not a reliable, verifiable, objective, neutral and conservative value to be used for financial reporting purposes. However, we do agree that fair value has high relevance power when used for the investment decision-making. On the other hand, that information should be reserved for valuation reports, not financial statements. The effects of fair value accounting implementation on financial markets had been noticed during the Great Depression, but we are witnesses of those effects once again. By using the correlation of nominal GDP and the S&P 500 from 1950 to 2015, we have noticed the creation of yet another asset bubble. We suppose that the burst effect of that bubble will happen during 2016.

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E-BUSINESS

CHALLENGES OF HUMAN RESOURCE MANAGEMENT IN A VIRTUAL BUSINESS ENVIRONMENT

Jelena Đorđević Boljanović,
Gordana Dobrijević,
Filip Đoković

Singidunum University,
Belgrade, Serbia

Abstract:

As a result of ubiquitous information technologies (IT) and their growth in the modern business environment, a virtual business reality is very close to being part of everyday existence. It is up to organizations to identify their own recipe for success against this new business backdrop. That being so, more and more organizations tend to structure their individual functions as to make them more flexible and adaptable to change. One more implication is the need to adjust human resource management (HRM) to virtual business operations, based not only on the innovative reorganization of activities, usually IT-based, but also on the readiness of HR managers to employ a new approach to the standard issues – from leadership, teamwork, the development of required and necessary skills, to sometimes indispensable outsourcing of the very HRM function. The paper will discuss the impact of a virtual business environment on all aspects of the business process and efficiency of the HRM function.

Key words:

human resource management (HRM), virtuality, HR outsourcing.

1. INTRODUCTION

A virtual business environment is a fact of life. A workspace is defined by time zones, not walls; the boundary between work and home no longer exists. What might certainly give a boost to employee productivity is to give your employees a choice as to where and when they prefer to work. As if to make it possible, organizations have already accepted IT-based networks as a way to increase flexibility as one of the prerequisites for timely responses to frequent and permanent changes in the environment. Sara Sutton Fell, the founder and CEO of the *Flex Jobs* website that promotes distance work, says that 99 percent of employed people check their emails and phone calls wherever they are, while according to different outlooks a half of the workforce will be doingdistant work by 2020. A recent study by *FlexJobs*has identified 76 companies in different industries that opted for a work-from-home concept, involving all or nearly all of their employees (Vozza, S., 2015). Yet another proof that "the virtual" is already a part of everyday existence for a good part of the business community is the following list of industry leaders that have been using different types of flexible hours, flexible hiring and virtual operations (Lepore, M., 2014): *Apple, Dell, Humana, American*

Correspondence:

Đorđević Boljanović Jelena

e-mail:

jboljanovic@singidunum.ac.rs

Express, Xerox, IBM, About.com, Microsoft, Thomson Reuters, Mozilla, Bausch&Lomb, SAP, General Electric, Cisco Systems, Google, JetBlue, Citibank.

The inescapable conclusion is that doing business in a virtual reality sets a series of new requirements before an employer: to hire the right employee or professional, prepared to immerse in innovative technologies and shift from the traditional work concept to a flexible, virtual business environment; to recognize the traits of the upcoming generation of employees (the so-called Millennial Generation), to whom geographic parameters, the location or time, do not matter very much in doing a job; to identify the correct method of communication and a degree of flexibility to be applied on assignments and schedules; to recognize and use the advantages of new technologies. Given the above, the question arises as to what kind of a role the HRM function plays, and in what way this vital managerial segment needs to be transformed to make "the virtual" a hallmark of the environment in which HRM strategies, policies and procedures are implemented.

2. HUMAN RESOURCE MANAGEMENT AND VIRTUALITY

When it comes to virtual jobs, it is human resource management that strikes a balance between employers' concern that they won't be able to control their employees unless they are physically present and they can actually see them, and the need for flexibility as the *sine qua non* of innovation, creativity and growing employee productivity.

Kevin Eikenberry and Wayne Turmel, the two authors of the *Remote Leadership Institute* (Tartell, R., 2015) have offered three-step directions to help virtual leaders. We believe them to be a good guide for HR managers as to how to exercise the leadership role they by all means have in modern organizations. The two authors suggest there are three key courses of action in virtual networks:

Leadership and management. A virtual business environment changes the context in which the connection between the leader and employees is created and maintained. The many advantages of face-to-face interaction are no longer available, and new, different elements are to be added to enrich communication. There is a very clear need for HR managers to provide more information on the given assignment or policy of the company than they would normally do when able to read non-

verbal cues by their employees. Likewise, frequent and regular communication is as important as the selection of employees, based not only on their skills and knowledge, but also personal traits and the ability to adapt to a virtual job.

Technology and methods. *Facebook, Twitter, WebEx, Skype* and *Face Time* are just a few communication tools used by leaders and, by extension, HR managers. It is necessary to choose the right method of personal communication, relying largely on the personal empathy involved in the method, and, alternatively, its availability and the specter of influence.

Skills and influence. Low levels of proficiency in using technological tools and methods in a virtual business environment can only generate mediocre results. If participants in these new modes of communication are not concentrated enough, that can only add to the unwanted outcome. The recommendation is to create an environment that can largely recreate a face-to-face meeting. It is only a proper groundwork and good knowledge of the environment and co-workers that can make it happen. Another fundamental ingredient to add is the existence of common goals between HR managers and employees, as the only way to create a cohesive environment and determination to implement a corporate strategy.

Most authors believe there's a fourth aspect to be discussed – the organizational context, including formal structures and expectations within the organizations. (Tartell, R., 2015)

4. TEAMWORK AND VIRTUAL TEAM MANAGEMENT

It goes without saying that a virtual work environment implies virtual teams and the need to manage them. HR managers are the traditional leaders in their respective organizations, dealing with the challenges of managing the teams and guiding them to full efficiency on a daily basis. They are invariably serious, given the difficulties inherent to this category of teams – monitoring and evaluation of team results without a direct contact, different time zones, technological and cultural barriers, to name a few. Some researchers have found out that as many as one-fourth of virtual teams fail to meet the expectations. (Lepsinger, R. at al, 2015)

Practice has singled out the RAMP model, standing for Relationships, Accountability, Motivation and Process, designed to lead virtual teams. (*Virtual Team Study Report,* 2016)

Relationships. It is very important to build relationships with the members of a virtual team, and take a proactive approach to building them. In a virtual work environment, it is often impossible to meet people personally, which is why the leaders and HR managers should do all that's necessary to build relationships based on mutual trust. It is not only the mutual trust, but also common goals and interests that can serve as the fundamentals of building these relationships, often relying on informal activities such as video chats, the so-called *virtual coffee breaks* or *care calls,* which require no official, pre-arranged agenda.

Accountability. Managing accountabilities in a virtual environment generates additional challenges, including limited opportunities for observing the work process directly and the question of employees' autonomy. Virtual workers often need to manage themselves, and account independently for the deadlines and the quality of their work. In spite of the restricted options for the managers to observe their employees, there are ways to manage accountability. Some of them rely on software, like *Basecamp, Work Zone* or *Wrike,* which can make an entire project visible to all members of the team, and give everyone a clear picture if and to what extent their work can fit into the master plan, more precisely, the project as a whole. *Time Fox, Timesheet* and *Kronos* software can improve the productivity of teams, allowing the team leaders – or more to the point, HR managers – to track hours and the time individual members of the team invested in the job. (Lepsinger, R. *et al*, 2015)

Motivation. The members of a virtual team often feel isolated, losing a sense of importance of the job they are doing. In order for the downside of the concept to be eliminated, and to motivate the employees working in a virtual work environment, it is necessary to foster constructive communication, active listening, clear presentation of goals, to ensure permanent availability of leaders and managers, often outside the business hours, and to use the tools like video conferences, *Google Hangouts, Google Talk, Microsoft Lync (Skypefor Business)* and *Cisco Jabber,* allowing for permanent contacts with the team members, but in a less formal way.

Process. It would be wrong to assume that new employees might already know how to use the programs or understand the processes used in the company. Instead, they need to be trained how to use virtual collaboration programs like *Go To Meeting* or *Google Drive*. Virtual leaders should have all the processes documented, and all the protocols and procedures available to the employees, so that they can take part in all organizational processes. Corporate meeting software can lend a helping hand, including *WebEx,* once again *Go To Meeting,* then *Adobe Connect* and *Polycom conferencing.*

Most of HR managers might agree that a lion's share of their job has already switched to the virtual business context. John Cassida, a HR manager with the 40,000-strong *Sprint Nexel,* relying on the assistance of 46 HR professionals, says that the virtual components of their work are already a part of standard routine. Sharing his opinion is E.J. Blanchfield, a *Point B* HR manager running a team of 24 HR professionals, who do not necessarily work from an office to perform recruiting, professional development, compensations and benefits for 445 employees. (Krell, E., 2012) The two managers have underlined that managing performance, dealing with personal employee issues and materializing strategies are HR activities that can only benefit from personal contacts and in-person interaction. Even these activities can be conducted virtually, however, provided there's good leadership, a proper exchange of information and use of technology, the two managers have maintained.

A proof that the above arguments are in full correspondence with modern practices is a series of virtual HRM jobs that appeared on job search sites (*Indeed. com*) or social networks like LinkedIn: Virtual Human Resources Consultant, Senior Director of Talent, Virtual; Hospice Recruiter – Virtual; Virtual Corporate Contact Recruiter, Virtual Human Resource Consultant, Telecommute Human Resources Business Partner, Telecommute Human Resources Global Director.

5. HR OUTSOURCING

In addition to the above line of reasoning, practice has shown that small and medium-sized enterprises, as well as virtual companies with employees across the country, find virtual HR departments very attractive. If employees communicate via emails, *Skype* or other Internet technologies, the HR department needs to communicate the same way. As a matter of fact, the virtual companies offer the best example of feasibility and validity of outsourcing different business functions, including marketing, accounting, and more and more often, HR operations.(Hollister, J, 2015)

Speaking of outsourcing the HRM function, which many organizations have accepted, we need to list both the advantages and disadvantages of the process. (Armstrong, S., Mitchel, B., 2007) On the upside, HR professionals are more strategically oriented if routine opera-

tions are outsourced. Efficiency is another argument in favor or outsourcing – if the organization the HR operations have been outsourced to is specialized in performing those operations precisely, it will certainly get more done, and in less time than the HR professionals in the department. The shortcomings of this type of work organization lie in the threatened privacy of an employer (some organizations might not approve of certain aspects of their work being known to outsiders); reaction by employees (some of them might feel less connected to the organization); and relations with employees (outsourcing service providers might not be able to handle delicate issues properly).

In terms of the advantages and disadvantages of HR outsourcing, for an organization to make the right decision as to whether this type of work organization is justified or not, it needs to ask a few questions: Can the time, resources and money spent on the assignments we want to outsource justify the decision? What kind of an impact will the outsourcing have on the employees? Who will be in charge of coordination with the outsourcing service provider, and what kind of effects on employee productivity can be expected? What criterion will be used to select the outsourcing service provider? Only after answering these and a number of other questions can the organization discuss and consider properly the outsourcing decision. (Đorđević Boljanović, J., Pavić, Ž., 2011)

According to the *Forbes* magazine, the companies preferring virtual business operations, a virtual HR function or the idea of outsourcing human resources, have the following advantages to discuss: (Biro, M., 2013)

The organization can concentrate on its core competences. Even though the result of any HR department is neither a product, nor a service, it takes a lot of time and energy to organize one. A large HR department requires considerable resources, permanent oversight and innovation, which is why many organizations decide to outsource this function.

HR outsourcing saves the money needed to run this managerial function. It also makes it possible for organizations to hire top-class experts they could never afford on a permanent basis. This type of virtual workforce will continue to maintain a strong presence and a very important role.

Improved compliance. HRM legislation is expanding, and a failure to respect the regulations entails increasingly serious sentences. If the regulations and compliance are delegated to a compliance specialist, a chance that your organization might break the rules is reduced to the absolute minimum.

Improved recruitment. Recruiting top talent today is an art; as such, it needs to be addressed by a specialized organization that placed it on the top of its priority list, instead of being just one of many HR assignments.

Access to the latest tools and technology. The most innovative service providers use the latest technology, including Data Mining, analytics, virtual workforce leadership, cloud technology and social media, in order to address the organization's specific needs most effectively.

According to the same source (Biro, M., 2013), the organization should be aware of the risk of handing over to an outsider one of the fundamentals of its competitive advantage. As a result, the people selected for a job might be at odds with the company culture, while some consultants cannot always look after the employees as carefully as their own HR department would have. Likewise, the hired talent might prove to be a poor fit in terms of the corporate business strategy. In a word, outsourcing has great potential, but a decision to integrate it in the organizational structure must be very careful, and well-thought-out.

6. VIRTUAL HR PROCESS IN PRACTICE

Even though the need for flexibility is a rule rather than an exception, the question is to what degree the leaders, managers and even HR mangers are prepared to constant availability and flexibility the paper has addressed. The *Fast Company Magazine* issued in February (Holmes, R., 2016) presented the results of a research carried out by CEO.com, showing that 61 % of *Fortune 500* CEOs haven't joined social media, considering them a distraction. Given that two billion people are on social media as we speak, and the average user spends two hours a day on social platforms, that millennials watch more YouTube than TV, and three out of four consumers say that social media can shape their buying decisions, it's only logical to ask if the CEOs' position is valid and sustainable.

Adaptability is a necessity, and HR managers already have the tools to make their function more flexible and suitable for virtual business applications. What they can already do online is to perform a long string of duties falling within their competence – HR planning, recruiting, selection and training.

Below is a list of software applications used most frequently in HR practice for recruiting, selection and socialization, which many believe to be the critical stages

of the HR process. They allow for flexibility of experts and specialists in a virtual business environment. (*Compare recruiting management software, 2016*):

Job Diva is a Web-based tool that has been used since 2003 for applicant tracking and synchronization with the organization's business operations and management system. It operates on mobile devices, including iPads. One of the key features is "*Resume Search for Skills By Years of Experience,*" which saves the recruiter from manually reviewing a large number of resumes.

Bullhorn Staffing and Recruiting Software is one of the most popular applicant tracking and recruitment systems. It makes it possible for HR agencies and HR specialists in organizations to manage applicants' contacts, track candidates and fill the vacancies more effectively. The software can be adjusted to the needs of a company, and serve as a basis for business decisions by middle and top managers.

Greenhouse Software platform goes beyond applicant tracking, and allows a company to run the entire hiring process. The recruitment software is a link between an organization's recruitment needs and the best talent hiring practices in the given industry. The *Greenhouse* strategy begins with tracking the right candidates from multiple sources, based on job requirements, data from external agencies and recommendations. The platform is built to optimize the company's recruiting process, but it also encourages the employees to help attract new candidates for the job, by sharing applications and job vacancy adds on social media. The platform defines a consistent interview process, allowing for objectivity in comparing the candidate's advantages and weaknesses. A structured interview process the platform advocates consists of a candidate's resume, contacts, instructions for the interview and a scale to gauge the feedback from the interview.

Workable is very useful recruitment software, replacing emails and tables with a candidate tracking system, monitoring their results. It creates simple job descriptions and employees' career pages. The advantage of *Workable* is that it keeps in one place profile searches, interviews, notes, communications, schedules, comments and analytics, organizing the entire HR process online and in the next five steps: *Get a careers site, Get applicants, Track applicants, Interview candidates, Learn & Improve.* (Workable, 2016)

HR Onboard software is built to make the socialization process more effective. It helps companies run the recruitment and hiring process successfully, by facilitating the initial experience of a new hire and administrative HR operations. (HR Onboard, 2016)

7. CONCLUSION

A virtual work environment allows for different types of flexibility, from flexible hours to flexible employee engagements. Be it the functional or financial flexibility that arises from the need to adapt to changing business conditions, it is up to human resource management, a managerial function that manages the most valuable assets of an organization – the employees, their talents, knowledge and skills - to meet the requirements.

The practice has shown, and the authors proved in this paper, that there's no universal way to do it. Instead, it is up to the organization to choose, and offer arguments to support the choice of a method to reach a desired level of flexibility. A leadership style, required skills and the effect to be made, the technology and methods to be used are also shaping the decision.

The conclusion is that a virtual business, too, needs to foster positive relations with employees, set clear, inspiring goals and adjust them to the business strategy. Supported by a proper IT choice and software applications available to HR managers, virtuality can be placed within a framework of humane, motivating work environment, which is the ultimate goal of the HRM philosophy.

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E-BUSINESS

EMPLOYEE ENGAGEMENT IN AN IT COMPANY

Maja Džepina[1],
Lazar Dražeta[1],
Borivoje Đokić[2]

[1]Singidunum University,
Belgrade, Serbia

[2]Keiser University,
Fort Lauderdale, Florida, USA

Abstract:

Job satisfaction is an attitudinal variable that reflects feelings of employees about their job. It is directly linked to the level of employee engagement and work performance, thus representing one of the key elements of organizational culture. In this paper we used a job facets approach that focuses on different aspects of job(s) to enable a more complete picture of job satisfaction. Engagement survey was devised around nine different categories (facets) that represent critical job aspects. Each facet was defined by 2-10 questions that are scaled using 5 optional grades to answer. The survey was carried out in an organization within the short period of time and has achieved a very high response rate. The results have shown significant differences both between various job facets as well as certain factors (expressed by survey questions) within the same category. Furthermore, the activities that may help improve the specific aspects of employee engagement are discussed.

Key words:

employee engagement, job satisfaction, organizational culture, survey, IT.

1. INTRODUCTION.

Organisational culture affects all aspects of organisational life, including the way in which people interact with each other, perform their work and dress. It is closely linked to numerous facets of an organisation, including job satisfaction. The need to examine the concept of job satisfaction from the scientific point of view has emerged as a result of growing interest and desire to improve business policies and the overall decision-making process within an organisation, as numerous research has shown that the level of employee engagement positively correlates with employee satisfaction. Namely, greater employee engagement leads to better employee performances and business results, which is one of the principal goals of any organisation (Spector, 2008).

Research pointing to significance of employee engagement has led to it being measured in a great number of organisations. Any organisation that aims to be successful needs to establish this type of communication with its employees, primarily as it would bring multiple benefits to it. This type of research is of vital importance in the companies such as the one used in our study, *i.e.*, the companies whose employees are highly valued experts, and where business decisions may have a considerable bearing on employee retention and turnover.

Correspondence:

Maja Džepina

e-mail:

maja.dzepina@gmail.com

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In such context, it can be defined as service-profit chain, which is actually an indicator of relationship between profitability, customer loyalty and satisfaction, employee loyalty and productivity. The relationships in the chain indicate the following: Profit and growth are mainly stimulated by customer/ employee loyalty; Loyalty is a direct result of their satisfaction; Satisfaction is largely influenced by the value of services provided to customers/ users; Value is created by satisfied, loyal and highly productive employees; Employee satisfaction results primarily from high-quality support services and policies that enable employees to deliver results to customers (Harvard Business Review, 2014.).

The aforementioned shows that the concepts of organizational culture and job satisfaction depend on the quality of relationships and business decisions, which an issue that is further explored within the human resources and organizational behavior sector. Accordingly, the authors shall provide the theoretical background on these two research fields.

2. HUMAN RESOURCES AND ORGANISATIONAL BEHAVIOR

Fierce competition in the market, which is becoming global in some sectors such as IT, has made it difficult to define practices that can lead to enhanced competitive advantage. In modern times characterised by perpetual changes and innovations, a good idea and a man as its initiator, are the safest way towards achieving competitive advantage and knocking the socks off the rival companies. Accordingly, human resource management has been constantly developing with the aim to achieve desirable results and development at both individual and organisational level. The principal goals of management at an individual level inlcide performance and quality, employee satisfaction and their long-term loyalty to an organisation. Depending on the organisational level, the goals are concerned with an increase of the average productivity, improvement in working conditions and market survival (Petković, Janićijević i Bogićević, 2010).

Research aimed at identifying the links between human resource management practices and perfromance, *i.e.* finding practices that would lead to perfromance gain. Richard and Thomson (1999) claim that there is a positive correlation between innovative and sophisticated practices of human resource management and greater business performance. Also, numerous researchers highlight that policies and practices should be perceived in groups, *i.e.* a particular set of interrelated practices

that will have a greater impact on business outcomes, than when implementing a single practice or several of them (Torrington, Hayll, Taylor 2004).

Seven key policies for managing human capital have been proposed: employment security, selective hiring of new emplyees; self-managed teams and decentralisation of decision-making as the basic principles of organisational design; higher compensation contigent on organisational performance; extensive training; reduced status distinctions and barriers; extensive sharing of financial and performance information throughout the organisation and growth and development of an organisation with additional profit (Torrington, Hayll, Taylor 2004).

Our research is primarily based on examining personal attitudes and evaluation of employees as individuals. Therefore, it is necessary to provide the theoretical background of organizational behavior. The same as human resource management, organizational behavior examines individual behavior and group behavior within an organisation. They only differ in terms of the topics they cover. Namely, organisational behavior covers topics such as personality, emotions and affection, motivation, social concept and identity, decision making, justice and trust, leadership, groups and teams, organizational culture and climate. On the other hand, human resources primarily deal with the analysis of employee engagement, selection, training and development, performance assessment, quality of business life, strategic human resource management.

Organisational behavior is a field of study that examines the impact of individuals, groups and structures on behavior within an organization, with the aim to achive growth of an organization and greater efficiency. That implies that organizational behavior can be analysed at three levels: individual, group and organisational (Robbins and Judge, 2013).

The relationship between organizational behavior and human resources is based on the fact that human resource management can be used as a means to shape organizational behavior. The effective use of human resources enables creating employee perceptions and behavior, in compliance with the interests and goals of an organization.

As a matter of fact, the factors of organizational behavior at an individual level need to be included in any human resource practice, and they form attitudes on the issues considered relevant for successful functioning of an organization as a whole (an example of such relationship is the impact of formal and informal communication in modern entreprises).

In order to specify the fields that can be affected, it is necessary to list the factors that influence behavior in an organization, such as: personal characteristics of employees and individual differences, attitudes, types of personality, contributions, orientations and roles in an organization; Job satisfaction and motivation to perform job assignments; the level of employee engagement; loyalty to an organization; functionality of an organization; organizational culture (Armstrong, 2006).

In accordance with our research, we shall provide a theoretical review of some of those factors, namely organizational culture and job satisfaction. Special segment shall be devoted to employee engagement, as the principal subject of this research.

3. ORGANISATIONAL CULTURE AND JOB SATISFACTION

Organisational culture is still a relatively new concept, and is the construct of organisational psychology, which aims to explain the notion of organisational behaviour. As is the case with any social, and in particular psychological phenomenon, there is no final and comprehensive definition.

Some definitions of organisational culture are as follows: ''Organisational culture is a social glue that joins the members of an organisation through acceptance of mutual values, symbols and social ideals'' (Smirichic, 1983). When it comes to organisations, culture is viewed as the general pattern of behaviour, shared beliefs and values that members have in common.

Conclusions on organisational culture can be drawn based on what people say, do and think within an organisation. It involves learning and transfer of knowledge, beliefs and patterns of behaviour within a specifc time frame. That means that organisational culture is quite stable and does not change so often. It usually determines the so-called tone of the company and patterns of human behaviour (Weihrich, Koontz, 1994.)

Organisational culture influences all facets of an organisation, including job satisfaction. Schmeider (1983) describes organisational culture as ''the system of values and assumptions that determine the way in which business activities are performed in an organisation''. However, when Schmeider (1975) talks about job satisfaction, he defines it as ''personal evaluation of the present work conditions''... He further explains that job satisfaction is connected with individual perception and

evaluation of one's own job. This clearly indicates strong correlation between organizational culture and job satisfaction, *i.e.*, the way in which organizational culture is implemented affects employee reactions.

One of the most widely explored issues within the domain of organisational culture and organisational behaviour is job satisfaction. Generally speaking, it can be said that it is a multidimensional phenomenon affected by internal and external factors. This phenomenon is extremely complex and is not formed separately, but it depends on numerous variables, including organisational structure, working conditions and leadership, as an integral part of the concept of organisational climate and culture.

The most frequently used definition of job satisfaction is proposed by Locke (1976). He defines it as a satisfactory or positive emotional state, resulting from the appraisal of one's job or job experiences. Hulin i Judge (2003) also state that job satisfaction includes multidimensional psychological reactions to one's job, and that such reactions have cognitive, affective and behavioural components, which is in agreement with the statement that job satisfaction is measured through examining employees' attitudes (Judge, Klinger, 2008)

Locke (1976) explains that the understanding of the job related attitudes, *i.e.* understanding of job dimensions that are rather complex and interrelated in nature, is of vital importance for researchers. He lists the following job dimensions as the most common ones: type of job, salary, opportunities for progress, employee recognition, benefits, supervisors, colleagues, company and its management. Kerego i Mthupha (1997) perceive working conditions and job dimensions through observing the current recruitment policy, communication channels, employee participation in the decision-making process, security and good management.

The combination of factors that should definitely be taken into consideration regarding the impact on satisfaction, would include the following: anatomy and independence, benefits, career development opportunities, career advancement opportunities, compensation/salary, communication between employees and management, job contribution to organisational goals, feeling safe in an organisation, flexibility in achieving balance between business and private life, job security, specific job training, management recognition of employee contributions, purpose of job, networking, opportunities to use one's own skills and potentials, organisation's attitude towards employee professional development, entire

corporate culture, relationship with colleagues, relationship with the supervisor, the job itself, job complexity (Robbins and Judge, 2013).

The need to achieve high levels of employee satisfaction is based on the statement that motivated employees are satisfied employees. As part of organisational behavior, motivation is of vital importance for achieving the primary goals of an organization. Having that in mind, it is evident that it definitely pays off to invest in development of motivation programs and strategies. Motivated employees are willing to make additional effort and record better performance, which further contributes to enhancing the overall productivity and growth of an organisation.

4. EMPLOYEE ENGAGEMENT

Employee engagement can greatly contribute to the overall growth and smooth functioning of an organization. Managers should devote particular attention to finding, attracting and hiring individuals who possess not only necessary technical knowledge, but also other relevant social traits, such as devotion, loyalty, socially-responsible behavior *etc*., which all have a positive bearing on achieving wider interests.

All these segments are of vital importance when considering employee engagement, *i.e.* organizational behavior in one of its parts. However, despite the fact that individuals should possess these traits, that does not necessarily mean that they will positively affect an organization. It is crucial to determine the ways to stimulate and maintain these values for the sake of achieving successful business performance.

Kevin Kruse (2014) talks about employee engagement as an emotional attachment, and believes that when motivated, employees are more productive, give better service and even stay in their jobs longer. All that leads to more satisfied clients, who spend more money, and thus increase sales and profit.

In accordance with the research that provides an insight into specific positive outcomes of growing engagement, this field has attracted considerable interest in recent years. Four general reasons have been highlighted: 1) People have become the primary source of competitive advantage. The Brookings Institute has shown that in 1982, 66% of an organization market value came from tangible assets (machine, goods, plant). In 2002, 80% of value came from intangible assets (brand, intellectual property, and the most important, the quality of

workforce). 2) Despite large financial costs, considerable attention is devoted to employee engagement. Retaining key quality human resources and attracting talents is considered an imperative policy. 3) It has become evident that employee engagement is connected to motivation, and thus it is necessary to identify things that individuals do well and work on them, as well as to recognise and reward their achievements and effort. 4) The positive correlation between employee engagement and organisation's performance suggests that there is a substantial upside to organizations that focus on enhancing employee engagement, *i.e.* greater engagement leads to more favourable business performances (Wellins, Bernthal, Phelps, 2003).

Research has identified two key elements that are needed to truly boost employee engagement. The first one is the rational aspect, which is related to understanding of the business role, its position in an organization and the ways to harmonize the goals of certain job position with the overall organizational goals. The other aspect is emotional, and is concerned with how people feel about the organization, and whether their job provides them with the feeling of personal contribution, and how they are related to management (Armstrong, 2006).

We can analyse these two aspects through numerous factors affecting behavior, in particular through examining employee attitudes towards the issues related to their business roles and general feelings about the job. Organisations can use different methods to increase employee engagement. The three most relevant factors when choosing the appropriate method are employees, leaders, and organizational system and strategies (Wellins, Bernthal, Phelps, 2003).

Pursuant to the above-stated, it was necessary to develop an instrument that would be adequate enough to measure engagement, paying attention to what it represents and what components may affect it. To that end, an employee engagement survey was developed as a method that can enable communication with employees, based on which it could be possible to measure the level of engagement. It is a method that has been observed and confirmed as purposeful by numerous studies.

Engagement survey, *i.e.* measurement of the main engagement drivers within an organization based on which it is possible to determine the level of engagement, was the main reason for choosing this method. It is based on the assumption that satisfied employees are those who are motivated, and that they will invest more efforts into doing successfully their job assignments.

As regards drivers, there are no official standards, but the most common ones are: opportunities for progress, recognition, salary and benefits, role in an organization, training and development, job opportunities, leadership and its impact, work environment *etc.*

This method also aims to encourage communication with employees, as it provides us with necessary feedback. Practice that company uses to measure the components such as employee satisfaction and leadership and management efficiency and impact of work environment, provides the company with necessary information on what should be changed. Also, using a questionnaire to get necessary information enables communication with similar organisations or research endeavours in the field.

5. RESEARCH RESULTS AND DISCUSSION

The subject of our research is the company for software design and development, which has shown to be very successful both at regional and European level. Research was conducted based on an anonymous survey. Besides questions related to determining the structure of cause (gender, age, work experience in the company, sector *etc.*), the survey contains 42 statements grouped into categories. The survey for the herein observed company was designed in a way that would give a clear picture of the following categories: overall feelings about the workplace or overall satisfaction; relationship and feelings for the first line supervisor or team leader; feelings for the team in which one works; feelings for one's personal performance and evaluation; attitude towards leaders, planning and communication; training and development; salary and benefits.

Out of 160 employees in the company, 157 have completed an anonymous survey, which provides a very high response rate for engagement survey. All survey statements are grouped into 9 categories that represent critical job facets. The average value of responses was calculated for each category (*i.e.* the sum of arithmetic means).

I. The research results for the observed categories are as follows: I. My first-line supervisor (4.47): My first-line supervisor treats me well and respects me (4.82); My-first line supervisor recognizes and awards my positive performance (4.60); I consider my first-line supervisor a competent professional (4.83). My first-line supervisor values my opinion, talent and contribution (4.62);

My first-line supervisor sets realistic and clear expectations regarding my performance (4.42); My first-line supervisor regularly provides me with useful and constructive information (3.94). My first-line supervisor actively participates in my professional development (3.87).

II. Employees' overall feelings about the workplace (4.47): I would recommend a friend to look for the job in the company (4.63); I consider my work environment satisfying and motivating (4.55); I am proud to be part of the company (4.53); I plan to develop my own career within the company in the following two years or more (4.31); Most of the time I feel happy to be part of the company (4.32).

III. My role in the company (4.31): I am completely aware of my role in the company (4.50), I have the authority to decide on the things related to my job (4.33); My job enables me to adequately explore my skills and abilities (4.13); I am motivated to do more than formal work activities (4,25); The level of stress I am exposed to is acceptable considering my role and volume of responsibilities (4.21); I dispose of adequate resources necessary to do my job well (4.41).

IV. My team (4.40): The cooperation and communication between colleagues in my team is extremely good (4.67); My team leader actively participates in giving instructions and monitoring my work and strengthening of my motivation for the current job (4.14).

V. Leadership, planning and communication (4.19): I understand the vision and business strategy of the organisation (4.48); I feel that I can express my opinion honestly and give suggestions concerning necessary changes without being afraid of possible consequences (4.32); Leaders in the company act for the wellbeing of all employees (4.57); I am familiar with the things that happen in the organisation (4.06); Organisation gives me enough recognition for the things I do well (4.04); I am conversant with the feedback provided by clients and their satisfaction (4.20); Goals are adequately set within my team (4.02); I need to be consulted in advance about the changes that can affect me (3.79); There is good cooperation and communication between the teams in the organisation (4.02).

VI. Performance and evaluation (4.26): I understand the process of performance evaluation and its rel-

evance (4.56); the analysis of my performance is done on a regular basis (4.05); I believe that my performance is objectively assessed (4.18).

VII. Training and development (3.98): I am encouraged to explore the opportunities for growth and improvement in the organisation (4.37); I am familiar with the skils and experience cruicial for my career development (4.31); Organisation provides me with sufficient training (3.26).

VIII. Orientation and 'entry' into the organisation (3.86): My role in the organistion was adequately presented to me during recruitment process (3.95); I was provided with enough training upon entering the organisation, which has enabled me to do my job efficiently (3.77).

IX. Compensation and benefits (3.57): Generally speaking, I am satisfied with the benefits package (3.84); I am well-paid for the job I do (3.74); My salary is competitive in relation to the market (3.14).

The possible responses are provided in the following form: I fully disagree; I disagree; I neither agree nor disagree; I agree; I fully agree.

The statistical analysis included comparison of mean values (Mx) of each category in relation to: the time when the survey was conducted (2014 and 2015 respectively) and the length of employment of the surveyed participants. The value of each category (Mx) was compared with the sum of mean values of all the categories (4.14). Two-sample T-test was carried out, using a PHStat2 program, to devise the p-value for the set of means regarding the time of survey and the length of employment (Table 1) and cross-category comparison (Table 2).

Any variable having significance at some arbitrary levels can be selected for data analysis. More traditional levels of significance, such as 0.05, can fail to identify variables known to be important for this type of business researh. According to the Laerd Statistics (2015), we may need to increase the value of significance making the study less robust in terms of error, and easier to recognize statistically significant differences. To that end, we decided to use significance level of 0.2 since this introductory study should show all the variables important for building the analysis model. Hence, * assigned to certain mean values in the Tables 1 and 2 represents the computed p-value $\leq$ 0.2.

	Time of the survey		Length of employment	
	2014	2015	> 2 years	< 1 year
I. Overall feelings	4.15	4.47*	4.44	4.58*
II. My first-line supervisor	4.20	4.47*	4.27	4.59*
III. My team	4.16	4.31*	4.25	4.39*
IV. My role in the company	/	4.41	4.38	4.52
V. Performance and evaluation	3.87	4.19*	4.03	4.35
VI. Leadership planning, communication	/	4.26	4.33	4.29
VII. Training and development	3.64	3.98	3.94	4.05
VIII. Orientation and entry into the company	/	3.86	3.54	3.96*
IX. Compensation and benefits	3.28	3.57	3.22	3.78*

Table 1. Comparison of Means (Mx) by categories

	I	II	III	IV	V	VI	VII	VIII	IX
Mx	4.47*	4.47*	4.31*	4.41	4.19	4.26	3.98	3.86*	3.57*

Table 2. Comparison of means (Mx) between categories

Based on the above-given results, statistically significant improvement of employee engagement could be observed in 2015 for the categories I, II, III and V compared to the previously surveyed period (Table 1). This is an indicator of improvement of organizational culture within the company for these categories, *i.e.*, a measure of positive impact influenced by organizational culture activities that were carried out within the company during the above-mentioned time period.

Furtehrmore, there is a statistically significant difference of engagement in regard to the length of employment in an organization. Employees with the shortest length of employment (up to one year) showed higher engagement mean values in relation to the employees with longer length of employment (more than 2 years) (Table 1).

This phenomenon, which is common in practice, was supported by research showing that most employees are strongly motivated at the beginning of their employment, but motivation tends to decline over time. This research was conducted in 100 companies and included over 1.2 million employees, and its findings could be considered relevant in 85% of companies ((Sirota, Mischkind, Meltzer, 2006).

The overall results in Table 1 lead us to the conclusion that the categories I, II and III are enablers of organizational culture, while VII and IX represent barriers and obvious areas for improvement. We recommend that the corrective plan of actions for improving organizational culture should be based on mutual comparison of categories and their dimensions (*i.e.* proposed questions) that determine them as a true measure of employee engagement for various job facets of engagement survey. This approach permits a more complete picture of employee engagement and clearly distinguishes between different levels of satisfaction with various job facets (Spector, 2008).

Individual questions in each category cannot be compared by means of a statistical analysis due to variability of the sample size, as certain categories are determined by two to three, while others with nine to ten questions.

Statistical analysis has shown that categories VIII and IX are the areas that require most change, and the authors shall briefly present the corrective actions stemming from the present research.

Within the category VIII (Orientation and entry into company), both statements demonstrate low rates: I was provided with enough training upon entering the organisation, which enabled me to successfully do my job (3.77) and I was made conversant with my role in the organisation during the recruitment process (3.95). We suggest the following corrective actions: 1) Run a training needs analysis (TNA) to determine training/development requirements per employee, team and organization; 2) Set up an employee orientation program for all newcomers and junior employees; 3) Improve the current mentorship system, by asigning personal responsibilties to future mentors and mentorship standards they have to meet; 4) Install regular two-way feedback with the newcomers to get an insight into their attitudes, relationship with the mentor and current progress.

Compensation and benefits was the lowest rated category (IX) for the following statements (questions): My salary is competitive in relation to the market (3.14); I am well paid for what I do (3, 74), and I am satisfied with the benefits package (3.84). We suggest the following corrective actions: 1) Run a compensation and benefits survey within competitive industries in Serbia to determine market wage for each position; 2) Devise a communication plan and carry out series of meetings with employees to discuss the current compensation and benefits model; 3) Organize a series of focus groups with employees to gain bottom-up information of their engagement as a stepping stone for devising the organizational corrective action plan to deal with all the issues such as: work-life balance, overtime working hours, organizational structure, performance management, compensation and benefits model, feedback, *etc*.

Furthermore, within the categories that were generally positively rated, communication appears as a potential denominator, *i.e.*, the source of the problem. Besides the activities proposed, it is necessary to devote special attention to communication as the key factor for the improvement of functions of an organization. Accordingly, special attention should be assigned to leadership communication skills.

6. CONCLUSION

The results of the engagement survey indicate the necessity of fully mobilising organizational resources to improve the organizational culture. Improvements made within categories I, II, III and V over the past 12 months render certain actions plausible and open the possibility to check other categories. This is particularly appropriate for the categories VIII and IX that require special attention in dealing with certain issues. Therefore, structured corrective action plans have been proposed.

However, the lack of systematic approach in dealing with certain issues shall mobilise management of an organization to devise and implement tailor-made solutions. Faceted approach based on mutual comparison of categories and their building blocks (dimensions) enables a detailed overview of job satisfaction. This in turn provides a clear picture of the areas for improvement, as well as the key enablers of organizational culture.

Subesquently, this paper provides a guide that can be implemented within any organization with the aim to address the issue of employee engagement and compare organizational culture and climate. The statements expressing job process and employee attitudes clearly indicate possible steps and measures that could improve the overall business performances of an organisation and lead to more favourable business outcomes.

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E-BUSINESS

IMPLEMENTING A BALANCED SCORECARD METHODOLOGY IN SMES

Siniša Janković[1*],
Nikola Škobo[1],
Mile Stanišić[2]

[1]University of Sinergija,
Bijeljina, The Republic of Srpska, B&H

[2] Singidunum University,
Belgrade, Serbia

Abstract:

Traditional systems for performance measurement are mainly confined to monitoring financial indicators as the only relevant criteria. Various surveys conducted worldwide have shown that relying solely on financial indicators is insufficient and leads to long-term decline in the overall performance of the company. By applying a balanced scorecard list of criteria, the company is permitted to observe its business from multiple perspectives that show a comprehensive picture of enterprise performance. This methodology has proven to be very successful in large enterprises, while in small and medium-sized enterprises its use has not been sufficiently explored. In this paper, we analyze the compatibility, applicability and efficacy of the balanced scorecard methodology for performance measurement in small and medium-sized enterprises.

Key words:

Balanced Scorecard, performance measuring,
small and medium-sized enterprises

1. INTRODUCTION

The methodology of Balanced Scorecard has been developed to allow an efficient integration of many variables that must be considered when measuring the performance of companies. Balanced Scorecard is a set of criteria that allows managers a holistic view of the organization. Traditional performance measurement systems place special emphasis on purely financial indicators and ignore the others. Balanced Scorecard as an innovative methodology introduces a number of other indicators that should allow the all-assessment of the performance of the organization. In addition to the financial perspective, balanced scorecard introduced perspective customers, internal processes, as well as learning and development, which are of equal importance to the organization. The initial methodology devised by Kaplan and Norton is developed for large companies, but application in SMEs is also possible with some adjustments, taking into account the specific characteristics of SMEs.

2. ABOUT BALANCED SCORECARD

Balanced scorecard (BSC) is a management system that can activate the energy, skills and specific knowledge that people in the organization possess and these can be directed towards the fulfillment of long-term

Correspondence:

Siniša Janković

e-mail:
sjankovic@sinergija.edu.ba

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strategic goals. Strategic map provides a framework for describing how the strategy links intangible assets to the process of value creation. BSC is a system of measurement of results and performances of the company and involves setting up financial and strategic company goals and measuring their achievement. Setting financial and strategic objectives includes short-term and long-term goals. BSC helps organizations to resolve three major issues: organizational effectiveness measurements of success, increasing intangible assets and challenges of implementing the strategy. These are the three main factors affecting each organization. The measuring system of organization makes a powerful impact on people's behavior inside and outside the organization. In order for the companies to be able to survive in the information age competition, they must use measurement and control systems derived from their strategies.

To be able to clearly monitor what is happening in each of these prespectives, it is necessary to draw up a strategic map. Strategic map structure makes four perspectives and their causal connections. The structure according to Kaplan and Norton includes:[3]

- learning and growth perspective,
- internal procceses perspective
- customer and
- financial perspective.

Each generic measures must be defined to explain and, depending on the type of activities and strategic goals, form the measurement system and monitor performance. BSC translates the mission and strategy in the tasks and criteria, organized into the four perspectives. By defining the outcomes that the organization wants as well as the drivers that lead to these outcomes, managers direct the energy, skills and specific knowledge of people in the organization towards long-term goals.

Learning and growth perspective describes the intangible assets of the company and its role in the strategy. Intangible assets are: [3]

- human capital - availability of qualified personnel, talent and knowledge necessary to implement the strategy.
- information capital - availability of information systems, network and infrastructure necessary for establishing the strategy.
- organizational capital - what kind of environment and organization is required to maintain the process changes required to implement the strategy.

Making BSC involves three main categories for learning and growth perspective: opportunities, employ-

ees, features of information systems, motivation and initiative. The process of measuring the readiness of human capital begins with identifying the necessary skills by individuals who carry out important internal processes of the organization's strategic map. The organization first identifies a competent profile, which describes the fundamental requirements for the groups of tasks that define the strategic success. Competence profile describes the knowledge, skills and values that a person employed at a particular position is necessary to have.

Internal perspective identifies key processes that are expected to have the greatest impact on strategy. Particularly interesting are the following four groups of processes:[4]

- operational processes,
- management processes to customers,
- innovation processes,
- regulatory and social processes.

Operational processes are the primary activities of Porter's value chain. The link between strategy and operations requires a comprehensive framework that integrates sales and production planning, resource allocation, dynamic forecast (budget) in operating and capital expenditures and financial forecasting profitability. Mass production and delivery of standard products and services must be replaced by a flexible, dynamic and high-quality delivery of innovative products and services that can be individualized for targeted customer segments.

The company develops management processes by identifying the main tasks, which encourage achievement of the objectives in connection with customers, as well as financial goals, then assigns the key performance indicators that encourage excellence in the process. In order to improve the process of design and development, employees are required to have process indicators that motivate them, but also monitor whether the existing projects achieve success.

Management processes deepen customer relationship with the target group through selection, recruiting and retaining of customers. They also increase the volume of work. Customer retention derives from excellent services.

Customers perspective describes how the organization will create sustainable value for the customers. This perspective includes several well-known benchmarks in relation to the customers: customer satisfaction, recruiting, customer retention and market share.

Financial perspective describes the tangible results such as return on investment, value for shareholders,

profitability and revenue growth. Its ultimate goal is to bring profit to the maximum. The financial perspective is the crown of the previous perspectives. Basically, the financial strategies are simple. Businesses can gain more money: higher sales and reducing costs.

3. FITTING BALANCED SCORECARD TO SMES

In their research, professors Kaplan and Norton have expressed the opinion that the BSC methodology is not designed exclusively for large companies. It is shown that small and medium-sized enterprises can also benefit greatly from the use of this model. Following the publication of this research, a number of authors have been inspired to redesign this innovative model in order to adapt it to small and medium enterprises. A large number of researchers confirmed the hypothesis presented by Norton and Kaplan: the hypothesis that it is possible to adapt this model to the specific characteristics of SMEs. The conclusions of this study point out that even in some segments, it is easier to implement this methodology in SMEs than in large enterprises, as their size can be used as a major advantage to confirm this thesis. This research emphasized the importance of the BSC for SMEs in terms of the introduction and improvement of the system for performance measurement, as well as issues related to the strategy of the company.

The biggest problem when it comes to the basic model for implementation of Balanced Scorecard in SMEs is the lack of their strategies. Most SMEs do not give enough importance to the strategy, while a large number of them have not even formulated the strategy. Because BSC is the system for measuring the performances closely linked to the strategy, it is clear that this is the biggest problem related to the implementation of the BSC. The actual model for implementation proposed by Kaplan and Norton is based on the top-down logic. This means that the base point in the implementation of the BSC is actually formulating the mission and vision of the company, which should enable the commencement of the process of performance measurement.

This methodology has been developed for large companies and its application in SMEs is inadequate. One of the most redesigned models for implementation in SMEs is incremental model developed by Hudson and Smith. With this model the whole process of implementing BSC is placed in a circle: [2]

- ◆ Name: the main strategic objective to focus upon is immediately identified;

- ◆ Act: the performance measures connected with that strategic objective are identified, along with the improvement actions needed;
- ◆ Use: the measurement system is implemented and the improvement actions are activated;
- ◆ Learn: the target achievement is monitored and, at the same time, the adequacy of the selected measures is assessed.
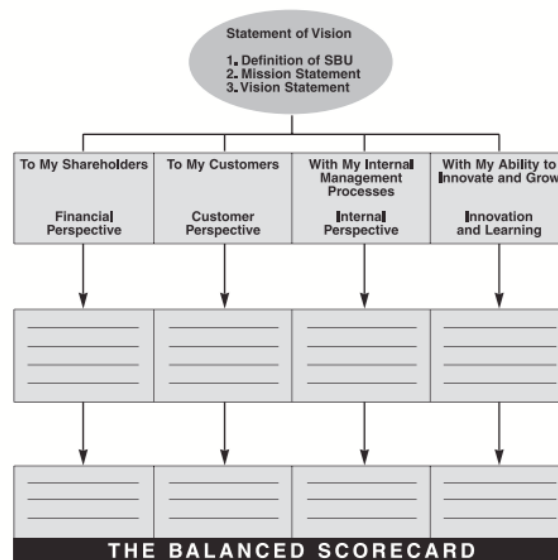
Figure 1. Linking Meauserments to Strategy[3]

In addition to this model, it is important to mention the model developed by authors Biazzo S. and P. Garengo, which is based on a circular approach for the implementation with four basic steps that should be followed when implementing the BSC in SMEs. This is one model that fits in SMEs, taking into account their specific characteristics. [1]
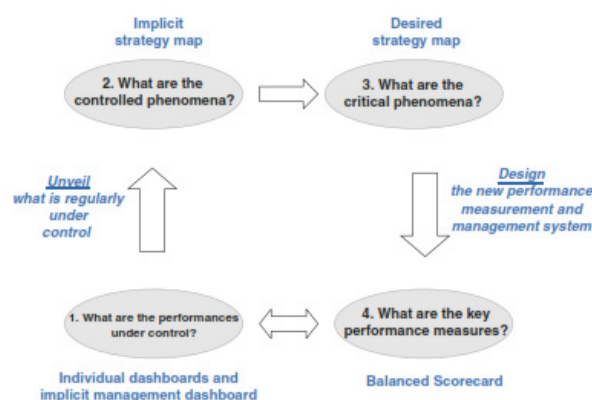
Figure 2. A circular approach to the implementation of the BSC[5]

In the first step, it is necessary to determine the performances that have already been under the control of the company. This step leads to the development of implicit strategic map. It is necessary to develop the desired strategic map which sets new performance measures that are essential for the company. In the process of creating the BSC, it is necessary to allocate individual dashboards. After this step, a circular process that enables control of BSC execution begins.

When it comes to implementation of the BSC in small and medium enterprises in Bosnia and Herzegovina, the situation is specific. Bosnia and Herzegovina is a country in transition where the management systems are at a low level of development. Most small and medium enterprises in Bosnia and Herzegovina continue to rely exclusively on financial indicators as the basis for decison-making.

4. SOFTWARE AS THE BASIS FOR SUCCESSFUL IMPLEMENTATION BSC IN SMES

When it comes to using software for BSC, the main problem with SMEs are mostly high prices of software. SMEs are generally not able to buy software that is available in the market place. Therefore, they usually resort to the use of cheaper varieties.

Here we will introduce three open source software that companies can use for managing BSC.

1. BSPG Balanced Scorecard. This is a complete BSC environment running on PostgreSQL and comparable to many similar commercial software for measurement-based management. It manages a company strategy through objectives, measures and targets, reports and graphics.

2. BambooBSC Balanced Scorecard is an open source BSC for creating, managing BSCs vision, perspectives, strategic of themes, objectives of strategy, key performance indicators, personal and organization performance analysis, strategy map, KPI report, personal and organization BC report.

3. cBSC collaborative balanced scorecard is a collaborative tool to support the strategic development of a company or public BSC. All employees of a business unit can develop together a balanced scorecard using cBSC tools.[7]

Also, a large number of SMEs are now relying on the use of Excel software of Microsoft Office, which al-lows a relatively good track and manage of BSC. A good basis for understanding the potential of this software for BSC use is the book of the author Ron Person "Balanced Scorecards and Operational Dashboards with Microsoft Excel", that shows the possibilities for combining the benefits of balanced scorecards, operational dashboards, performance managements, and data visualization and then implementing them into Microsoft Excel. [6]

5. CONCLUSION

Balanced scorecard is an innovative methodology for performance measurement developed for large companies. However, it can also be implemented in the small and medium-sized enterprises. Due to the fact that integrated management systems in Bosnia and Herzegovina remained poor and inadequate within an ever-changing environment, the need for such system proved to be of crucial importance. With the use of systems such as the BSC, SMEs can set up an effective framework for the establishment of integrated system for performance measurement.

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E-BUSINESS

ACCOUNTING INFORMATION SYSTEMS AS A SUPPORT TO FINANCIAL REPORTING OF COMPANIES

Aleksandra Mitrović

University of Kragujevac,
Faculty of Hotel Management and
Tourism,
Vrnjačka Banja, Serbia

Abstract:

With the help of accounting information systems, we established the basis of the information system for financial reporting, *i.e.* informing of external and internal users. Having in mind the continuous development of information systems, leading to the improvement of accounting information systems' role, this paper aims at identifying and presenting the development of one of the frequently asked questions in research that refers to accounting information systems, *i.e.* financial reporting. A series of issues regarding the financial reporting, starting from the manner of reporting, volume of information provided, purpose of information usage *etc.*, can be observed in the context of accounting information systems, as pointed out herein.

Key words:

accounting information systems, support, company, financial reporting.

1. INTRODUCTION

Information and communication technology (ICT) with its development year by year has transformed the way in which enterprises operate. "The information system is the set of formal procedures by which data are collected, stored, processed into information, and distributed to users" (Hall, 2013, p. 5). When speaking about accounting, it can be pointed out that accounting achieved tremendous progress thanks to the development of ICT. The accounting software today replace traditional ways of performing tasks, and depending on the needs of companies they can contribute to the realization of specific demands by the accountants of a company. Information technologies have led to numerous advantages in the processing and presentation of accounting information, and in this respect, in particular for reporting purposes, shortened the time required for accountants to prepare and disclose the report and improved the level of efficiency in presenting information, which is also certainly positive looking from the aspect of the quality of business decisions of various interest groups.

Two broad types of information systems of a company include: the accounting information system (AIS) and the management information system (MIS). The AIS is composed of three major subsystems: (1) the transaction processing system, which supports daily business operations

Correspondence:

Aleksandra Mitrović

e-mail:
aleksandra.stankovic@kg.ac.rs

with numerous reports, documents, and messages for users throughout the organization; (2) the general ledger/financial reporting system, which produces the traditional financial statements (income statement, balance sheet, statement of cash flows, and other reports required by law); and (3) the management reporting system (MRS), which provides the internal financial information needed to manage a business (Hall, 2013, p. 5.) However, we should bear in mind the fact that management often requires information that goes beyond the capability of AIS.

The flexibility of AIS is an important characteristic that has to be present in the modern company. The characteristic of AIS to adapt to the changes dictated by the modern environment and to continue to provide information needed for functioning of the organization, stands out as an imperative of modern business.

Having in mind the development of ICT that affect the development of AIS, the paper shows the development of the AIS role in supporting the financial reporting of enterprises. Accordingly, through the review of the literature presented in the first part of the paper, the question of the role of information technology is discussed, particularly the influence of information technology development on generation and publication of financial information within the AIS, exploring the relevant academic literature. In the second part, relying on the possibilities of the development of AIS, the trends, issues and challenges are pointed to, offered by the accounting profession in the segment of reporting and the possible responses of information technology in this regard. The same part is devoted to perception of a future trend concerning the development of AIS to support financial reporting of the company.

2. LITERATURE REVIEW

AIS is an important segment of business operations, and in this sense, numerous researchers are engaged in the research of different specific issues related to AIS (Vaassen, 2002; Romney & Steinbart, 2009; Sutton, 2010; Nicolaou, 2011).

Liu & Vasarhelyi (2014) state that there is a number of significant and major issues when investigating AIS, and in this regard they list several characteristics of accounting:

1. Accounting is based on data;
2. Accounting entails a substantive amount of information processing;
3. Accounting is the field of business measurement;

4. Accounting entails substantive data analysis;
5. Accounting is ultimately delivered through reporting;

It is important to emphasize that the AIS can be traditional, which uses a database that is distributed by departments and integrated, where there is no above-mentioned distribution, but you have access to the data in the department in which business is carried out and to all other data necessary for the execution of tasks (Knežević et al., 2015).

According to Stanković, Knežević & Mitrić (2013) in performing the tasks, management is informationally dependent on AIS, and therewith information having a great significance for the management of the company, the existence of a modern comprehensive database is important for the control and reporting of the company. The information of AIS is presented in the form of paper reports or displayed on a computer screen. Financial statements represent ''the crown'' of accounting. They are the bearers of accounting information and the basic tool for financial communication of a company with interested users outside the company. Fundamentally, the financial statements are a key source of information on the financial position of the entity at the end of the period, on the total result of the entity for the period and the cash flows of the entity, and are used to make economic decisions by a wide range of users (Knežević et al., 2012). Also, according to the same authors, AISs are a basis of information system of the company for financial reporting to internal and external users. The foregoing additionally gains in importance if one bears in mind that the AIS, in addition to input and processes, also deals with the output, *i.e.* with the publication of financial statements, by which accounting communicates with internal and external users, providing them thus information necessary for business - financial decision making.

Accounting reports *i.e.* information, in the content are prepared as a basis for decision-making, namely, their users are holders of management and decision-making authorities (Stanković et al., 2012). It is important to emphasize that the content of the accounting information is in the functional dependence on the objects it relates to, on the temporal aspect and on the holders of the management bodies (Đurić et al., 2011).

As regards the delimitation of internal and external reporting of a company, it must be mentioned that the AIS should adequately respond to information management requirements in the company. AIS deals with producing financial statements that are important for management and decision-making of management, and

acting of management to eliminate the disadvantages of producing repeated requests, represents the initial impulse to improve the information content of AIS.

Speaking about the advantages of computerized information systems used for accounting, Ghasemi, Shafeiepour, Aslani & Barvayeh (2011) cite several advantages thereof, namely: the increased functionality (through increasing the timeliness of accounting information), improved accuracy (through increase of internal control mechanisms), faster processing (through faster processing of large amounts of information) and improvement of external reporting (through improved ways of reporting). And through the guidance of the aforementioned authors, and based on numerous benefits of AIS, we can certainly speak in more detail about the benefits produced by the modern AIS in relation to the traditional way of organization of data processing in accounting, and therefore on the impact on the financial reporting of the company as well. When it comes to improving external reporting, it can be said that it leads to investors, and other stakeholders, based on the report, being able to consider whether the enterprise is a good investment through the possibility of investment.

3. ACCOUNTING INFORMATION SYSTEMS AS A SUPPORT TO FINANCIAL REPORTING OF COMPANIES – A LOOK INTO THE FUTURE

Speaking about the AIS in terms of support to company financial reporting, several questions are raised. One of them may relate to the manner of delivery of information, then, who are the recipients of information, how will the information be used and for what purpose, and other significant issues. Nowadays, owing to development and support of ICT, reports that are immediately available are generated, both summary and reports by the different segments (*i.e.*, segment reporting), which actually provides the possibility of diversification of information to the level of transaction needed.

Statutory accounting regulations in different countries have, when it is about the financial statements drawn up by the companies, defined the layout and content of forms. In this sense, we may speak of the need to update a set of accounting reports when there is a need to change the regulation in one country.

In more advanced environment, companies may be required to open their own databases, so that interested users could get the information they need from the set of customized reports, with the help of variable time frame

and with different structures of accounts. It is important that by the establishment of such a system, the protection is ensured of confidential information and the system that protects from their disclosure (*e.g.*, on the suppliers, customers, wages, *etc.*) (Liu & Vasarhelyi, 2014, p. 13). In the case of providing larger satisfaction to the needs for accounting information of enterprises by the investors, the managers should be prepared to deal with the disclosure of different types of information, and therefore, it is necessary that they determine which information should remain confidential, on the one hand, and providing accounting information to users should take into account the requirements of the users, on the other hand, which is often very complex to be realized in a practical setting (Gal, 2008, p. 95).

Financial reporting in the future should focus on automatic reporting, and data access will be implemented through the provision of electronic data access (Mitrović & Vučić, 2015).

Wishing to show future developments and trends that will affect the future of accounting services in the second half of the 21st century, Geoffrey Moore (AICPA 2012) cites three crucial trends, which will be of great importance:

1. digitization (from paper to digital),
2. virtualization (from physical to digital presence) and
3. transformation (from generalization to specialization).

Speaking about the trends shown above, Liu & Vasarhelyi (2014) launch issues relating to the same trends that will affect the future of accounting, of which part of the questions relate to the reporting as one of the specific field of accounting and therefore open-ended questions that will be developed in the future on the basis of the development of AIS. The questions in the context of digitization trend relate to receipts and usage of reporting and new data analysis approaches in accounting/auditing, as part of the trend of virtualization, referring to the information processing issues and change of accounting measurement, while in the context of transformation, the questions relate to information processing issues (Table 1).

Belfo & Trigo (2013) among others, as part of the accounting challenges nowadays and responses of information technology to them, state also several accounting challenges relating to reporting. Thus, in the context of the challenges relating to external reporting and response to them in the form of information technologies, they state Web Services & Internet of Services, then Mobile

Trends[a]	Digitalization	Virtualization	Transformation
Questions	Receipts and usage of reporting New data analysis approaches in accounting/auditing	Information processing issues The change of accounting measurement	Information processing issues

Table 1. Summary of Trends and Questions

[a] Source: Adapted by: Liu & Vasarhelyi (2014)

Devices and Cloud Computing. If we consider further the challenge related to real-time reporting, as the answer to this type of challenges in the form of information technologies, the following are mentioned: Mobile Devices, Cloud Computing, Business Intelligence and Business Process Management. The challenge relating to tailor-made and interactive reporting with the response of information technologies is solved through: Business Intelligence, Computer Assisted Auditing Tools and Techniques and Big Data.

4. CONCLUSION

Having in mind that AIS are the sysetms used to record the financial transactions of a business or organization, through the unifying role they affect the fulfillment of organizational goals of modern enterprises. We present more details about the benefits produced by the modern AIS in relation to the traditional way of organization of data processing in accounting, and therefore on the impact on the financial reporting of the company as well.

In order to show the frequently investigated issue during the development of AIS, relating to financial reporting of companies, in a number of specific points, the aim of this paper was to display in more detail the AIS as the support to financial reporting of companies. The development of AIS directly affects the development of financial reporting.

The overall conclusion is that the transition from traditional ways of processing data in the accounting to the modern ones, leads to various advantages, among which the most crucial are reducing the time and improving the efficiency and accuracy of information. The foregoing in terms of continuous development of AIS leads to the reports being available immediately at the request of the appropriate user groups with the specified requirements, concerning the detailed information. Further development implies that it is possible to get the information needed from a set of customized reports, with the help of variable time-frame and different structures of accounts.

Also, the future of financial reporting with the help of AIS as the support is providing electronic access data. Further, the trends of digitalization, virtualization and transformation through the open questions and possibilities of development are of great importance, as well as many other challenges of reporting to which the development of information technology may provide the answer.

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THE PERSPECTIVE OF E-BANKING
IN SMALL BUSINESS BANKING SECTOR

Duško Ranisavljević[1],
Zoran Jović[2]

[1]Marfin Bank,
Dalmatinska 22, Belgrade, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Small Business Banking (SBB) segment is one of the most important segments of the banking sector in Serbia because it includes different sectors such as entrepreneurs, micro and small enterprises sectors. SBB segment is the sector with the highest growth in the post-transition period. This sector is attractive for banks because of its profitability and risk diversification. E-banking is becoming increasingly important in business correspondence between banks and SBB customers. E-banking platforms, in addition to the functions of payment transactions, become an advanced communication channel when applying for micro loans in the SBB segment. This paper discusses the potential for development of advanced e-banking channels of communication in the SBB segment, with reference to the advantages and disadvantages as well as the risks of implementing this system. It compares the commercial banks in the domestic banking market according to the criteria and effects of e-banking in the SBB segment. The conclusion is that the application of this concept reduces operating costs of banks, increases profitability, but it also increases the risk of loans. Commercial banks should gradually and cautiously approach the implementation of e-banking in the credit process in the SBB segment, because it may cause an increase in the percentage of non-performing loans.

Key words:

e-banking, credit process, payment transactions, operational risk.

1. INTRODUCTION

In the post-transitional period, in almost all strategies of economic recovery in the countries of South East Europe, the sector of small and medium businesses and entrepreneurs assumes the most important place. The reason for this lies in the fact that this sector is recognized as a sector which is adaptable to new market requirements, new technologies, and which can also have the greatest impact on reducing unemployment. For commercial banks in Serbia, SBB sector is being increasingly recognized as the sector which deserves the most attention.

In the period of economic growth (2005-2008), there was a noticeable orientation of the domestic banking market towards corporate clients (medium and large businesses), while small businesses and entrepreneurs were not the priority clients for most banks. Corporate clients had special

Correspondence:

Duško Ranisavljević

e-mail:

dusko.ranisavljevic.12@singimail.rs

conditions in most of the banks, such as lower payment system costs, lower interest rates for credit loans, as well as lower costs for other banking operations. It is safe to say that in the mentioned period, SBB customers did not have equal treatment with other client groups. The global economic crisis has left its mark in the domestic banking sector as well. As expected, primarily corporate client decreased their economic activity, which led to SBB customers becoming the most important group of clients both for banks and other institutions.

Over the last few years, there has been a decreasing trend in interest rates for SBB sector as the result of other measures by both state authorities and commercial banks. Commercial banks are increasingly recognizing the importance of SBB segment, and besides adjusting the credit policy, SBB segment is being offered more and more favorable payment system tariffs as well as more functional and more efficient communication channels. Until a few years ago, it was almost unthinkable that commercial banks would provide information solutions for SBB customers, such as automated cash payments, electronic orders at any given time, online applications for loans *etc*. All this leads to a reduction in operating costs of banks, and the time will show whether and to what extent it will increase business risks.

A study of Basel Committee for Banking Supervision came to a conclusion that: E-banking increases banks' dependence on information technology, thereby increasing the technical complexity of many operational and security issues and furthering a trend towards more partnerships, alliances and outsourcing arrangements with third parties, many of whom are unregulated. This development has led to the creation of new business models involving banks and non-bank entities, such as Internet service providers, telecommunication companies and other technology firms [1].

This paper will analyze the advanced information solutions in the communication of commercial banks and SBB customers, their representation in the national banking sector, and the risks that these systems cause.

2. CORRESPONDENCE BETWEEN COMMERCIAL BANKS AND SBB SECTOR IN THE REPUBLIC OF SERBIA

Traditional banking involves either daily or frequent contact between customers and bank employees. Moving the payment system to commercial banks (2002/2003), clients were directed to specific commercial banks, and

since then banks have been in daily contact with their customers. With the arrival of a great number of foreign banks in the last ten years, domestic banking sector has been significantly modernized. Commercial banks have introduced various platforms for e-banking payment system. In the beginning these were simple applications, with limited possibilities. They were only able to carry out certain transactions under certain conditions. The first innovative e-banking solutions in the domestic banking market for the correspondence with business customers were given by Pro Credit, Raiffeisen Bank and Bank Intesa, then Uni credit, Societe Generale, Hypo Bank and EFG Eurobank and then the others, mostly the banks with majority foreign ownership.

Today, almost all commercial banks in the domestic banking market have their own developed e-banking platforms for dinar and foreign currency payments. E-banking as well as standard payment system in bank premises is now in compliance with the payment clearing system of the National Bank of Serbia, which means that it is done in the manner and in the dynamics of the standard money orders.

As the number of users of e-banking in SBB segment increased over time, commercial banks have begun to recognize other advantages of this system. E-banking itself, as a banking service, has become more accessible, particularly when it comes to its price, but also in simplicity of usage. Expensive routers have been replaced with universal readers, which has enabled clients of several banks to use parallel e-banking, without increasing the fixed costs.

Furthermore, the platforms themselves have been customized for SBB clients of average "computer literacy", so the number of users has increased considerably. Finally, the price of e-banking and payment system tariffs of commercial banks have become more competitive in relation to the tariffs of "standard" payments system.

After checking the official payment system tariffs of commercial banks in Serbia (which are available on the websites of all banks), it can be seen that the average payment system tariffs are 30-40% lower compared to the rates of standard payment system. In addition to lower fees, banks also allow SBB customers to send orders 24 hours a day, finalize the order just before the last clearing (after the official working hours of banks), have a statement copy at any time, work with multiple accounts simultaneously using one digital certificate, save time *etc*.

In this way, banks encourage customers to use electronic payments in large numbers, because of the indirect savings in operating costs. This means that the banks need

fewer and fewer employees in the payment system. Some of these employees can be relocated to the front office, to the position of loan advisors because the increase in sales of products and bank services is the main business mission of commercial banks today. However, according to official indicators of operating expenses of banks rose in the first three quarters of 2015 compared to 2014 by 8.5% [2].

In addition to e-banking, commercial banks also offer other solutions for SBB users, such as mobile banking, non-stop through the use of ATMs for payment and cash withdrawal *etc.*

3. THE ANALYSIS OF E-BANKING AS A CHANNEL OF CORRESPONDENCE BETWEEN BANKS AND SBB SEGMENT

Credit process in SBB segment in majority of banks is uniform and determined by both NBS regulations and policies of the banking group to which a bank belongs.

The basic rule of a high-quality credit analysis implies that a bank gets to know their client well. Unlike credit analysis of individuals where the most parameters are measurable even without "the presence of the client," with analyzing SBB credit requests the presence of the client in a commercial bank or vice versa, a commercial bank with the client is necessary.

In order to analyze the possibilities of implementing the loan process via e-banking platform in SBB segment, we should first analyze the functionality of the standard SBB loan process.

Basic phases of a loan process with SBB customers are:

- The application (request) for a loan by the client;
- Collection and presentation of the documentation (balance sheet reports, assessment of collateral, *etc.*);
- Analysis and making the decision on the request;
- Writing a contract and the establishment of collateral;
- Loan disbursement, monitoring and repayment;

The traditional (conservative) banking assumes direct communication between a client and a bank in the first and second stage of the loan process. In that way a commercial bank acquires a realistic insight into the client's business.

Most often the client is visited in their business base, and balance sheets and other business indicators are compared on-site. This provides a realistic picture of the

benefits and possible drawbacks in the client's business activities.

As there are 30 banks in the domestic banking market, and the demand for loans in all segments including SBB segment is lower than in previous years, some banks are trying to "simplify" the credit process in SBB segment, and one way to do it might be the use of e-banking platform.

In this paper, we analyze the e-banking platforms as well as e-marketing in 5 major commercial banks that, according to the criteria of the net asset balance sheet, have a total market share in the amount of 54.27% (1632.4 from 3007.5 billion rsd-on day 26.11.2015. according to the NBS) [3].

The following review provides an overview of the net asset balance sheet of banks mentioned:

Neto bilansna aktiva u mlrd rsd (nov.2015)
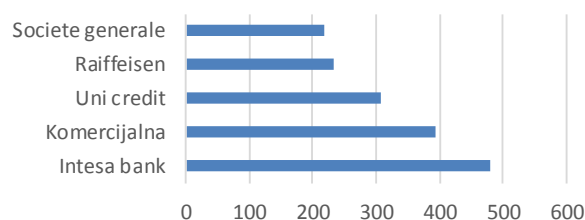
The analysis in this paper was done in two directions. First, we analyzed the e-banking platforms and the system of functioning of the credit process with SBB clients without going to the bank, *i.e.* electronic loan applications. The quality and intelligibility of the presentation of bank's offers, which should be comprehensible to a customer of the average information and financial literacy, are also analyzed. Channels for communication for SBB clients are compared through the official bank presentations in three aspects:

- A - how developed e-banking platform is for payment system;
- B - efficiency of e-marketing;
- C - how developed credit channel of communication is for SBB loan applications;

The results of both analyses should reveal which commercial banks have the most advanced system of electronic communication with SBB clients, and whether they are actually the banks with the best business indicators.

Each of these criteria in the first analysis carries the rank of 1-3, with the rank "1" being the most efficient implementation of e-banking and e-marketing for SBB customers, according to the author, then the rank 2 which is slightly less efficient, and the lowest ranking is 3. The average of all three gives the final coefficient that determines the ranking of a particular bank. According to the above-given criteria, the analysis of the listed commercial banks provided the following results (Table 1):

Bank	A	B	C	koef.
Intesa banka	1	2	2	1.67
Komercijalna	1	2	3	2
Uni credit	2	3	3	2.66
Raiffeisen	1	1	2	1.3
Societe generale	1	2	3	2

Table 1.

As can be seen in the above-given table, the analysis showed that Raiffeisen bank is a commercial bank that has made the greatest progress in accordance with the given criteria [4], followed immediately by Intesa Bank [5], Komercijalna [6] and Societe Generale [7].

The coefficient or the ponder of the results according to the three given criteria determines the final ranking of the efficiency of e-banking and e-marketing concepts. All the banks have an efficient operational system of electronic payments. Many banks have introduced the possibility of connecting to state institutions (such as the tax authorities), thus expanding the possibilities for the users. The greatest progress is estimated to be in the foreign exchange electronic payments, where many innovations and benefits have been introduced, primarily in the flow and presentation of necessary documents (invoices, customs documents, *etc.*) between commercial banks and customers. It is interesting that none of these banks has an official channel for submitting applications for micro-loans or SBB loans, similar to the one for retail loans. There is a model of requests and explanations for particular SBB loan products, as well as the forms, but they still have to be physically delivered to the banks' offices, at least when it comes to SBB clients.

Popularization of such communication channel, when it comes to the SBB loan applications, would imply higher costs, and it is certain that the existing software solutions and application of classic e-banking represent significant costs for the banks.

With regard to the overall savings in the economy and society, commercial banks have not had any significant technological advances in recent years, except for the system 24/7, where the modern ATMs allow customers non-stop transactions without the standard front office. In the analysis it was not considered as an advantage for customers because it is not specifically intended for SBB customers.

The second line of analysis included the analysis of the balance sheets of presented commercial banks according to the following criteria:

A - increase / decrease in balance sheet assets;

B - increase / decrease in interest incomes;

C - increase / decrease in business profits (none was a money loser company);

This line of analysis gives indicators of the percentage increase or decrease of the key balance sheet items of the listed banks, in recent period. We compared the indicators for the third quarter of 2015/2014 (source NBS), because these are the most recent data provided by the NBS. The results are given in the table below (Table 2):

Bank	A	B	C
Intesa bank	↑0,46%	↓2,85%	↑73,2%
Komercijalna	↑3,3%	↓11,1%	↓63,2%
Uni credit	↑15,85%	↑10,4%	↑54,4%
Raiffeisen	↑0,87%	↓11,4%	↓10,9%
Societe generale	↑5,04%	↓0,97%	↑20%

Table 2.

From the table above it can be seen that all the banks in the period 2014/2015 had balance sheet assets growth, to a lesser or greater percentage. When it comes to income from interest, some banks had a growth and some a decline. Some banks even had a drop in income from both interest and profit, with balance sheet assets growth. Three banks increased their net profit.

It should be noted that the present trends are the consequence of the fact that we compared the data from the third quarter, which is not the last quarter (quarter of final balance sheet). In practice, this implies frequent change of indicators, so it is possible that the bases of indicators for the previous year change for the next quarter, which led to obtaining such data. For example, the manifold increase in profit of one of the banks is the result of accounting in the previous year, which for the quarter taken in the analysis gave very little net income. The quarter in the following year which it was compared to gave regular and real net income, but the growth trend is unrealistically high.

If we compare the results from both tables, we can reach the following conclusions. The bank with the best rated e-banking and e-marketing systems for SBB customers is Raiffeisen Bank, but their business trends in the last year and a half have not been great, but certainly not bad as well. A more detailed analysis of the balances for previous years shows that the bank achieved a significant growth, and the presented results most likely show a cyclical decline.

On the other hand, the bank with the largest increase in net balance sheet assets, and the largest increase in income in the reporting period, Uni Credit Bank, according to the results of this analysis is behind the other four banks when rated by the criteria of electronic commerce and adaptability to SBB customers [8].

Intesa Bank has the best balance indicators, a significant increase in profits. It can be said that quite good e-banking system for all user groups, with advanced application solutions. Due to the good territorial dispersion of the organizational units, large networks, significant media campaigns, this bank is no need for excessive investment in some new channels of communication, although it is expected in a way, and although we can reasonably assume that there are resources for it.

Komercijalna banka and Societe Generale are similarly ranked, according to the criteria of implementation of electronic banking, but they are quite different in terms of business results. The first one has had a significant decline in profitability, while the other one has had a significant growth.

4. CONCLUSION

Previous analysis points to the basic conclusion that business results of the banks are not crucial for new innovative solutions in the fields of e-banking, e-marketing or new application models of communication not only with SBB clients, but with other client groups as well.

Despite recognizing the importance of SBB segment in banks' business activities, conservative banking, *i.e.* traditional approach to resolving loan applications and processing of credit applications, has still remained dominant.

Our research has shown that the banks can save time and operating costs only at the stage of loan application, while in the micro business, due to the complexity of the process and the necessity of observing business clients from several aspects, simpler scoring models, or unified credit procedures, like retail loans, on-line loans or so-called "without going to the bank" loans are not possible.

Intelligibility of communication channels, then security, convenience, accuracy and speed are the most important for the perception of usefulness of an e-banking user [9].

In the short term, the sudden and uncontrolled popularization of applications which, via the Internet and other solutions, shorten the process of consideration of a client's business activities, can cause savings in operating costs, which would improve the performance indicators. There are fears that in the medium and long term, such loans could become problematic.

There is not enough affordable data in order to perform a more detailed analysis of the possible connection between the percentage of problematic loans and the level of e-banking in the SBB segment, but the risks that may occur are certainly not negligible.

The final conclusion is that commercial banks initiate the credit process electronically (sending offers, pre-approval decision on the loan application), so it can be expected that such a model of communication between SBB customers and banks will become common in a relatively short period of time, in the same way in which electronic banking system has become a widespread system wit lots of features and affordable to all client groups.

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GREAT POTENTIAL OF E-BANKING IN SERBIA

Miroljub Hadžić[1],
Vladimir Mladenović[2],
Milica Krulj Mladenović[2]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]Business School for Applied Studies,
Blace, Serbia

Abstract:

E-banking and its use have improved the whole banking industry, banking management and induced quick transformation of the society. E-banking use gives several important advantages to banks and their clients, which prevail in comparison to its drawbacks and resistance to its use. In the past, e-banking use gave to a bank the characteristic of innovative one, while today it is a precondition for its survival.

In Serbia, e-banking use got momentum during the last decade, mainly due to foreign banks, newcomers to the market. Today, each single bank offers e-banking services. However, in spite of quick development, domestic supply is still bellow the offer in the advanced transitory economies. At the same time, there are still signals of resistance to its use among entrepreneurs and citizens.

The aim of the paper is to envisage the contemporary stage of development of e-banking in Serbia and to prepare comparative analysis of development of the main distribution channels between Serbia and countries within the region. The results of the analysis and assessment of its development would be used in an attempt to suggest measures on both levels: the level of national economy and level of each single bank, by which e-banking use can be improved.

Key words:

advantages, drawback, resistance, development.

1. INTRODUCTION

There are plenty of articles in news, conferences organized and comments on e-banking in Serbia. Although we are the witnesses of its fast development during the last decade, there are still lots of prejudices among citizens and entrepreneurs in relation to its use, lack of information, fears, especially about its security and doubtful advantages.

E-Banking has rapidly grown over the last decade, with legal and institutional infrastructure being established. It started in 2003, practically with the transfer of payment operations into the national banking system. Today, more than one half of payment operations are made electronically. Law on electronic sign was passed and the national IT strategy was adopted. Along with that, the development of e-government has also started.

Nevertheless, one cannot be satisfied with the level of its use in comparison to developed and advanced transitory economies and with the low share of citizens and entrepreneurs use of e-banking and e-trade. One can note that supply side is also poor as there are only few e-traders. Also, it seems that there are regulations that ask for improvement, like those

Correspondence:

Miroljub Hadžić

e-mail:

mhadzic@singidunuum.ac.rs

which mandatory obliged clients for personal contact with bank's officials and plenty of paper forms to fulfill. Clients of banks are not well and fully informed about the advantages and security of e-banking and e-trade, which points that banks and the Government have to be involved more.

2. ADVANATAGES AND DISSADAVATAGES OF E-BANKING

IT and its use have revolutionary changed bank supply, banking management and everyday life of consumers and entrepreneurs. Among others, it increased the quality of banking services offered, bank's efficiency, cut operational costs and cut prices of services (Kovačević, Đurović, 2014). „It is clear that e-banking is here to stay and will be main channel to acquire and service customer"(Agarwal, Rastogi, & Mehrota, 2009). Almost all companies use computers, but most advanced users are banks, insurance companies, logistic and transportation companies (Ignjatijević, Matijević, & Carić, 2011). E-Banking improved quality of services, which is in line with CRM approach (client relation management), today very important for banks, as consumers became very dynamic and less loyal than before (Marinković and Senić, 2012). As a results of fast development of Information Communication Technologies (ICT) and their implementation, economy and society were transformed into informatics economy and society. Almost all industries were transformed in qualitative and quantitative term, with new products and services, which gives platform for information society (Đorđević, 2012).

If we are talking about e-banking services, we have to differentiate several distribution channels, by which banks are offering their services: home banking, Internet banking, Mobile banking, POS (Point of Sales) terminals, payment cards, ATM (Automated Teller Machine), E-money. The main characteristics of e-banking are: individuality, mobility, independence of place and time, flexibility and interactive relation with customer (Seity, 2003). Advantages are as follows: decreasing operational costs per transaction (branch 1,07$, post 0,73$, telephone 0,54$, ATM 0,27$ and Internet 0,01$), covering services 24 hours per day and 365 days per year, covering whole world, dispersion and creation of new products and services. For a customer, e-banking is less time consuming, provides easier access, higher quality of services, it is more flexible for personal demand and more secure in comparison with transaction with cash (Ljubić, 2015). All internet consumers are potential clients of banks.

For a bank it means less employees and less costly operations, higher quality of services, less organizational units, while covering larger territory, more clients, instant data processing, lower fees, higher accessibility, innovative image of a bank, higher competitive strength and higher profitability (Hadžić and Mladenović, 2014; Kovačević and Đurović, 2014).

At the same time, there is a fear of using e-banking products and services among citizens and entrepreneurs, especially in less developed countries, including transitory economies. It is the wide spread feeling in spite of printable evidence of transaction, every day improvement of security of services, using smart cards, PIN codes, prepared forms, personal identification prior to using those services (Sanchez-Franco, 2009). Although there are strong arguments in line with e-banking advantages to customers whatever they are, citizens or entrepreneurs, recent investigations suggest rather that this kind of services are still new, with just few serious researches about the relationship between trusts of clients and their loyalty, which suggests that differentiated approach to different segments of users is more useful for banks (Sanches-Franco, 2009).

Banks are facing several kinds of risk when practicing e-banking operations: operational (related to mistake of human resources), reputation (possibility that good image of bank can be put under question mark), systemic risk, legal risk, crime, international risk (Kovačević and Đurović, 2014). Nonetheless, we have to be aware that although banks are improving security of operations of e-banking, there are hundreds of hackers every day who are trying to find ways to avoid security mechanism within banks. Also, the Internet is the global network without national or global supervision, which is a very important fact for users facing their security. Some of services, like e-wallet and e–money, ask for high investments into infrastructure, so they cannot be cheap for small national market, but for huge only. In countries and economies with high importance of so-called shadow economy (informal economy), there will be resistance to the use of e-banking, because of tax evasion in sight.

Among those who argue in favor of e-banking future, there is often idea that the classical bank with shelters and branches will disappear, while e-bank will survive. However, strong counter argument could be that credit lines, especially heavy in volume, like for corporative clients, ask for trust and personal relationship with the client. Those credit lines cannot be finalized virtually, but rather in an old-fashioned way - personally. It is a very important issue for small corporate clients, small and medium scale companies and entrepreneurs (SMEs) (Marinković and Senić, 2012).

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3. DEVELOPMENT OF E-BANKING IN SERBIA

Fast growth of e-banking in Serbia started in 2003 with the transfer of payment operations into the national banking system. This trend was in line with inflow of foreign banks, newcomers to the market. From this point on a huge step forward was made. Generally speaking, Serbian position is good regarding ICT development and its use. It is important as a prerequisite (platform) for e-banking use.

In Serbia, 64% of all households possessed PCs in 2015 (63% and 60% in 2014 and 2013, respectively)(RSO, 2015). At the same time, 39% of households possessed a laptop (39% and 32%, respectively). Mobile phones could be found in 90% of households (90 and 87%, respectively). Use of ICT is also respectable, as Internet connections had 64% of households in 2015 (63% and 56% in 2014 and 2013). DLS connection is still the main type for connection to Internet (51%, 55% and 51%, respectively), cable connection (38, 35 and 33%), and by mobile phone (19, 24 and 17%)(RSO, 2015).

Serbian companies are even in a better position regarding ICT access and use. PCs are used by all companies in Serbia (100% in 2015, 2014 and 2013). In 27% of all companies, ¼ of employees used PCs at least once per week, while in 36% of companies, ¾ of all employees used PCs once a week. Internet connection had 99% of all companies in 2015 (100% in 2014 and 2013), of which 98% of

companies had broadband internet connection (98% in 2014 and 2013, respectively), 75% of all companies had their own website (74% in 2014 and 2013, respectively). The less favorable situation is regarding e-trade. Only 40% of all companies in Serbia bought/sold products and services via the Internet in 2014, the same as during the previous two years (RSO, 2015).

As can be seen in Table 1, the number of e-cards issued by banks in Serbia is respectable (in comparison to whole population, 7,1 million). However, if we analyze their use, only ½ of debit cards were used. At the same time, ½ of credit cards were used, but with the decreasing trend. The use of business cards is somewhat higher.

Table 2 can provide a better insight into e-card use. As can be seen, value of transaction with debit cards is dominant in total value, more important was increasing, and reached almost 4 billion € in 2015. At the same time, the value of average transaction with debit card is still low (59 €), which can be explained with low average wage (400 € per month).

The infrastructure for e-card use and electronic payment and e-trade is not well developed. Table 3 shows that the number of ATM is low and stagnant, and the number of POS terminals is modestly increasing. It is rather encouraging that the number of transactions and their value is increasing.

Serbia is still looking for better infrastructure as a prerequisite for higher use of e-banking services. Compared

	Issued			Active			%		
	Debit	Credit	Business	Debit	Credit	Business	Debit	Credit	Business
2015	5,350	958	147	2,655	517	91	50	54	62
2014	5,176	964	127	2,478	515	81	48	53	64
2013	5,133	955	120	2,317	530	76	45	55	63
2012	4,876	952	107	2,125	544	68	44	57	63
2011	5,270	970	111	2,367	630	76	45	65	68
2010	5,109	936	103	2,200	674	71	43	72	69

Table 1. Serbia - E-cards (source: NBS)

	Transaction value, mil RSD			Average value RSD		
	Debit	Credit	Business	Debit	Credit	Business
2015	490,413	12,399	32,641	7,296	4,611	16,720
2014	451,259	12,932	24,910	7,101	4,513	15,286
2013	413,632	14,019	20,963	6,823	4,444	14,661
2012	366,033	14,613	15,312	6,594	4,453	13,357
2011	319,073	12,997	11,189	9,259	4,307	6,249
2010	266,047	14,067	7,927	5,846	4,114	10,988

Table 2. Serbia - E-card transaction (source: NBS)

	ATM	Transaction number*	Transaction value**	POS	Transaction number*	Transaction value **
2015	2,705	19,845	158,089	65,428	34,876	71,304
2014	2,632	18,596	141,756	64,142	30,500	62,597
2013	2,673	17,820	131,266	59,822	27,036	59,765
2012	2,785	16,584	115,763	62,656	23,607	54,147
2011	2,830	15,035	101,003	58,012	19,908	44,408
2010	2,857	13,757	85,933	57,459	17,405	39,619

* - thousand, ** - million RSD

Table 3. Serbia - ATM and POS terminal (source: NBS)

to the countries in the region, such as Croatia and Monte-negro, which is given in Figure 1 and 2, number of ATM and POS in Serbia is lower, especially measuring per 100 thousand of citizens. So, it is clear that banks in Serbia have to invest more in ATM and POS network in order to get more revenues from e-banking services.

Conisdering e-transfers in total transfers by number and by value, as can be seen in Figure 3, there are no crucial differences between countries within the region. By the share of e-transations in total transactions,measuring the

number of transactions, Serbia falls well behind Croatia and Montenegro (36%, 58% and 48% respectively). By value Montengro had less, 40 % of e-transaction in total, while Serbia and Croatia had ½.

Figure 4 provides a rough picture of potential of the national market of ICT, including the Serbian one. It is clear that Serbian ICT market is simmilar by revenue with Croatian, which speaks about its high potential, rather than high level of development.
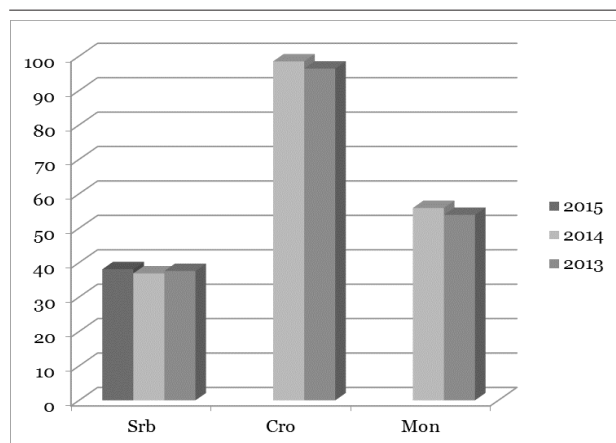

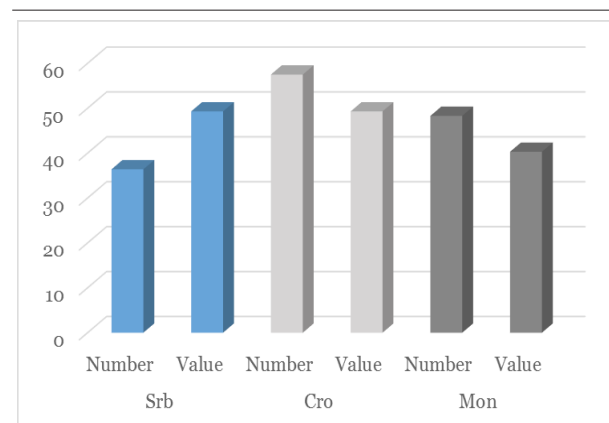Figure 1. ATM number per 100 thousand of citizens (source: CBs)

Figure 3. E-Transfer in Total transfers % - 2013 (Surce: CBs)
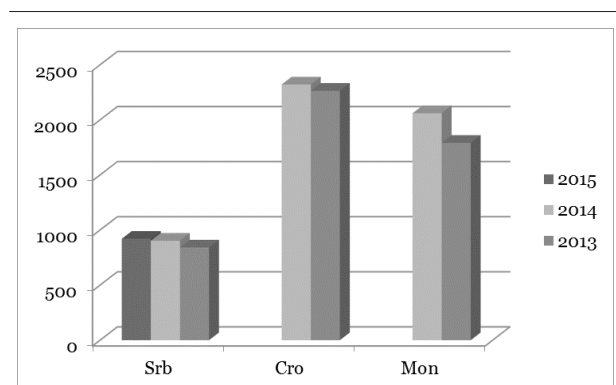
Figure 2. POS number per 100 thousands of citizens (source: CBs)
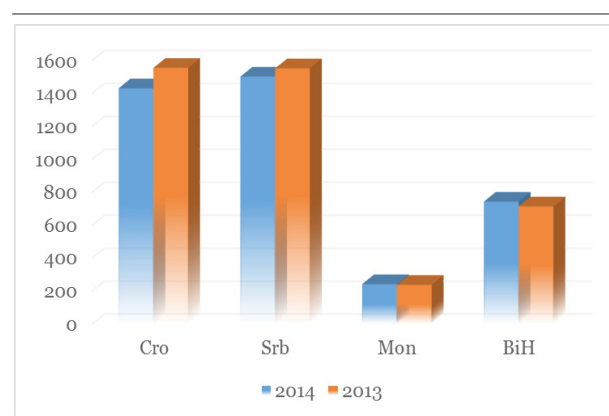
Figure 4. Total Revenue of ICT market – million € (source: national RATEL)

4. E-BANKING – HOW TO USE ITS POTENTIAL BETTER

Based on the assessment of e-banking and e-trade in Serbia, one can conclude that there is high potential for e-banking development. In other words: a) necessary infrastructure is developed well and use of ICT is on respectable level; b) e-banking use is on modest level of development, facing the widespread fears, especially related to its misuse and legal obstacles; c) e-trade is on the low level of development.

In order to speed up ICT use in banking and trade industries, it is necessary to introduce three lines of activities: firstly, there are several prerequisites to overcome prejudices and make ICT use much easier; secondly, banks have to introduce measures and activities in order to motivate clients and to get more from e-banking; thirdly, there are also possibilities for the Government to make the environment more favorable for e-banking and e-trade use.

Legal framework in Serbia has been improved, but there are still some obstacles. Serbia is among the countries which enacted Law on electronic sign late, so it takes some time for it to be fuly adopted and ready for use. Also, legal framework asks for further improvement, regarding complex relationship between banks – traders – users. Late use and problems of Pay Pall is an example of such situation (Radojević and Čelarović, 2009). We are still waiting for the Law on e-money. IT education is necessary among the young generation within school system, seeing it as a part of wholesale reading and writing abilities, but also among the older generation. In school IT use abilities development have to be hand in hand with entrepreneurial spirit strengthening. It would be useful to think even on free wireless access, as a possibility which can give a lot in long run.

The main line of activities has to be initiated on the level of each bank. Those are the companies which would be better off with wider use of e-banking. They have to be aware that e-banking development is not a matter of innovative image any more, but rather condition for survival on the market. So, they have to develop and realize e-banking strategy appropriate to specific needs of each bank, in which client oriented needs have to be fulfilled. Transaction security issues have to be treated with special attention in it. Experience in the emerging market pointed that customer perception and attitude toward and satisfaction with e-banking are the most important. The security of IT use and trust are essentially relevant

if want to cover more clients, while banks have to prepare adequate market segmentation (Agarwal, Rastogi, & Mehrota, 2009). Interactions with customers is necessary, as those who are already user and potential users are high income persons with higher knowledge and very sensitive on the feed-back from banks, their professionalism and innovative image (Sanchez-Franco, 2009). Client relation management (CRM) is important especially for loyalty development of corporate client, as competition among banks increases, as well as the volume of information and their quality available for (potential) clients.

Government together with Central bank has to pay special attention and make conditions for ICT use favorable and user friendly. It is not relevant for e-banking and e-trade only, but rather for development of information society. There are lots of countries which already started with realization of e-society, among other introduction of e-government, in which digital communication with citizens and entrepreneurs make life and business much easier and more efficient. E-Government is a priority on the EU 2020 Agenda. E-Education is a part of a program by which education would be adjusted to future knowledge-based economy (Đorđević, 2012). ICT National Strategy was adopted and several important laws related to its realizations have been recently enacted, but it takes some time for their implementation.

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A COMPARATIVE ANALYSIS OF THE DETERMINANTS OF LIQUIDITY RISK EXPOSURE IN THE BANKING SECTOR OF THE REPUBLIC OF SERBIA AND BANKING SECTORS OF FORMER SOCIALIST COUNTRIES

Željko Račić[1],
Nemanja Stanišić[2],
Nenad Stanić[2]

[1]Higher School of Professional Business Studies,
Vladimira Perica Valtera 4, Novi Sad, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The purpose of this paper is to point out statistically significant empirical determinants of exposure to liquidity risk for banks operating in the Republic of Serbia, and to perform a comparative analysis of the impact of these determinants on Serbian banks and banks from countries that have gone through a transitional period from being socialist countries to becoming EU members. The results indicate that increased exposure to liquidity risk in the local banking sector is associated with the following factors: high financial leverage, GDP growth, decline in the unemployment rate, decline in the deficit of balance of payments and an appreciation of local currency. The general impression is that the local banking sector is faced with an excessively high level of liquidity. Based on the comparative analysis carried out, and assuming that the Republic of Serbia undergoes the transition process that follows a model similar to that of the analysed EU members, several conclusions can be drawn regarding the nature of the effect of determinants of exposure to liquidity risk on banks during the transition period. It is to be expected that larger banks will keep their liquidity at relatively lower levels, that the development of financial markets will lead to a change in liquidity management strategy and reorientation of local banks to purchased liquidity management, and that the levels of capital adequacy will converge to that prescribed by the Basel regulatory framework.

Key words:

banking sector, liquidity risk, the Republic of Serbia, panel data, regression analysis.

1. INTRODUCTION

It is characteristic of small European countries, and especially those that go through a transition process, that they rely heavily on the banking sector. The liquidity of the banking sector is therefore a very important issue, especially in times of economic crisis. In the years preceding the most recent global economic crisis, the liquidity of banks was at satisfactory levels. Funding sources were available at relatively low cost, which is why liquidity management was not given priority over the management of other types of risk. However, immediately upon the outbreak of the crisis, many banks worldwide were faced with the issue of jeopardised liquidity. This dramatic change in market conditions at the global level has forced banks worldwide to consider efficient liquidity risk management as a priority. The Bank for International Settlements defines liquidity as the ability of banks to fund increases in assets and settle their short-term

Correspondence:

Nemanja Stanišić

e-mail:
nstanisic@singidunum.ac.rs

financial liabilities as they come due, without experiencing unexpected losses. The main challenge for banking institutions in terms of liquidity management is interdependence between loan approvals and withdrawal of funds by depositors. Liquidity issues may arise in the case of deposit withdrawal when loans are not being repaid and when it is even more difficult to quickly encash less liquid assets. In addition, the off-balance-sheet items of banks can have a profound impact on their liquidity. This mainly refers to credit lines that could be used to a greater or lesser extent and guarantees that can be activated. Empirical data indicate that in normal circumstances the daily deposit outflow is mostly compensated for by the daily inflow of new deposits and daily bank revenues. However, the more frequent occurrence of financial crises, together with specific seasonal fluctuations, such as the period around New Year and the holiday season, often results in greater daily outflows compared with the daily inflows of financial assets (net deposit drains), which can have adverse effects on liquidity.

Liquidity risk is managed by means of asset management, *i.e.* affecting the size of liquid assets by converting less liquid assets into cash, by attracting new deposits and borrowing on the capital market, and by combining the above-stated strategies. The first strategy is based on using liquidity reserves that can enable banks to compensate for the lack of liquidity (stored liquidity management). Liquidity reserves are divided into primary and secondary reserves. Primary liquidity reserves, which are examined in this paper, include cash in hand and funds held at the central bank in the form of required reserves and excess reserves. Secondary liquidity reserves are highly liquid securities such as government securities and securities issued by a central bank. Yet, another liquidity risk management strategy is based on attracting new deposits as well as obtaining liquid assets through the money market and capital market (purchased liquidity management). This strategy is being increasingly employed by banks worldwide. The main reason for this is the fact that the development of money and capital markets facilitates access to nondeposit funding sources, which reduces the opportunity costs of holding larger amounts of liquid reserves and makes managing maturity mismatches on banks' balance sheets easier (Račić *et al.*, 2014). In transition countries such as the Republic of Serbia, the share of total loans in banks' total assets is greater than that in banks operating in more developed financial markets. Therefore, the quality of credit risk management is an important issue in the analysis of bank exposure to liquidity risk.

In order to analyse the exposure to liquidity risk of the banking sector in the Republic of Serbia, research was conducted to analyse the influence of variations in certain internal bank characteristics and macroeconomic factors (Račić, 2014). The scientific goal of the research is to point out statistically significant determinants of the liquidity of banks in the Republic of Serbia, and to perform a comparative analysis of the nature of the influence of those determinants on the exposure to liquidity risk in Serbian banks and banks from former socialist countries that have gone through a transition phase and are now members of the EU. The social goal of this research is to contribute to the process of tracking the exposure of Serbian banks to liquidity risk. The general hypothesis of the research starts with the assumption that there are internal and external statistically significant determinants of exposure to liquidity risk, and that differences in the nature of their influence on banks' exposure to liquidity risk depend on the degree of development of the market in which the analysed banks conduct business (Tsanana and Katrakilidis, 2014).

The structure of the paper is as follows. After the introduction, the second section discusses basic conclusions of earlier research concerning the determinants of banks' exposure to liquidity risk. In the third section, we specify the model and define the variables that are used in this research. The fourth section provides a description and analysis of the results from applying the model to a sample of banks that conduct business in the Republic of Serbia. The fifth section is based on a comparative analysis of the results obtained from applying the model to a sample of banks from the Republic of Serbia and banks from Hungary, the Czech Republic and the Slovak Republic. Finally, the last section presents the conclusions reached from the conducted research.

2. LITERATURE REVIEW

This section highlights the most significant factors associated with levels of bank liquidity, briefly delivers the theoretical arguments on their anticipated effects, and summarises some notable empirical contributions to this subject. A considerable amount of research on bank liquidity in countries of Eastern Europe has been undertaken by Pavla Vodová. In a number of successive studies using panel data regression analysis on data sets that cover the period from 2001 to 2010, she examines the levels as well as the determinants of liquidity.

In general, we differentiate between two sets of determinants of potential liquidity: macroeconomic ones such

as monetary policy and economic strength indicators, and individual ones such as a bank's size or its business focus. However, determining the direction and magnitude of their impact on a bank's liquidity is by no means a trivial task. The analysis of the results of research papers dealing with this subject reveals their inconsistency across countries and time periods. Despite apparent similarities between the countries in the region of Eastern Europe, the same factors affected banks' liquid assets in individual countries in rather different ways.

The factors that are assumed to influence a bank's liquidity in a systemic and potent manner are macroeconomic ones, such as the GDP growth rate, the employment rate, the monetary policy interest rate, foreign exchange policy, inflation *etc*. Poor economic growth and climbing unemployment rates negatively influence liquidity levels through an upsurge in the ratio of NPLs, which can further promote the recession by means of triggering a credit crunch. Clearly, there is a specific feedback loop between the two, which creates a belief that the association between them has to be positive. A number of empirical results expectedly indicate that liquidity levels are adversely affected by negative macroeconomic conditions, such as the onset of a financial crisis, an economic downturn, and an increase in unemployment.

On the other hand, liquidity holdings also tend to be lower when alternative investment opportunities become more attractive (Valla *et al.*, 2006). Consequently, the impact of GDP growth on a bank's liquidity is found to be ambiguous in some research papers (Vodová, 2013b). The effects of inflation depend on the country, and are positive or insignificant.

Liquidity shocks are typically systemic shocks that affect many financial institutions simultaneously. The same economic forces that trigger liquidity shocks may also directly affect firms' investment opportunities (Schnabl, 2012). Even though an association between overall economic prosperity and bank liquidity levels always exists, the onset of financial crises is proven to affect its magnitude and thus make an adverse feedback loop particularly prominent. The recent 2008-2009 financial crisis was not different in this respect, and if anything, it illustrated that regulatory capital requirements cannot prevent a liquidity crisis. Its negative impact on liquidity levels is reported in a number of research papers. This domino effect results in reciprocated overreactions that are typical during the crisis episodes, and this research shows that on average, bank liquidity is about 8% less than what is consistent with economic fundamentals during financial crises (Moore, 2010). The aforementioned trait

of financial crises provides good reason for treating it as a separate factor that impacts liquidity above and beyond the basal dynamics of economic growth.

Under extreme circumstances, the traditional concept of "bank liquidity" could be complemented by considerations of the liquidity of monetary and other financial markets (Valla *et al.,* 2006), which calls for intervention with the use of monetary instruments. Some authors hypothesise that monetary policy is even more potent during financial crises because easing of aggressive monetary policy can make the aforesaid feedback loops less likely (Mishkin, 2009). The theories associated with the so-called monetary policy transmission channel such as the "conventional" interest rate mechanism operating through the interest rate sensitivity to spending, the "borrower net worth" mechanism assuming that the financial difficulties of borrowers can amplify the impact of initial interest rate changes, or the "bank lending" channel, can help us explain the relationship between monetary policy and bank liquidity. On this topic, researchers find that tightening monetary policy induces a decrease in liquidity, which concurs with the results reported by Lucchetta (2007) of the significant relationship between the increase in the risk-free interest rate on the one hand and loans, investment and bank risk-taking behaviour on the other. The same logic holds for Hungarian (Vodová, 2013b) but not for Slovakian banks, where the supposed effect of the monetary policy interest rate is found to be insignificant.

The effect of a bank's size seems to moderate this relationship by making large commercial banks more capable of isolating their lending activities from changes in monetary policy conditions (De Santis and Surico, 2013). Owing to this and other reasons previously noted, we regard a bank's size as the most important micro-level characteristic. Another reason is the fact that small banks are more adversely affected by an increased potential for a squeeze if adverse economic conditions materialise (Fecht *et al.*, 2010). In such conditions, large banks can rely on the interbank market, whereas small and medium-sized banks have to hold a buffer of liquid assets (Vodová, 2011). Moreover, the former, by virtue of their size, benefit from factors which reduce the level of their portfolio risk such as diversification and better investment opportunities. It can also be argued that the large size of a bank provides unwarranted incentives for managing liquidity risk as a result of the somewhat sensible perception of the improved odds of government bailout (the well-known "too big to fail" concern). As expected, the size of the bank is consistently reported to have a negative association with the level of liquidity. The results based

on the analysis of a sample of commercial banks from the Czech Republic, Slovakia, Poland and Hungary support the hypothesis of such a negative relationship (Vodová, 2012; Vodová, 2013b). Even though the size effect has a clear negative effect on liquidity, it is repeatedly included in studies, since it has to be controlled for in order to improve the measurement precision of the effects of other variables included in the model.

Many banks are currently under regulatory pressure from Basel III to improve liquidity by investing in more short-term, low-risk securities and to fund assets with more long-term, stable sources of debt. Of course, higher capital adequacy and improved liquidity bring a cost in the form of reduced net interest spread (Handorf, 2014) and a resultant reduced profitability (Molyneux and Thornton, 1992). The research results obtained by a group of authors (Trenca *et al.*, 2012) confirm the existence of a relationship among the banks operating in the countries of Eastern Europe. They examined a sample of 30 commercial banks from Bulgaria, the Czech Republic, Lithuania, Romania, Slovakia, Slovenia and Hungary and report that net interest spread is one of the main determinants of bank liquidity. However, the results of the analysis of Hungarian banks show that bank liquidity is positively correlated with interest rate spread and profitability (Vodová, 2013b), while another analysis on a sample of Slovak commercial banks finds no such statistically significant relationship. This inconclusiveness makes the interest rate spread between lending and deposit interest rates an additional variable of importance for future research.

The results of similar research bring to light some further interesting macroeconomic factors. For instance, it is observed that in extreme regimes (pure floating exchange rate regimes at one end and currency boards and dollarised economies at the other end), bank assets are more liquid than those in intermediate regimes (Bunda and Desquilbet, 2008; Deléchat *et al.*, 2012). In addition, the depreciation of the domestic currency shows a positive correlation with liquidity in Czech commercial banks (Vodová, 2013a).

The ownership structure of the banking sector is another relevant factor when analysing the reaction of bank liquidity during the crisis periods. Some authors have suggested that international banks transmit liquidity shocks across countries and that transmission is strongest for domestically owned banks that borrow internationally, intermediate for foreign-owned banks and weakest for locally funded banks (Schnabl, 2012).

In consideration of the ambiguity that is more than apparent in studies of countries in Eastern Europe, we hope to add to the body of existing knowledge and contribute to the further clarification of this complex subject. With this goal in mind, we have collected a comprehensive dataset related to banks operating in the Republic of Serbia for a comparable period and analysed it by using the panel regression technique.

3. METHODOLOGY AND STATISTICS

In order to identify and assess the impact of the empirical determinants of liquidity risk exposure in the Serbian banking sector, an econometric panel model that combines cross-sectional and time-series data was used. Depending on the properties of the regression coefficients, the following regression models are typically used in panel research:

- ◆ Pooled OLS model
- ◆ Fixed effects model
- ◆ Random effects model

Each of these three models offers different estimates in terms of values and statistical significance. The decision on the model that best describes the observed interdependencies is made based on the test results provided in Table I (Corbae *et al.,* 2010).

Contrasting Models	Model Selection Test
Pooled vs. Fixed effects model	F-Test
Pooled vs. Random effects model	Breusch-Pagan Test
Fixed effects vs. Random effects model	Hausman Test

Table I. Tests for model selection in panel research

The following regression model was used for the identification and assessment of the impact of the empirical determinants of liquidity risk exposure in the Serbian banking sector:

$$L_{ij} = \beta_0 + \beta_1 cap_{ij} + \beta_2 size_{ij} + \beta_3 dummy_j + \beta_4 roae_{ij} +$$
$$\beta_5 gdp_j + \beta_6 inf_j + \beta_7 une_j + \beta_8 repo_j + \beta_9 excr_j + \beta_{10} def_j + \varepsilon \ (1)$$

The dependent model variable consists of ratios that provide an assessment of bank liquidity. Research includes the following ratio numbers:

$$L_1 = Liquid\ assets/Total\ assets \qquad (2)$$

The liquidity ratio L1 refers to first-degree liquidity, which takes into account cash and cash equivalents as well as revocable credits and deposits. It should provide information on the general liquidity shock absorption capacity of a bank. As a general rule, the higher the share of liquid assets in total assets, the higher the capacity to absorb liquidity shock. Nevertheless, a high value of this ratio may also be associated with inefficiency due to the high opportunity costs of holding liquid assets. That is why banks most often keep liquid assets at the prescribed regulatory level, while they aim to lend the leftovers. The global economic crisis has also led to a lack of funds in the global money and capital markets. Despite an apparent growth of the deposit base in the years following the crisis, an insufficient amount of external nondeposit sources for domestic banks is an aggravating circumstance when it comes to the application of purchased liquidity management. Therefore, the conclusions based on the research results start from the assumption that lower values of liquidity ratio L1 imply greater exposure to liquidity risk.

$$L_2 = Granted\ loans/Total\ assets \qquad (3)$$

The ratio L2 measures the share of loans in total assets and hence provides information on the proportion of the bank's assets tied up in loans. Within the domain of traditional banking, loans are viewed as illiquid assets due to their typically long repayment period. Thus, conclusions based on the research results start from the assumption that the ratio L2 could be considered an inverse indicator of bank liquidity.

$$L_3 = Granted\ loans/Deposits \qquad (4)$$

The liquidity ratio L3 shows the amount of loan placements covered within deposit sources. The balance sheet structure of banks in the Republic of Serbia is such that loan placements dominate total assets, while deposits dominate the source structure. Loans as mainly long-term placements reduce the liquidity potential of banks mainly because the deposit structure is dominated by those with a maturity of less than a year. Taking into consideration the above-mentioned facts, ratio L3 can be considered an inverse indicator of bank liquidity.

In previous research, a large number of factors that determine the exposure to liquidity risk of banks operating in many different countries has been analysed. This paper examines the influence of factors that in earlier research have shown statistically significant influence on liquidity risk exposure. Potential determinants of the liquidity risk exposure of Serbian banks are shown in Table II.

Variable	Definition	Source
cap_{ij}	Capital/total assets (for the i-th bank in the j-th year)	*Bank balance sheets, www.nbs.rs*
$size_{ij}$	Natural logarithm of total balance sheet assets (for the i-th bank in the j-th year)	*Bank balance sheets, www.nbs.rs*
dummy	Dummy variable. During the crisis period (2009 and 2010), the value of the variable is 1, while for other years it is 0.	-
$roae_{ij}$	Net profit/average capital (for the i-th bank in the j-th year)	*Bank balance sheets, www.nbs.rs*
gdp_j	Real growth in GDP (%) in the j-th year	RZS, NBS, NSZ I RFPIO
inf_j	Growth rate of consumer prices (average for the period) in the j-th year	*Public Finance Bulletin*, Volume 111, November 2013
une_j	Unemployment rate according to the labour force survey RZS in the j-th year	RZS, NBS, NSZ I RFPIO
$repo_j$	Reference interest rate –1w repo in the j-th year	Overview of financial stability chart, *www.nbs.rs*
$excr_j$	Exchange rate trends (December 2007=100) in the j-th year	Overview of financial stability chart, *www.nbs.rs*
def_j	Current account balance deficit (as a % of GDP), Ratio of the four-quarter moving totals in the j-th year	Overview of financial stability chart, *www.nbs.rs*

Source: Author's review

Table II. Independent variables of the regression panel model

The analysed sample comprised 27 banks from the Republic of Serbia, whose liquidity was monitored for the period from the end of 2007 to the beginning of 2013. An analysis of the obtained statistically significant estimates of regression coefficients is presented in the following section.

4. ANALYSIS OF THE INFLUENCE OF STATISTICALLY SIGNIFICANT DETERMINANTS OF LIQUIDITY RISK EXPOSURE OF BANKS IN THE REPUBLIC OF SERBIA

The results of the panel regression model are presented in Table III. Variations in the independent variables explain 41% of variations in the share of liquidity reserves in total assets, while the remaining 59% depends on variations in other factors that are not included in this research. Variations in the independent variables explain 27% of variations in the share of loans in total assets as well as 25% of variations in the values of the loan to deposit ratio. The fixed effects regression model is considered the most suitable for the analysis of associations for all three liquidity indicators.

Starting from the fact that liquidity in the banking sector in the Republic of Serbia was at a satisfactory level during the observed period, the analysis of the statistically significant estimates of the regression coefficients leads to several conclusions. From the analysed internal bank characteristics, a statistically significant impact on exposure to liquidity risk was observed for variations in the bank capital to total assets ratio as well as for variations in total asset values. The research results support the assessment that growth in the share of capital in relation to the bank's total assets leads to an increase in the loan to deposit ratio, which increases the exposure to liquidity risk. The fact that well-capitalised banks are better protected from risk exposure enables them to maintain the outlined position without liquidity consequences.

The next internal characteristic that has a statistically significant association with banks' exposure to liquidity risk is variations in total assets. The research results support the supposition that an increase in total assets results in an increase in the ratio of loans to deposits. In the case of larger domestic banks, increased exposure to liquidity risk is compensated for by their financial strength, broad diversification of loans and improved access to external nondeposit funding sources. Large domestic banks are mostly owned by foreign entities which enables them to gain inexpensive cross-border credit lines, and efficient application of purchased liquidity management (Dinger, 2009). Smaller banks are more oriented towards stored liquidity management.

In addition to internal characteristics, liquidity risk exposure is affected by numerous external factors. From the analysed external (macroeconomic) factors, a statistically significant association with liquidity risk exposure is observed for variations in GDP, unemployment rate, balance of payments deficit and currency exchange rate deficit.

Independent variables	Coefficient L_1		Coefficient L_2		Coefficient L_3	
	Regression coefficient	Std. deviation	Regression coefficient	Std. deviation	Regression coefficient	Std. deviation
cap	-	-	-	-	3.048*	1.586
size	-	-	-	-	0.241**	0.112
gdp	-1.369***	0.229	1.486***	0.247	3.298**	1.187
une	2.463**	1.023	-	-	-	-
excr	1.339***	0.319	-0.790*	0.421	-	-
def	1.118**	0.462	-	-	-	-
Model	*Fixed effects (within) regression*		*Fixed effects (within) regression*		*Fixed effects (within) regression*	
R^2	0.41		0.27		0.25	
Total obs.	135		135		135	

Source: Author's calculations (the starred coefficient estimates are significant at the 1% (*), 5% (**) or 10% (***) level.

Table III. Statistically significant determinants of liquidity

Studies show that liquidity has, for the most part, a negative association with the business cycle. GDP is the best indicator of the current business cycle phase of a given economy. The research results support the assessment that GDP growth results in increased lending activity and a decrease in the share of liquid reserves in total assets, which then increases bank exposure to liquidity risk. An increase in lending activity is expected during an expansion, as most business entities want to take loans when there is a higher probability of carrying out lucrative business projects. It is important to highlight the fact that growing economies are less susceptible to systemic risk, which reduces the interest rate for external funding sources. This enables banks to efficiently implement purchased liquidity management.

During the analysed period, a negative GDP growth rate accompanied by an increase in unemployment was observed in the Republic of Serbia. Results from previous studies show that the unemployment rate is negatively correlated with the lending activities of banks (Bernal-Verdugo *et al.*, 2013). This assessment is confirmed in the case of the banking sector of the Republic of Serbia. The growing unemployment has shrunk the pool of potential creditworthy borrowers and caused a drop in their borrowing capacity, thereby forcing banks to reduce lending activities in order to preserve liquidity.

Another macroeconomic variable that determines banking sector exposure to liquidity risk is variation in the balance of payments. The balance of payments was in deficit during the observed period in the Republic of Serbia. The research results support the assessment that an increase in the balance of payments deficit leads to a decrease in a bank's lending activity as well as an increase in the share of liquid reserves in assets. A greater number of imports than exports is an indicator of the poor competitiveness of domestic products and reduced aggregate demand for them, which further contributes to a decline in economic activity and increase in NPLs, which in turn force banks to reduce their lending activity.

Finally, the last factor that determines banking sector exposure to liquidity risk covered in this research is the exchange rate variation. The research results support the assessment that an increase in the exchange rate leads to a drop in the share of loans in total bank assets and an increase in liquidity reserves. Depreciation of the local currency enables local export-oriented companies to decrease their demand for loans and rely more on internal sources of funds. At the same time, it increases the share of NPLs in total loans. About 70% of loans in the Republic of Serbia are indexed in euros, which is why an increase in the exchange rate leads to an increase in loan instalments that debtors pay to banks. The growth in loan instalments, together with growth in the unemployment rate, has resulted in a greater number of NPLs, thus forcing banks to reduce their lending activity.

5. A COMPARATIVE ANALYSIS OF THE INFLUENCE OF STATISTICALLY SIGNIFICANT DETERMINANTS ON LIQUIDITY OF SERBIAN BANKS AND BANKS FROM FORMER SOCIALIST COUNTRIES

The Republic of Serbia is a former socialist country that is striving to transform itself into a modern European country. The transitional period began in 2000 after democratic changes and is still ongoing, with Serbia being on the verge of starting initial negotiations with a view to joining the EU. The financial market in the Republic of Serbia is bank-centred, and it can be said that the banking sector makes an important contribution to the process of transforming the economy into a market economy. Therefore, monitoring, measuring and managing the liquidity risk of the banking sector is extremely important during this transition period. In this section, a comparative analysis of the influence of determinants of the exposure to liquidity risk among banks from the Republic of Serbia and their influence on banks from former socialist countries which have already gone through a transition period is presented. The analysis includes banks from the Slovak Republic, Czech Republic and Hungary. As far as determinants of bank liquidity from the above-mentioned countries are concerned, it is important to emphasise that the results from earlier research have been used (Vodová, 2011; Vodová, 2013b).

For banks that conduct business in the analysed financial markets, the impression is that larger banks are less liquid. For most banks in the Republic of Serbia and the Czech Republic, lower liquidity is the consequence of a larger volume of loan placements in relation to deposits. In the case of larger banks from the Slovak Republic and Hungary, lower liquidity is the consequence of retaining a smaller share of liquid assets in total assets. It can be concluded that financial strength, the possibility of broad diversification of placements and a better approach to external nondeposit sources enable larger banks to retain their position of greater exposure to liquidity risk without consequences.

	Serbia			Hungary	Slovakia			Czech		
	L_1	L_2	L_3	L_1	L_1	L_2	L_3	L_1	L_2	L_3
size			+	-	-					+
cap			+	+	-			+	-	-
gdp	-	+	+	+		-	-		+	
dummy					-	+	+	-		
une	+					+	+			

Table IV. Nature of influence of statistically significant determinants of liquidity risk exposure of analysed banking sectors
Source: Adapted from Vodová (2011, 2013b)

The financial markets of the Czech Republic, Hungary and the Slovak Republic are more developed and flexible than the financial market of the Republic of Serbia. That is chiefly due to the fact that since 2004 they have been members of the EU and have better access to international money and capital markets. Banks that conduct business in developed financial markets principally rely on purchased liquidity management. On the other hand, banks that do business in developing markets, as is the case with banks from the Republic of Serbia, mostly rely on liquidity reserves. Figure 1 shows that banks in the Republic of Serbia hold a larger share of liquid assets in their total assets than banks that conduct business in the financial market of the EU.

However, results show that stored liquidity management has exhibited greater efficiency in the initial impact period of the latest world economic crisis. A lack of financial resources on the global money and capital markets resulted, in the case of the Slovak Republic and Czech Republic, in the fall of their liquidity. On the other hand, in the case of banks from the Republic of Serbia, liquidity remained stable, which implies that orientation toward traditional banking provides stable bank liquidity in the initial impact period of an economic crisis.

The next statistically significant determinant of the exposure to liquidity risk of the analysed banks is the capital to asset ratio. Banks that have larger values for this indicator are less exposed to risks because they finance assets from their own sources. Banks in Serbia that are financed from their own sources have a higher ratio of loans to deposits, while banks in Slovakia have a smaller portion of liquid assets in total assets. Banks in the Republic of Serbia are able to maintain the described position without consequences for liquidity because their level of capital adequacy far exceeds the minimum prescribed by the Basel regulatory framework. On the other hand, values for this coefficient in the case of the banking sector of the Czech Republic and Hungary are lower, which means that banks keep their capital at a level that is closer to the regulatory minimum. According to the research results, in the case of the Czech Republic and Hungary the growth in the value of the capital to asset coefficient is associated with the growth of liquid assets in total assets and can be a consequence of the need for larger liquidity as required by the Basel regulatory framework. Figure 2 shows the values for the capital to asset coefficient of the analysed banking sectors. It can be seen that the Serbian banking sector is much better capitalised than other banking sectors covered by this analysis.
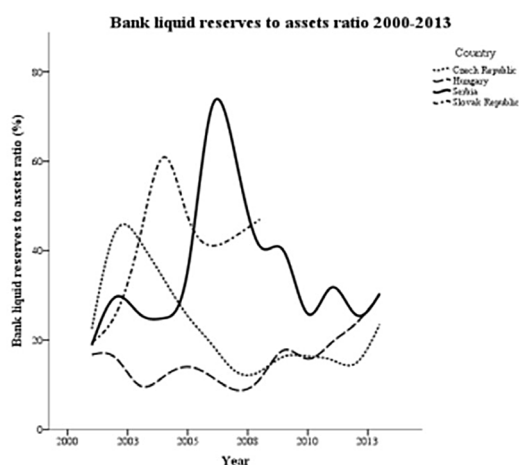
Figure 1. Bank liquid reserves to bank assets ratio (*World Development Indicators, The World Bank*).
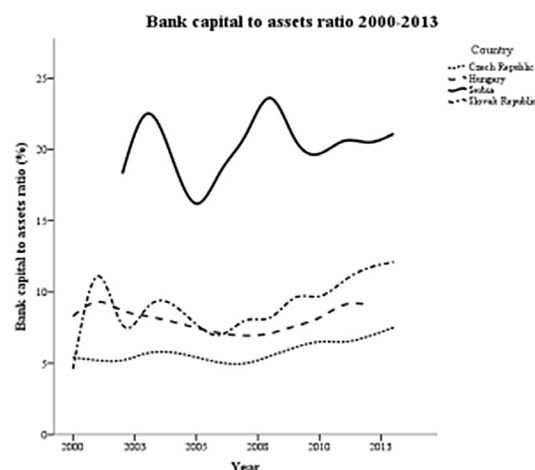
Figure 2. Bank capital to assets ratio (*World Development Indicators, The World Bank*).

Studies have shown that the phase of an economic cycle statistically influences banks' exposure to liquidity risk. Results mostly point to the fact that liquidity is inversely associated with the business cycle phase as confirmed by the cases of banks from the Republic of Serbia and the Czech Republic. GDP growth influences an increase in the lending activity of banks, which therefore reduces their liquidity. In the case of the Czech Republic, this correlation is statistically significant with a three-year lag. That means that companies in the Czech Republic needed three years after the recession to increase their lending capability and start to provide loans. The ability to recover without necessarily increasing debt shows that companies in the Czech Republic are sufficiently developed to overcome a crisis by using their own resources. On the other hand, variations in GDP in the Republic of Serbia influence banks' exposure to liquidity risk without a time delay. This means that the economy is underdeveloped and that internal resources at its disposal are not adequate to overcome the consequences of a crisis. After the impact of the global financial crisis, the economy of the Republic of Serbia entered a recession that has quickly resulted in a growth in unemployment, an increase in the share of nonperforming loans in total loans and a reduction in lending activity. The ratio of nonperforming loans to total loans for the analysed banking sectors is chronologically presented in Figure 3.
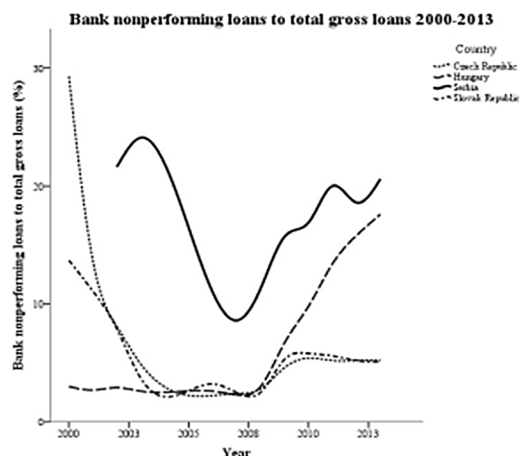
Figure 3. Ratio of bank nonperforming loans to total gross loans (*World Development Indicators, The World Bank*).

Unlike the Republic of Serbia and the Czech Republic, in the case of the Slovak Republic and Hungary the relationship between the liquidity of banks and the business cycle is positive (Moore, 2010). That means that during the expansion phase, companies from these countries re-

duce the level of debt to banks by relying more on growing internal sources. The opposite also applies, which means that during the recession phase the number of approved loans grows thus resulting in a reduction in bank liquidity. In the case of the Slovak Republic this effect is becoming statistically significant after two years, which means that companies during the recession phase have enough resources to do business for two years without increasing their credit debt. Their ability to rely on internal resources after the economy has entered the recession phase offers banks protection from increased exposure to credit risk during the period of transition to the recession phase.

5. CONCLUSION

The research results support the conclusion that domestic banks are faced with decreased lending activity in the post-crisis period, which is for the most part the result of an increase in the number of NPLs and a decline in the number of potential creditworthy clients. The decline in lending activity has resulted in an increase in the share of available liquid assets in total assets and consequently has resulted in high levels of liquidity. In order to avoid the opportunity costs of holding liquid assets above the optimal level, many banks have initiated repayment of cross-border loans. The given scenario is in accordance with the second Vienna initiative, which aims to create sustainable bank business models that rely more on local rather than on external funding sources. Thus, it is important to stress that the deposit base of the banking sector in the Republic of Serbia experienced growth during the observed period, which also contributed to the creation of an efficient banking system relying on the second Vienna initiative model.

The research results suggest that greater banking sector exposure to liquidity risk is triggered by several factors. The first factor refers to the value of total assets. Larger banks are able to achieve a wide diversification of loans and to apply purchased liquidity management more efficiently, thus maintaining higher loan to deposit ratio values. Also, results confirm that banks with a larger capital share in balance sheets are generally more protected from risk exposure. External variables with a statistically significant impact on increased exposure to liquidity risk include growth in GDP, a decline in the unemployment rate, a decrease in the balance of payments deficit and a drop in the exchange rate. An increase in the lending activity of banks and a reduced share of liquid assets in total assets are observed during the expansion phase of a business cycle. This increases exposure to liquidity risk

as well as the possibility of the efficient application of purchased liquidity management as a result of a decline in systematic risk. With regard to the current account balance, the results support the proposition that a decline in the current balance of payments deficit through increased exports and demand for domestic products, contributes to an increase in economic and lending activity, which further increases bank exposure to liquidity risk. The last factor that has an impact on increased exposure to liquidity risk is a decline in the exchange rate. This leads to a reduction in credit instalments that debtors pay to banks due to euro-indexed loans. This results in a decline in the share of NPLs in total loans and an increase in the number of creditworthy clients, which thus enables banks to increase their lending activity, which further increases exposure to liquidity risk.

Assuming that the Republic of Serbia continues to develop its use of the model of former socialist countries that are included in this analysis, several conclusions can be drawn regarding the exposure to liquidity risk of the Serbian banking sector. Economic development and the development of financial markets could, in at least two ways, influence the reduction in the opportunity costs of banks based on maintaining high levels of assets that are not lent. Development of the financial market could increase efficiency in the application of purchased liquidity management. On the other hand, development of the real economy might contribute to a reduction in credit risk, which would then create conditions suitable to increasing lending activity and to reducing the capital adequacy level to close to the regulatory minimum. The results of this comparative analysis indicate that the nature of the influence of the analysed internal macroeconomic variables on banks' exposure to liquidity risk depends on the degree of market development where the banks conduct business; this, therefore, confirms the general hypothesis of the research.

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E - BANKING

THE PROPOSAL FOR INTEGRATED ICT SOLUTION FOR THE ENFORCEMENT OF MONETARY CLAIMS AGAINST A JUDGMENT DEBTOR – NATURAL PERSON IN MONTENEGRO

Dejan Abazović[1],
Andrija Jovović[2],
Budimir Lutovac[3]

[1]Central Bank of Montenegro, Head of IT
Podgorica, Montenegro

[2] Central Bank of Montenegro,
Head of Payment System,
Podgorica, Montenegro

[3] University of Montenegro,
Faculty of Electrical Engineering,
Podgorica, Montenegro

Abstract:

Bearing in mind the problems currently occurring in the functioning of enforcement against monetary claims (hereinafter: enforced collection) of a judgment debtor – natural person, this paper presents a proposal for a project design which would resolve the main existing problems. The project design is based on the concept of implementation of an integrated information and communications technology (ICT) system which would generally include all the writs of enforcement against judgement debtors - natural persons. The ICT system would be implemented in the Central Bank of Montenegro. Employers would pay wages arising from personal income in two instalments, the first of which would represent the funds excluded from enforced collection, while the second would be available for collection. The implementation of this proposal would require amending the existing regulations, finalizing the manner of the processing of personal income with the employer, as well as recording natural persons' earning with commercial banks. In addition, this solution includes the adjustment of both the organization and system of the issuer of the writ of enforcement, because all the writs of enforcement would be submitted to the Central Bank of Montenegro electronically.

Key words:

enforced collection against natural persons, enforced collection, the centralized processing of enforcements, Central Registry of Enforced Collection, ICT system of enforced collection.

1. INTRODUCTION

The enforcement against monetary assets (hereinafter: enforced collection) at the account of the judgment debtor or sole trader represents a legal obligation and the power of the Central Bank of Montenegro (CBM) to ensure the settling of the obligation stated in the grounds for enforced collection for the benefit of the transaction account of the judgment creditor, from all transaction accounts pertaining to the judgement debtor in which there are funds, according to the time of receipt of the said grounds for the enforced collection, under the rule of law. The enforced collection is levied pursuant to numerous regulations, the Law on Enforcement and Securing of Claims being the most important among them (Decision on Determining E-messages for levying Enforced Collection).

While the process of enforced collection against the account of a legal entity or sole trader is levied completely synchronously with the use and utilization of information communication technologies (ICT), organized as a integrated information system, the process of enforced collection

Correspondence:

Dejan Abazović

e-mail:

dejan.abazovic@cbcg.me

against natural persons is levied asynchronously with multiple entities, without uniform approach and with numerous problems. The problems in the process of enforced collection against natural persons occur in all entities involved in the process: the issuer of the writ of enforcement, commercial banks, employers, and finally the judgement debtors.

A hierarchical description of the system, in the technique diagrams of data flows, comes down to the fact that at higher levels are defined global processes, and then to the next level down, new data flow diagram. Because of this, in accordance with the method of Structural System Analysis (SSA), we opted for a data flow diagram at the top of this hierarchy, which is called context diagram (Faculty of Organizational Sciences, 2000) .

This paper presents a proposal of the project design for the establishment of uniformly organized ICT system of enforced collection against natural persons. The system would be implemented in the Central Bank of Montenegro (CBM) while the process of enforcement would be implemented exclusively in commercial banks, similarly to the corresponding process for legal entities and sole traders. This conceptual solution would encompass all the issuers of writs of enforcement in Montenegro.

Preconditions for its implementation include amending the Law on Enforcement and Securing of Claims, finalizing the manner of wage processing of the employer, as well as changing the manner of recording monetary assets in the transaction accounts of natural persons in commercial banks.

2. ENFORCED COLLECTION AGAINST THE ACCOUNTS OF LEGAL ENTITIES AND SOLE TRADERS

The ICT system (IS PNPL) was established for the implementation of enforced collection against the accounts of legal entities and sole traders. The system has been in operation in the CBM since 2008.

The Central Registry of Transaction Accounts (CRTR) for legal entities is kept within the IS PNPL. As of 30 June 2012, the data on the number of legal entities and sole traders recorded in CRTR are harmonized with the data on active legal entities and sole traders recorded in the Central Registry of Business Entities (CRPS), on a monthly basis.

As at 31 January 2016, the Central Registry of Transaction Accounts included 77,208 legal entities and sole traders, which is a 0.30% increase in relation to 31 De-

cember 2015, when this number was 76,973. Updating of other data published in relation to the levying of enforced collection is done accordingly.

The IS PNPL was updated on multiple occasions, with the final major update done in 2013. Through its implementation, the process of enforced collection against the accounts of legal entities and entrepreneurs was completely based on ICT (Indicators of enforced collection).

The ICT system of enforced collection against the accounts of legal entities and sole traders is implemented in the CBM, which is connected with the commercial banks in Montenegro through a business network. The enforcement of the basis for the enforced collection is done through the exchange of e-messages between the CBM application systems and commercial banks. Special transaction system functioning on the principle of SWIFT messages was developed for the purpose of message exchange (Figure 1). The structure of messages and their content are defined in the internal document of the CBM - "Decision on Determining E-messages for levying Enforced Collection".
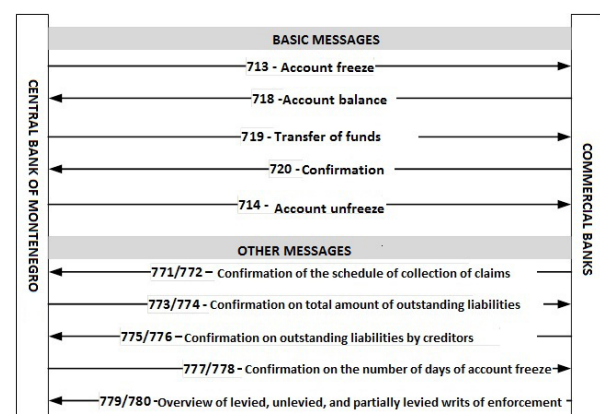
Figure 1. Transaction system for message exchange

Tax identification number (PIB) of legal entities represents their main identifier, while for the sole traders it is the personal identification number (JMB) of the natural person performing the registered business. Upon receiving the writ of enforcement, the CBM initiates the enforced collection proceedings by freezing all the accounts of the legal entity or sole traders (hereinafter: judgement debtor) with commercial banks. At the same time, other banks cannot open new accounts for the judgment debtor. Upon receiving the confirmation of the freezing of the account, the CBM receives data on the balance of funds on such account. On the basis of the previously defined algorithm for the collection of

funds from the transaction accounts, the CBM orders the commercial banks to transfer the funds from the frozen account of the judgement debtor to the account of the judgement creditor. Upon completion of the enforced collection procedure, the CBM orders the banks to unfreeze the account of the judgment debtor.

With regard to enforced collection against the legal entities and sole traders, pursuant to the Payment System Law, the CBM is obliged to publish the names of legal persons and/or sole traders, their register/personal identification numbers, the frozen amounts, and the number of days of uninterrupted account freeze. The names of legal persons are taken from the CRPS. The CBM publishes the above mentioned data on a monthly basis, with the balance as at the last day in the previous month (Law on Payment Transactions).

The CBM publishes the above mentioned data on a monthly basis on its website on the first business day of the following month in alphabetical order. The identification numbers for sole traders are not published because their transaction accounts are recorded in the CRTR under their personal identification number (JMB), and publishing this number is not in line with the Personal Data Protection Act.

In 2015, the CBM developed e-service which enabled all the legal entities in Montenegro, whether they are judgement debtors or creditors, to acquire necessary information regarding the enforced collection in a manner compliant with the Law on Enforcement and Securing of Claims. The main prerequisite is the possession of qualified digital certificate. In this manner, pursuant to the Law on Electronic Signature, the authentication of the legal entity requesting the data from the CBM system is performed on the e-portal.

3. ENFORCED COLLECTION AGAINST NATURAL PERSONS

3.1 CURRENT SITUATION AND OPERATIONAL ISSUES

Pursuant to the latest amendments to the Law on Enforcement and Securing of Claims, the CBM is obliged to keep the CRTR of natural persons. Upon the establishment, as at 3 August 2015, the CRTR of natural persons was also made available in the form of e-service via internet on the e-portal of the CBM.

The enforcement officers and other competent state authorities acquire data on the transaction accounts of natural persons – judgement debtors based on written communication or using the e-portal of the CBM.

The process of the enforced collection against natural persons is implemented completely asynchronously, without uniformly arranged and organized system.

There are many problems occurring in the process of enforced collection against natural persons, arising with all the participants in the collection process. Pursuant to the Law, the enforced collection is levied through prohibition and pay out. Basically, in majority of issuers of the writs of enforcement, the process is carried out as follows:

- ◆ Pursuant to the Law on Enforcement and Securing of Claims, the enforcement against wages is conducted with the employer. In order to levy the enforced collection in such manner, the issuers of the writs of enforcement receive from the Tax Administration of Montenegro the information on whether the judgment debtors are employed, and if so, who is their employer. Upon receiving such information, the issuer of the writ of enforcement submits to the employer a writ of enforcement, which the employer is obliged to comply with.

- ◆ These data are often unavailable or outdated. In those cases, it is checked whether the judgement debtor is in the Pension and Disability Fund's records (PIO Fund). If it is so, the Fund is delivered the writ of enforcement.

- ◆ If the judgement debtor is not in the PIO Fund records, the issuers of the writ of enforcement acquire information on the banks where the judgement debtor has opened transaction accounts. Upon receiving information on transaction accounts, the issuers deliver the writs of enforcements to the banks. Public enforcement officers receive data on the transaction accounts in paper or electronic form from the CRTR of the CBM.

- ◆ In the situations referring to traffic offences, the issuers (Ministry of Interior, misdemeanor courts) deliver the final uncollected writs of enforcement to the Register of Fines, following the described procedure. In these cases, the persons prosecuted or fined for the traffic offences, shall not be allowed: a) to register or extend the registration of the motor vehicle, and b) to be issued or to extend the validity of a drivers license, until they have paid all fines and court costs recorded in the Register of Fines.

This manner of enforcement levying does not apply to the funds found on the judgement debtor's account arising from wages. Commercial banks encounter problems with regard to "recognizing" such funds in the account, therefore it often happens that both the employer and the

bank withhold funds arising from wages. In such situations, the return of funds to the judgement debtor can be lengthy and complicated.

It happens very often that some commercial banks do not respond to the demands of issuers of the writ of enforcement or that the issuer of the writ of enforcement does not have the information on whether the writ of enforcement is carried out. In most cases, the process of implementation of the writ of enforcement lasts for days while the law prescribes that the writ of enforcement must be carried out without delay.

As the main form of communication between the issuer of the writ of enforcement and the bank is in the written form, which often requires significant time, the situation at the transaction account is often changed. In addition, due to the written communication, freezing of the account of the judgement debtor can last for a very long time despite the fact that the judgement debtor has sufficient funds for the payment.

It often happens that a large number of cases, the writ of enforcements, remain in backlog before the misdemeanor courts for a long period of time. In this way they acquire conditions to become obsolete, which makes courts inefficient.

Given that the commercial banks where the judgement debtor has no transaction account do not have information on writ of enforcement, it is possible that the judgement debtor, while his transaction account is frozen with one commercial bank, opens the transaction account with other commercial bank, thus avoiding the enforced collection.

Recording of received writ of enforcement and actions with commercial banks is a very complex process. Tens of thousands of writ of enforcements in individual commercial banks is monitored and they are mostly treated without orderly IT process. Banks are exposed to the need for additional employment risk and expenditures risk. Also, due to the enforced collection against natural persons' accounts, reputational risk of a commercial bank is very high. Consequently, it results in a higher number of requests for closing the transaction accounts of their clients, natural persons.

In cases of the execution of enforced collection through the offence warrant (order) of the Ministry of Interior Affairs, due to traffic offense, which is in most cases implemented with the employer, writ of enforcement is often carried out after several years. By this, the meaning of the sentence and changes in behavior of perpetrators of this type of offense are completely lost.

3.2 PROPOSAL OF PROJECT DESIGN

Accordingly, the execution of the enforced collection from natural persons must be organized through uniform information system (IS PNFL – Information System of Enforced Collection from Natural Persons), the implementation and management of which is under the responsibility of the CBM. This writ of enforcement would allow the enforced collection from natural persons in a unique manner.

The IS PNFL would include all issuers of writs of enforcement that would be delivered electronically for the enforcement. The processing of the enforcement as well as the coordination and implementation of all activities related to enforced collection would create conditions for the establishment of the Central Registry for Enforced Collection (CRPN). Such an organized and regulated CRPN would allow all types of statistical analysis and insight into the balance of the enforced collection, regardless of whether it is a debtor or creditor, for legal and natural persons.

The enforced collection from natural persons would be implemented in commercial banks in which the judgement debtor has transaction accounts. All earnings made by a debtor can be summarized only at the transaction accounts with commercial banks. Primarily, it refers to earnings based on the right on personal income or fees realized on various grounds. Similarly, this applies to all other earnings and acquired rights to compensation (welfare assistance, child allowance, disability allowance, and the like).

Employers would divide wages divided into two parts (Figure 2), in accordance with the Law on Enforcement and Securing of Claims. The first part of the wage would represent funds exempted from the enforced collection. The second part of the wage would represent funds that are available to the enforced collection.

For each employee, the employer would send information on wages to commercial bank in two parts. Based on this information, the commercial bank would keep records on all wages of the transaction account holder in the supporting table. If the recipient of funds is not subject to the enforced collection, commercial bank would not have to keep records on the type of earning (free/available for enforced collection).

If the judgment debtor has other earnings, for example on the basis of service contract, on the basis of his participation in the work of a board of directors and the like, these funds would be transferred under the type "funds

available for the enforced collection", but also the commercial bank would not have to record the type of earnings if the recipient is not subject to enforced collection.

If the debtor has earnings realized on the basis of welfare assistance, child allowance, and the like, those earnings would be transferred under the type "free", but also the commercial bank would not record the type of earnings if the recipient is not subject to enforced collection.

All other earnings would be also transferred under the form defined by the legislator, while the commercial bank would not have to record the type of earnings if the recipient is not subject to the enforced collection.

Once the commercial bank receives the message that the client is subject to the enforced collection, the commercial bank reserves the funds held at the account for the purpose of the enforced collection in the amount defined by the legislator (for example: funds available for the enforced collection are all funds at the account holder above the minimum wage in the state or the like).

Thus, for each subsequent inflow, depending on the type of earnings, the commercial bank allows the account holder to dispose of those funds or reserves them for the enforced collection, until obtaining the message on the termination of the.

If a commercial bank for the same client again obtains a message for the enforced collection, the present funds would be treated in the same way as the first time.

Unless transaction account holder is not subject to the enforced collection procedure, he/she manages all the funds at the transaction account in a regular manner.

3.3 DATA FLOW DIAGRAM

Data flow diagram is a model system that consists of four basic components: data processing (the active component of the system), objects environment (interface) with which system communicates, data warehouse which processes use and / or update and the data flows which connect other components in the whole system (Structural System Analysis).

The main characteristics of data flow diagrams are:
- clear graphics specification, suitable for communication with the user,
- clear and detailed description of the system, using the method of abstraction so that the system at higher levels of abstraction describes in general and on the lower detailed level.

Data Flow Diagram - Diagram of context, according to the SSA, is shown in Figure 2.
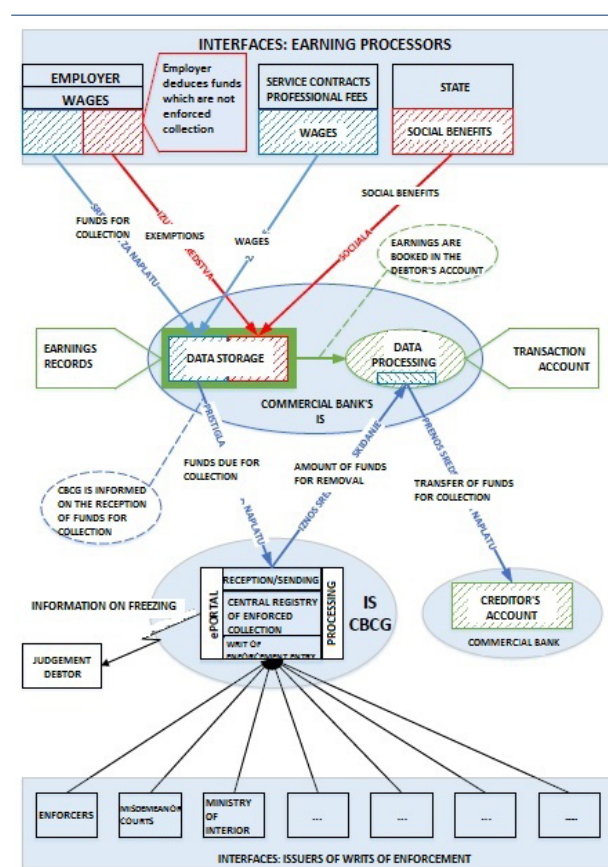
Figure 2. *Uniform system of enforced collection from natural persons*

The enforced collection at the accounts of natural persons would be realized in the following steps:

1. Upon the receipt of a writ of enforcement, and after the examination, the CBM would forward a message to all banks requiring the freezing of transaction accounts of the debtors. The same message would prohibit the opening of transaction account by the debtor with commercial banks where the debtor does not have a transaction account.

Note: The term "freezing" of transaction account of a natural person as a judgment debtor means that the enforced collection is executed over that transaction account. Judgment debtor remains free to dispose of the funds that are exempt from the enforced collection. Based on this information, the commercial bank would know that the CBM should submit data on inflows of funds available for the enforced collection for that judgment debtor.

2. After obtaining the confirmation on account freezing, the CBM would receive information from banks on the funds available for the enforced collection. A commercial bank would calculate this amount in relation to the current situation, based on defined legislator's norms.

3. After collecting information from all commercial banks on available funds at the transaction accounts (funds held at the account) for the enforced collection, the CBM would send a message to individual banks with an order for transfer of funds from the transaction account of judgment debtor to the judgment creditor's account. The remaining funds at the transaction account would be at the disposal of the judgment debtor.

4. If the execution of enforced collection could not be fully implemented due to the lack of funds, the judgment debtor's transaction account would remain under the enforced collection - frozen account. In this case, the IS CBM would wait for a message from the commercial bank on the inflow of funds available for the enforced collection. In accordance with registered funds, the commercial bank would submit to the CBM the amount of funds available for the enforced collection. At the same time, the commercial bank would register total amount of funds at the transaction account of the debtor.

   Note: Should time period in which funds are registered at the transaction account of the judgement debtor until their removal, on the basis of received message from the CBM, is long enough for the judgment debtor to withdraw them (upon completion of daily work of the IS PNFL or on Saturdays), the commercial bank should reserve these funds.

5. On the basis of the information on the amount of funds at the account that are available for the enforced collection, the CBM (in accordance with the remaining debt) would recalculate and send to a commercial bank a message on the amount of funds for the removal from the judgment debtor's transaction account. The process is repeated until full payment to the judgment creditor.

6. After entirely realized payment, the CBM would send a message to all commercial banks on unfreezing of the transaction accounts.

7. Any creditor and debtor could get at any time the information on the balance of the enforced collection that is in progress via the e-portal, and an overview of the previous enforced collections.

4. CONCLUSION

This project design represents the basis for building the IS PNFL and provides guidelines for possible amendments to the Law on Enforcement and Securing of Claims. Lessons learned in the IS PNPL implementation and management were the basis for its development. This project design provides for, with the use of the existing hardware, communication, system and application infrastructure in a fast an efficient and relatively inexpensive way, the planning and organizing of the enforced collection of natural persons' monetary assets in Montenegro.

It is obvious that this proposal for a project design consists of a multitude of processes, interfaces, flows and data warehouses. The specification is complete and clear.

Centralized coverage of all writs of enforcement, regardless of the issuer, and the levy of the enforcement at transaction accounts of the judgment debtor in commercial banks, make the system efficient and effective. In this way the enforcement costs would be reduced to a minimum, the process would be secure and transparent and all entities, participants in the process, would be professionally satisfied. Also, all the elements of social policy would be protected.

In the event that the legislator accepts this proposal, laws and enabling regulations should define the handling of the initial funds *i.e.* funds held at the transaction account at the time of freezing. Also, all disputable situations should be solved as well as issues related to time deposits, alimony, enforcement against wages that the employer transfers from abroad, and the like.

Also, the CBM should amend the "Instruction on detailed manner of levying the enforcement against monetary assets at the account of judgement debtor" and "Decision on establishing electronic messages for the enforced collection" which defines in more detail the specifications and rules for data exchange between:

- Writ of enforcement issuer and the CBM (electronic exchange of writs of enforcement),
- Employer and commercial bank (form for submitting data on earnings), and
- Commercial bank and the CBM (exchange of messages in the enforced collection proceedings).

Terms of Reference for the development of application should include the processing of the CBM e-portal with amended and new electronic services according to the needs of judgment debtors, issuers and other entities participating in the process of enforced collection.

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CHALLENGES OF MODERN ELECTRONIC BANKING

Zoran Jović[1],
Goran Ćorić[2],
Igor Pejović[3]

[2]Singidunum University
32 Danijelova Street, Belgrade, Serbia

[2]Raiffeisenbank
Belgrade, Serbia

[3]College of Economics and Administration,
Imotska 1, Belgrade, Serbia

Abstract:

Electronic banking as a set of different ways of performing financial transactions using information and telecommunication technology provides the benefits of temporal and spatial limitlessness, speed of transactions, low prices and a wide range of banking products and services. On the other hand, apart from obvious advantages, e-banking incorporates certain risks that need to be precisely identified and managed. This is the reason why the Basel Committee on Banking Supervision established a task group called EBG (Electronic Banking Group) that consists of banking supervisors and central banks. The group has come to a conclusion that electronic banking impacts some of the traditional risks, modifying and augmenting them, this primarily referring to strategic, operational and reputational risks. Specific challenges of e-banking services relate to rapid changes, increased dependence on the design and system, the trend toward unregulated outsourcing and heightened importance of security controls. The principles of risk management in traditional banking are applicable to e-banking activities, but the complexities of the Internet dictate that the application of these principles be adjusted to on-line banking activities and related challenges. Because of rapid changes in technology, risk management principles of electronic banking are not given as mandatory requirements or strict regulations but as guidelines that express supervisory expectations, the aim being to ensure safety and stability of the financial system. Any rigidity in the regulation of e-banking may be counterproductive because such solutions would quickly become outdated due to a fast pace of technological change.

Key words:

e-banking, Internet, technology innovation, risk.

1. INTRODUCTION

One of the most important technological developments that has influenced the development of banking is electronic money, hence electronic banking. In today's world, money has become a piece of information which defines the right of an entity in relation to goods and services that are offered in society. Hence, the importance of an analysis of electronic banking channels, the mode of their operation, implementation and impact on the development of marketing and trade. The development of information technology has created conditions for the development of electronic banking which, by means of its wide distribution network, allows banks to offer their clients market-segmented banking processes and integrated packages of financial services targeted at certain segments of financial markets. Although banks initially had an aversion towards novelties brought about by the Internet, they have come to realise that

Correspondence:

Zoran Jović

e-mail:
zjovic@singidunum.ac.rs

this is not a passing phenomenon, but rather a part of a very promising business reality. In accordance with the bankers' inherent way of thinking, while developing new Internet-based products and services known as e-banking products, banks have also been developing adequate systems of protection and security of their business operations within this segment. By conducting electronic banking operations on a daily basis, banks are exposed to the risk of unauthorised entry into the banking information system, thus allowing third parties to illegally access financial assets or confidential data at the expense of the bank and its clients. By employing adopted methods and principles of risk management, banks eliminate or reduce to an acceptable level the risks that bank clients are exposed to, such as deliberate identity theft or accidental omissions by bank employees.

2. CONTEMPORARY ELECTRONIC PAYMENT SYSTEMS

Electronic money is generated when a certain amount of real money is withdrawn from circulation and electronic money in the same amount is introduced. In this way electronic money systems become separate entities interacting with the environment through an intermediary that performs conversion and payment to this environment.

The general model of an electronic money system includes three distinct domains:

1. Accounting-clearing domain,

2. Emission-operational domain,

3. Retail domain.

In the accounting-clearing domain, financial institutions, clearing banks and central banks perform interbank financial obligations. In the emission-operational domain, a structure for emission and acquisition of electronic value is established. In the retail domain, actual transfers of values between users, such as transfer, payment and deposit, are performed.

The electronic money system consists of several important elements that define its nature - security, anonymity, portability, two-way operation, possibility of off-line operations, and unlimited duration.

An expansion in the use of electronic money is closely linked with the development of electronic banking channels. The main channels of electronic banking are payment cards, ATM machines, POS terminals, mobile commerce, electronic data exchange system and micro-payment systems.

Payment cards are one of the most massively used means of electronic banking. In addition to being used as a means of payment for goods and services, cash withdrawals and electronic payments, they offer the convenience of currency conversion. In this way a client can make a payment in any country regardless of the currency of payment, and their account is charged with the transaction in domestic currency. Rapid development of payment cards and the ensuing substantial financial potential led to the creation of large international credit card franchise chains such as Visa, MasterCard, Diners Card, American Express.

ATMs are computerised telecommunication devices that allow clients to perform financial transactions in a public place without the presence of a bank official. They are classified as cash dispenser devices, info ATMs, ATMs for currency exchange operations, cash machines for payment of bills, cash machines for sale of value, and multifunctional ATMs. In terms of location, they can be installed at the bank entrance - the lobby, bank counter halls - indoors, or at entrances to public institutions and at busy public spaces - outdoors. ATMs can be linked to the bank's system in several ways: using a dial - up modem on the telephone line, using a VSAT line - satellite connection or via a leased line - GPRS.

The development of electronic payments and a growing number of clients who wish to make a payment using plastic cards force merchants to install POS terminals. It would be ideal if merchants could accept all cards but numerous complicated administrative procedures created by card organisations through authorised banks, sometimes multiply the number of different POS terminals at a merchant's. All POS terminals in the possession of a merchant are connected to the bank's network or processor and form the so-called banking trade network. Transactions that are carried out on these terminals go to the central system from where they are dispatched to the host bank or processor.

Mobile commerce understands any money transaction which is done via a network of mobile communications. Mobile technology allows purchase and payment of various goods and services, banking transactions, access to paid content and information from any place and at any time. Mobile services have experienced rapid development prompted by the mass character of mobile telephony market, the rapid development of the Internet and e-commerce, development of equipment and devices for mobile phones, the possibilities of authentication and authorization, and new principles of billing services. Mobile operations are carried out on the basis

of close cooperation between mobile operators, financial institutions and companies that issue debit cards. The advantages of using mobile phones when performing banking transactions that clients avail of are personal independence, easy to use, mobility and security. Problems in mobile business relate to profitability, legislation and various technical, health and social issues. Currently, mobile business has got no critical mass of users to become a standard in the market, but new mobile payment services are being further developed and improved.

The electronic data exchange system links business information systems and standardises electronic data exchange in order to overcome shortcomings of operations based on standard documentation. With the aim of reducing or eliminating errors in communication between business partners, EDI - electronic data interchange is used. It increases productivity and efficiency of operations and eliminates delays and mistakes that may occur in the process of exchanging paper documentation.

EDI is used for the exchange of documents such as purchase orders, invoices, receipts, forwarding supporting documents. All documents are in electronic and can be easily sent and received. This dispenses with delays that may occur as a result of forwarding paper documents, copying and multiplication. Since the process is automated, the cost of creating and sending documents is much lower.[1] The field of electronic data interchange (EDI) was standardised by a set of standards commonly known as EDIFACT - Electronic Data Interchange for Administrations, Commerce and Transport, which were introduced in order to facilitate and accelerate the flow of goods and services on the international level.

Micropayments are low-value electronic payments that are specially designed for e-commerce on the Internet, primarily for the purchase of goods and services worth a few dollars to a few cents or less (parking, transport, telephone, drinks, copying Internet content, lottery, gambling, *etc.*). A micropayment is a substitute for coins as it is inexpensive, e-mobile, easier to count, check and verify. A small number of operational micropayment systems have been created so far, the best-known ones being Millicent, Syber Coin and Net Bill.[2] Millicent provides anonymity when making payments. The customer purchases a card that is similar to a telephone card, exchanges the money with the broker and

makes a payment, while the seller collects the amount and exchanges it for money. Syber Coin system is based on the accounting transfer of the corresponding amount. Money is transferred from the user's temporary account to the seller's temporary account, which have been opened in the SyberCash bank for that particular purpose. NetBill is a micropayment system which is designed to act as a third party whose responsibility is to verify authenticity, manage accounts, process transactions, bill and inform clients and users in the network.

Two concepts of digital money have been introduced so far: the centralized concept (PayPal, Stripe, Web-Money, Payoneer) where operators sell their electronic currency directly to the end user and is used mostly for online transactions; and the non-centralized concept (Bitcoin, Litecoin) which is based on the monetary system within the network.[3]

3. RISK MANAGEMENT IN E-BANKING

An increase in the number of clients using electronic banking services via the Internet, an expanded range of electronic goods and services that banks offer and an increase in the number of transactions renders banks vulnerable to risks in their daily operations and to an increase in the number of fraud cases and perpetrators - cyber-criminals.

Security in business operations via the Network must be the main business principle governing bank's operations and services[4]. Although nowadays there are many highly reliable systems and mechanisms for the protection against Internet banking fraud and robbery, none of them can fully protect the bank and its clients.

Operational, legal and reputational risks are the most important risk categories for the majority of operations in electronic banking involving electronic money. Many practical problems are regarded as borderline cases in the risk categories. Security breaches and unauthorised access to client information can be classified as operational risk but at the same time it can be regarded as legal and reputational risks. Since different types of risk can be generated from one problem, risk management may require different approaches to managing each of these risks separately.

1 Vasković V., Todorović M., E-poslovanje, Beogradska poslovna škola, Beograd, 2013, pp. 87.

2 Jović Z., Primena Interneta u savremenom bankarskom i berzanskom poslovanju, Međunarodna naučna konferencija Sinteza 2014, Zbornik radova, Beograd, 2014, pp. 183.

3 Jović Z., Primena Interneta u savremenom bankarskom i berzanskom poslovanju, Međunarodna naučna konferencija Sinteza 2014, Zbornik radova, Beograd, 2014, pp. 182.

4 Hadžić M., Bankarstvo, Univerzitet Singidunum, Beograd, 2011, pp. 52.

Operational risk is the risk of loss due to significant deficiencies in system reliability or integrity. Security considerations are paramount as banks may be subject to external or internal attacks. Operational risk can also arise from misuse on the part of a client, as well as from an inadequately designed or implemented electronic banking system. Many of these specific potential risks apply to both electronic banking and electronic money.[5]

Operational risk can be related to security risks; design, implementation and maintenance of the system; misuse of products and services by the buyer. Security risk in electronic banking relates to the detection and prevention of counterfeiting. A breach of security via the Internet may incur fake liabilities and losses on the part of the bank and specific problems pertaining to access and authentication may occur. A hacker breaks into a bank's system via the Internet, downloads and uses confidential client information and introduces viruses into the bank's computer system. Besides external attacks, banks are also exposed to internal operational risk which can be a case of deliberate fraud or misuse by employees or their unintentional mistakes. Both cases can compromise the bank's system. Operational risks include the risk of counterfeiting of electronic money.

Operational risks also arise when the bank chooses a system that is not well designed, implemented or maintained, and as such, causes cessation or slowing down of the existing system. Some banks opt for outsourcing and engage service providers and external experts to carry out certain tasks, which potentially renders the bank even more vulnerable to operational risks if the providers do not have the necessary expertise to provide the relevant service or update their technology in a timely manner. Intentional or unintentional misuse of products and services by clients is also a source of operational risk. Clients who use personal information such as authentication information, credit card numbers and bank account numbers in unsafe electronic transactions could allow criminals to access their computer, this possibly incurring financial losses on the part of the bank due to transactions that the client did not approve or for reasons of money laundering.

Reputational risk is the risk of loss due to negative publicity tarnishing the bank's reputation and causing revenue reductions or a decline in the customer base and may arise when systems or products are not as efficient as expected, when security breaches occur as a result of external or internal attacks on the bank's system, or due to errors, fraud and malfeasance by third parties or targeted attacks on the bank. Reputational risk is of significance not only to one particular bank but to the banking system as a whole. The bank which has suffered significant reputational harm in connection with electronic banking compromises the safety of the systems of other banks, this possibly causing systemic disruptions in the whole of the banking system.

Legal risk occurs due to violation or non-compliance with laws, rules, regulations, and when legal rights and obligations of the parties performing a transaction have not been clearly established. Due to a large number of innovations in e-banking, rights and obligations of the parties in these transactions can be uncertain. Application of regulations to prevent money laundering may not be appropriate for some forms of electronic payment, while too liberal a system may attract money launderers. E-banking carries the legal risk of disclosure of client's confidential data and the issue of privacy protection, which in some countries may make the bank subject to regulatory sanctions. Digital certificates affect the safety of banking operations and can expose the bank to legal risk as well.

Risk management consists of three basic elements: risk assessment, risk control and risk monitoring.

It is essential that banks have comprehensive risk management that is subject to appropriate supervision by a board of directors and senior management. As soon as new risks in electronic banking are identified and assessed, the board and senior management must be informed about the changes, so as to be able to perform appropriate appraisal and introduce measures of control, as well as monitoring any risks that may arise from the proposed activities.[6]

Challenges in e-banking risk management relate to the pace of technological change and changes in customer service. In the past new banking applications were implemented following a relatively long period of in-depth testing. Today, banks are pressured by fierce competition into launching new business applications in a very short period of time, usually only a few months from concept to realisation. This only intensifies the challenge that the bank faces and that is to do everything in their power to establish security procedures, carry out a strategic assessment, and perform risk and security analyses.

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5   Risk Management for Electronic Banking and Electronic Money Activities, Basel Committee on Banking Supervision, Basel, March 1998, pp. 5.

6   Risk Management for Electronic Banking and Electronic Money Activities, Basel Committee on Banking Supervision, Basel, March 1998, pp. 10.

Challenges are also set by transactional e-banking web sites and associated retail and wholesale business applications that are substantially integrated. And, although the system of this kind reduces the chance of human error and fraud, it increases the dependence on the system design and architecture, as well as its operability.

Challenges of modern electronic banking also lie in increased dependence of banks on information technology which enhances technological complexity of numerous operational and safety issues and forces banks to form partnerships, alliances and engage in outsourcing although many of these fields are unregulated. The result is the creation of new business models that, besides banks, engage non-bank entities such as Internet services, telecommunication companies and other technology companies.

The Internet is ubiquitous and global by nature. It is an open, highly accessible network used by unknown parties routing messages by means of unknown locations and via fast evolving wireless devices. This considerably enhances the importance of security controls, customer authentication techniques, data protection, audit trail procedures, and customer privacy standards.[7]

In defining the principles of risk management, the Basel Committee deemed that it is the duty of the Board of Directors and senior management of banks to take steps to ensure that their institutions are reviewed, and that their existing risk management policies and procedures cover all current or planned activities of e-banking. The Basel Committee asked the EBG to identify key risk management principles which would help banks to expand risk monitoring so as to cover all their e-banking activities. This was the basis on which principles of risk management in electronic banking were created. They were not presented as absolute requirements or as 'best practice', but as guidelines for the promotion of safe electronic banking. The Basel Committee maintained that further detailing requirements for risk management in the field of e-banking could be counterproductive because these would probably soon become obsolete due to a fast pace of technological change. That is the reason why these principles do not represent strict regulations but only express supervisory expectations striving to ensure security and stability of the financial system.

The Committee recognizes that banks have to develop risk management procedures appropriate for their individual risk profile, operational structure and corporate culture governance and do so in conformity with specific risk management requirements and policies set forth by bank supervisors in their particular jurisdiction(s).[8]

This means that it is recognised that every bank's risk profile is different and that the presence of electronic banking, material risks, willingness and ability of the bank to manage these risks varies from case to case and that it is expected that the principles of risk management in e-banking are used as tools by national supervisors and that they should reflect specific national requirements where necessary in order to promote safe and secure e-banking activities and operations.

The principles of risk management in e-banking can be divided into three broad categories:

- Board and Management Oversight
- Security Control
- Legal and Reputational Risk Management

Board and Management Oversight shall make sure that e-banking plans are clearly integrated into strategic objectives; that a risk analysis of proposed e-banking activities is carried out; that appropriate processes are established to reduce the risk and monitor identified risks; and that electronic banking results are assessed. This category includes the following principles of risk management in e-banking:

- Effective management supervision of e-banking activities,
- Establishment of a comprehensive process of security control,
- Comprehensive analysis and monitoring of outsourcing relations.

Security Control should be given special attention because of security challenges posed by e-banking. In this category, the following principles are of particular importance:

- Authentication of e-banking customers,
- Non-repudiation and accountability for e-banking transactions,
- Data integrity of e-banking transactions, records and information,
- Appropriate measures to ensure segregation of duties,
- Proper authorisation controls within e-banking systems, databases and applications,
- Establishment of clear audit trails for e-banking transactions,
- Confidentiality of key bank information.

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7 Risk Management Principles for Electronic Banking, Basel Committee on Banking Supervision, July 2003, pp.5-6.

8 Risk Management Principles for Electronic Banking, Basel Committee on Banking Supervision, July 2003, pp.6.

Management of legal and reputational risks pressurises banks into taking responsibility to provide their clients with a level of comfort regarding information disclosure and client data protection. This category includes the following principles of risk management in e-banking:

- Appropriate disclosure of electronic banking services,
- Privacy of customer information,
- Capacity, business continuity and contingency planning to ensure availability of e-banking systems and services,
- Incident response planning.

4. CONCLUSION

Embracing the Internet across the world as a channel through which banking products and services are delivered provides new business opportunities for banks and secures benefits for their clients. Continual technological innovations have made it possible for electronic banking to be incorporated in traditional banking activities such as accessing financial information, taking out loans and opening deposit accounts, as well as relatively new banking products and services such as electronic bill payment services, personalized „financial portals" and business-to-business market places and exchanges.

As banking operations evolve, so do the risks involved. There is no safe bank that is so infallible that cannot experience a downfall. Banks can only accept, avoid or protect themselves from potential risks.

Although considerable means are being invested to fight cyber-crime, an increase in the number of services provided by banks and other financial institutions causes a considerable rise in the number of users of electronic services who, owing to the poor level of their education, are easy prey for much better organised cyber criminals. At present, the existing systems and mecha-nisms provide a high level of protection against online banking fraud and robbery, but none of them can fully protect the bank and its clients. However, the safety of operations via the network must be the key principle every bank shall abide by and shape their service palette accordingly.

Such growth prompted the Basel Committee on Banking Supervision to conduct a preliminary study of e-banking and e-money risks. The study showed an apparent need for more work to be done in the field of e-banking risks. This mission was entrusted with the working group EBG (Electronic banking group) consisting of banking supervisors and central banks. The report by the working group contains a list and assessment of major risks associated with e-banking, primarily strategic risk, reputational risk and operational risk, including internal security and legal risks. It states that e-banking activities do not incur risks which have not already been identified as traditional risks, but modifies and affects the overall risk profile. This means that strategic risk, operational risk and reputational risk are heightened by rapid introduction of e-banking activities.

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THE ROLE OF MOBILE BANKING IN SERBIA

Tijana Radojević[1],
Danica Rajin[2],
Vladimir Džamić[1],
Dalibor Radovanović[1]

[2]Singidunum University
32 Danijelova Street, Belgrade, Serbia

[2] Singidunum University
Faculty of Economics, Finance and
Administration - FEFA
Belgrade, Serbia

Abstract:

The aim of this paper is to provide the current situation of mobile banking implementation in Serbia. M-banking has changed the traditional business model which users are practiced in the use of banking services in the traditional manner. Mobile banking has allowed an increase in the number of existing distribution channels that banks used to offer their services. Following the tendencies of development of new services, banks in Serbia are increasingly opting to offer their banking services via mobile phones. Based on the analysis conducted herein, we find that 70% of banks that are operating in the banking system offers its clients m-banking services. Services are offered with much lower commission than traditional banking, thus leading to the dramatic increase in m-banking users in the last three years. Mobile banking plays the central role in the future of banking development.

Key words:

m-banking, banking services, mobile devices.

1. INTRODUCTION

Traditional banking is increasingly replaced by electronic banking, which is gaining in importance and a growing number of users. During the last decade, mobile banking was developed as a special form of electronic banking. Mobile banking offers great opportunities and has prospects for further development, especially if we know that the number of mobile phone users is constantly growing, and that phones are increasingly improved and can perform almost the same operations as computers. Contemporary information technologies have allowed banks to enable the production and delivery of financial services in cases where they are separated into different jobs. This means that banks can sell and manage services offered by other banks (often foreign) in order to increase their income.

2. DEVELOPMENT OF E-BANKING

Mobile banking is defined as carrying out banking operations with the help of mobile devices such as mobile phones or PDA - Personal digital Assistant (Rajnish and Buse, 2007). Mobile banking allows its clients to perform various transactions using portable computers, personal digital assistants (PDAs) and mobile phones.

Correspondence:

Tijana Radojević

e-mail:

tradojevic@singidunum.ac.rs

Every client in the bank has a need to have a concrete insight into the state of its account and wants to manage its funds. A few decades ago, such information was collected in the traditional way, by going to the bank counters or by telephoning the appropriate branch (Laukkanen and Pasanen, 2008). This mode of operation would require spending time and money. The solution which exceeded this traditional way was first found in e-banking, and then with the use of mobile phones, in m-banking (Sander, 2014). Mobile user is able to access the Internet through their bank or another financial institution that performs the necessary transaction (Guraău, 2002).

The first bank that began to offer services in the form of m-banking was MeritaNorthBanken in 1992. Seven years later, about 90% of banks in Europe had to offer some form of mobile banking (Rajnish and Buse, 2007).

3. TYPES OF MOBILE BANKING

The provision of banking services in mobile business is based on the two major software platforms:

1. SMS services
2. Applications that were developed as separate software programs installed on mobile phones.

SMS services

An organization that provides services (bank, partner - outsource) develops SMS portal that provides users with the ability to develop the use of this service. The desired information can be obtained on request, or at a certain time, so that this type of communication supports the push and pull models of business (Puschel *et al*, 2010). Pull technology is one in which the client initiates communications using their phone to call the gateway and thus requiring specific data, which are attracted to the application server to the mobile phone. In the latter, push technology, application server has more control over the mobile phone, and he makes the decision when to send data to the mobile phone. In this case, the previous request is not required. Any user who is interested in obtaining information about his/her account on this way, first should fill out the application in the bank in which report the bank about account number and number of mobile phone. The moment when the service is activated, the client is able to:

- to check the status of his account at the request, daily or after impact

- report on the execution of transactions related to payments
- see the exchange rate, *etc.*

Wireless Application Protocol (WAP)

WAP banking has appeared after the SMS banking with the development of WAP standard that enabled connection with the Internet via mobile phones. This means that the bank's clients can access to their bank account by using mobile phone via the Internet access. Some authors under the term of mobile banking refers exclusively WAP banking, while SMS banking classified as a special banking services. The connection with the bank is realized through mobile phone that has a built-in WAP device. The user must have a mobile phone that supports WAP in order that he could use WAP services of any bank. Thereby, the user pays only for the traffic generated to mobile network operator. Therefore, WAP banking involves access to banking services directly through mobile Internet or indirectly via specially installed applications in the mobile phone through which it connects to the mobile Internet.

After completing the registration, the user via SMS received confirmation of registration services, PIN and user manual. This mobile payment system is extremely easy to use and safe because the transaction is authorizes with personal PIN. The user via the mobile phone connects to the Internet and has an application that lets a user select a certain bank services (for example, reviewing account balances, making payments, a review of receipts and payments on all accounts, term deposits, insight into the exchange list, use the services of currency calculators, *etc.*).

Although WAP banking has so far not yielded the expected results on the global level, it is expected that with the development and simplification of applications that are directed to the end user and adapted to its real needs, there should be a greater number of users who use this type of banking services (Yang, 2009).

4. ADJUSTING THE BASIC REQUIREMENTS OF TARGET GROUPS

Nowadays, banks are more and more faced with technologically literate customers. Today's customers want to organize banking transactions while they are in the motion, regardless of the working hours (Yu, 2012). Banks have been able to react to these changes by introducing mobile services.

The key target group of mobile banking can be divided into three categories:

1) Young: segment aged 14-18 years has gained an important role in the growth of mobile telecommunications and related services. This group is recognized as the one that prevails technological achievements and is ready to experiment with innovative products and services. Young people are often on the move and require a service that is ubiquitous at any time. Although they are young, as a group and they could hardly be relevant for banks from a financial perspective, they represent a potential client and should bee nurtured as clients in the long-term marketing strategy of banks.

2) Adults: this segment refers to a group of young people, adults and students and trainees, as a segment which is usually marked as "onliners". Also, it is believed that this segment domineer of technological innovation. Although this group is not financially very strong, many of its members are already involved in stock market activity and many have now started professional career, therefore, it is necessary that this consumer segment be cultivated.

3) Business people: This group of users, which mainly covers the age group of 25-36 years, is considered the most important for mobile banking. Members of this group are generally well-educated and economically well-off customers. They need to be frequently on the move for professional reasons. Therefore, they carry mobile devices with them in order to provide them access to the provision of m-business services. For this reason, they are ideal candidates for using the services that can be offered via mobile devices.

In order to recruit new groups of client's banks tend to show mobile banking as an option that promises (Riquelme and Rios, 2010). However, these services represent additional features for the target user or group, also have their usefulness for banks.

5. MOBILE BANKING AND SERBIA

In Serbia, about 80% of population uses mobile phones of new generation, from whom about 30% are using smart phones that allow the use of mobile banking. In recent years, banks in Serbia are increasingly determined to offer their banking services through mobile devices.

According to the data of the National Bank of Serbia (NBS, 2016), the number of mobile banking users is increasing constantly. In Serbia, in 2013 the total number of mobile banking users was 97 150, while in 2015 that number increased to 464 167.
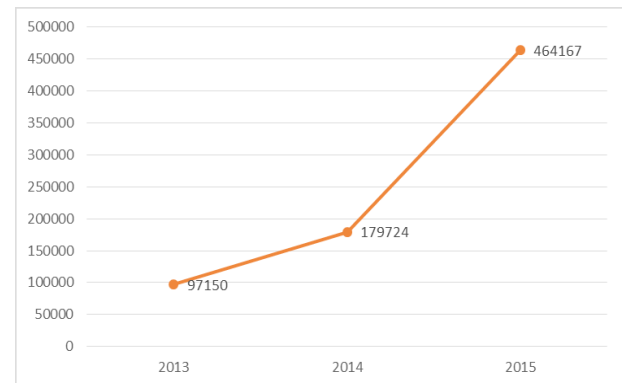
Figure 1. The number of mobile banking users in Serbia.

In Serbia, out of 30 banks operating in the financial system in 2016, 21 provide mobile banking services.

The first bank to introduce mobile banking in Serbia was Banca Intesa through Intesa Mobi application. This application allows customers that via their mobile phone quickly, easily and safely complete a payment whenever and wherever the customer wants, and without commissions. In 2014, there was a growth of 114% in the number of active users of Intesa Mobi application compared to the year 2013.

Commercial Bank offers its clients mBank service that allows performing all types of non-cash transactions without commission, internal transfers of funds from one account to another, repayment of the payment cards, as well as exchange operations, purchase and sale of foreign currency. The novelty of this service is that it is completely independent of the mobile operator and the network that the client uses.

Credit Agricole bank applications mBank is available for users of mobile phones with Android OS, while new m-banking services of UniCredit Bank provides full control over finances via mobile phone. Customers can pay on the move, quickly and safely, without limitation, access to the account 24 hours, 7 days a week.

ProCredit Bank has developed mBankar application that allows clients to perform various services via

mobile phone. Societe Generale Bank has developed m-banking application that is part of the Premium version of e-banking. It is currently available for Android, iOS and Windows operating systems, and in the future it will be versions for Symbian and BlackBerry.

Hypo Alpe Adria bank allows the use of mobile banking via Hypo M-banking applications, which is a convenient and fast way of doing banking transactions using mobile phones including all Android and iOS devices.

Raiffeisen Bank offers a new mobile banking application which meets the highest safety standards in electronic banking provided the use of tokens.

Erste Bank has gone a step further and offers their customers the Erste mBanking application "Take and pay". This option allows their clients to pay bills with just a few simple clicks without rewriting data from slips.

MobiBank PŠ is a service of the Postal Savings Bank which allows customers to regulate their obligations, regular monthly bills for different services for a fee up to four times less than at the counters. To start MobiBankPŠ services PIN is required.

The application for mobile banking of AIK Bank allows a quick, easy and safe way in which customers can monitor changes in the accounts, as well as to perform various transactions using mobile phones. Alpha Bank also provides services Alpha Mobile Banking through financial transactions via mobile devices at any time and from any location. Eurobank Serbia has developed m-Banking application that allows their clients the first 10 transactions to perform without commission each month. Jubmes mBank is an application of Jubmes bank that offers its customers a 50% lower commission than clients will pay at the bank counter.

NLB mKlik is an application of NLB bank that provides bill payment without limitation to minimum commission. OTP bank enables the use of m-banking application through an activation code which can be obtained at any branch of OTP Bank, then choose a unique PIN code, which is used for future application. Piraeus Bank has developed Winbank mobile application for Android phones. Winbank m-banking is a unique service Piraeus Bank Belgrade, which allows its users to quickly and easily perform all types of banking transactions through mobile phones. Sberbank has placed its m-banking application that lets payments at a lower fee than at bank counters. Application supports all mobile devices with Android or iOS operating system. Serbian bank has included in its offer highly innovative and advanced payment service via mobile

phone - mBank. The service allows users to pay bills with a significantly lower fee than at the bank counter. Vojvodjanska bank has developed an application mBank for their clients. Access to all the financial data and functionality of the application is available through m-pin known only to the user.

Great expansion in the spread of mobile banking in Serbia we have since 2013 when Telenor acquired 100 percent of the KBC Bank shares with a view to offer the citizens of Serbia Telenor bank - modern and innovative mobile financial services. Telenor bank is the first bank in the region, in which the banking is completely different - completely mobile. According to the mobile application Telenor Bank (Android and iOS), the whole bank is stored in the mobile phone.

Nowadays, experts predict even stronger expansion of mobile banking in the coming years due to fact that the number of mobile phone users greatly exceeds the number of Internet users.

6. CONCLUSION

Mobile banking is an opportunity for banks to retain their existing customer base which are based on smart technology, offering added value by providing innovative services. Mobile banking can actually help to attract new customers who were unable to obtain the services offered to its current product portfolio of banks. Undoubtedly, mobile banking is an opportunity to create additional income for the bank. His main contribution, however, can be expected in the strategic field. Mobile banking has the chance to become the instrument of differentiation.

Mobile banking in Serbia is developing along with modern technologies and trends in the world and allows its customers access to new ways of using banking services. Based on the conducted comparative analysis that we have done in this paper, we can conclude that the offer in the field of m-banking has a lot of progress. In a very short period of time, offer of mobile banking services has expanded dramatically and the number of clients has increased considerably. Clients via their mobile phones can perform almost all services that can be performed in the bank branch. Customer support by banks in using this application significantly increases customer satisfaction and confidence in the bank that offers mobile banking service.

Mobile banking has the potential, which could become one of the widespread and accepted applications in the field of mobile commerce.

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E - BANKING

CURRENT ISSUES AND COMPARATIVE ANALYSIS OF MOBILE BANKING IN SERBIA

Lidija Barjaktarović[1],
Angelina Njeguš[1],
Sonja Đurović[2]

[1]Singidunum University
32 Danijelova Street, Belgrade, Serbia

[2]Telenor bank,
Belgrade, Serbia

Abstract:

The goal of the paper is to determine the level of mobile banking development in Serbia through a comparative analysis of mobile banking services offered by the leading banks in Serbia. A criterion for the selection of the banks was the success in implementation of alternative channel management products (ACMP), and the highest profit on the basis of ACMP and total assets. The sample consists of nine leading Serbian banks in ACMP. Moreover, the subject of the analysis were the main issues, threats, and technology bases of mobile banking. Finally, the paper also considers the architecture of m-banking solution developed for the first digital bank owned by mobile operator.

Key words:

mobile banking, comparative analysis, mobile technology, mobile application, Serbian banks.

1. INTRODUCTION

The development of electronic banking services, smart phones, wireless communication networks, mobile applications and technologies have influenced the emergence of mobile banking. Due to an increasing number of mobile-cellular subscribers, around 7 billion in 2015 (Figure 1), mobile banking has become a key strategy for development and improvement of banking services.

The evolution of the Internet into the Internet of Things (IoT), the emergence of the big data analytic systems, the development of new information and internet technologies, as well as the change of users' awareness, affects banking business that needs to adapt to new trends and requirements. In order to keep up with those trends, banks are constantly working on process innovation, improvements of service efficiency, and personalization of the services that meet the finest demands of their clients. Mobile banking is an ideal way to introduce the aforementioned innovations, especially personalised banking. Through mobile banking, clients can save their time and money, have high qualitative and customized services in any time, and from any location (anywhere banking). Therefore, banks can further expand their offering to provide better services to their clients.

Correspondence:
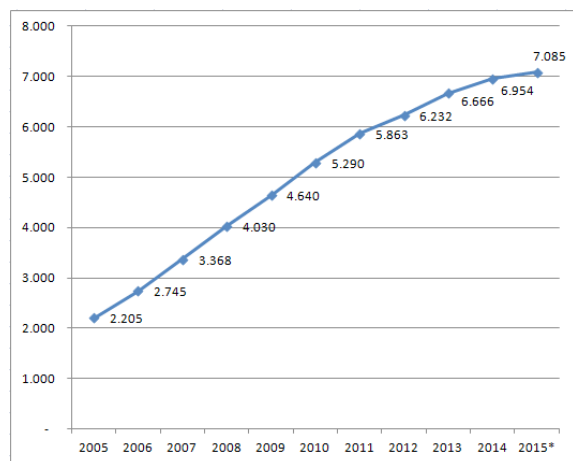
Angelina Njeguš

e-mail:

anjegus@singidunum.ac.rs

Figure 1. Mobile-cellular telephone subsriptions in the World (in millions) (ITU, 2015)

The aim of this paper is to determine the level of mobile banking development in Serbia through comparative analysis of mobile banking services offered by the leading Serbian banks. Criteria for the selection of the banks were the success in m-banking implementation, and the highest profit and total assets. The sample consists of the following nine Serbian banks: Banca Intesa, Komercijalna bank, UniCredit bank, Raiffeisen bank, Societe Generale bank, ProCredit bank, Erste bank, Telenor bank and OTP. The research is conducted during January 2016. The key research questions of this study are:

RQ1: How many banks in Serbia implement new m-banking services?

RQ2: What are the main issues in introducing m-banking solutions?

RQ3: Which bank offers a wider range of m-banking services?

RQ4: Which technologies are behind these solutions?

The structure of this paper is divided into three parts. The first part discusses mobile banking issues, and underlying technology. The second part represents the current state of mobile banking in Serbia, the comparative analysis of m-banking services by Serbian banks, and technical background of analyzed mobile applications. In the final part, the main conclusions of this research are given.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

In order to cope with the existing challenges such as competition, technology, security, costs, and customers, banks should act on improving their services, innovate processes, redesign existing platforms or creating new

ones, and analyzing customer behavior, their requirements, and desires. One solution is implementation of mobile banking. According to the Javelin Strategy & Research report, with mobile banking financial institutions can decrease costs, retain the existing and attract new customers using mobile banking. The can also become a market leader with technology and be more competitive (Van Dyke, 2015) (Federal Reserve Bank of Boston, 2013).

Mobile banking (m-banking) operates outside the confines of traditional infrastructures (such as physical branches, ATM's and so on) and provide access to banking services and execution of financial transactions using mobile devices (Ledgerwood *et al*, 2013) (Nicoletti, 2014). With m-banking client can perform individual and business banking and manage loans. M-banking services can be divided into three groups, as follows:

- Banking services (such as checking account balance, view transactions)
- Payment services (such as Bill payments, Virtual wallet)
- Value added services (such as Social media banking, Personal financial management, Biometric apps and security features, Cloud storage, Cross-selling and marketing)

According to the SANS Institute research, the most used m-banking services are: check an account balance or recent transactions (90%), transfer money between two accounts (42%), and made a bill payment (26%) (Pegueros, 2012). The latest generation of mobile phones, and 4G (IMT-Advanced) mobile communication system enable better availability of data, and the new range of services (such as voice mail, audio-video conferencing).

Mobile banking issues

M-banking brings new opportunities as well as risks. Among major concerns are security and confidentiality of information while performing financial transactions on mobile devices. Other reasons for not using mobile banking are: mobile phone screen is too small (39%), lack of feature in the mobile phone (37%), do not trust the technology (34%), do not have a smart phone (32%), lack of knowledge about mobile payment options (31%), difficult and time consuming to set up or use mobile payments (31%), lack of option at shopping places (23%) and other (KPMG, 2015). The major threats of mobile banking can be classified into three main categories: broad threats, phone/handset threats, and online/internet threats (Table 1).

Broad threats	Handset threats	Internet threats
– Unauthorized access	– Memorycards	– Mobile email
– Malicious applications	– Downloads	– Sms
– Cross platform malware	– Mobile browsers	– Mobile instant messaging
– Mobile viruses	– Smart card	– Voice
– Wireless carrier infrastructure	– Mobile applications	– Online games
– Unsecured WiFi	– Hardware and OS	– Online free applicatons

Table 1. M-banking threats (Islam, 2014) (SANS, 2012).

Besides customers, banks are also affected by m-banking risks. Clients usually save either their password, personal data, or payment receipt on mobile phone, so due to theft of mobile device, or virus infection, hacker can easily get this information. The most secure way for banks is not to send sensitive data to the handset or to delete it at the end of each session. In case that sensitive data are stored into the mobile phone, data encryption should be provided. However, banks should implement the appropriate privacy, and security governance programs. ISACA's Business Model for Information Security can address the context and protection of mobile payment data. The COBIT and Risk IT frameworks provide useful approaches for banks to ensure that an effective risk control mitigation process is established (ISACA, 2011).

Technological basis of mobile banking

Architecture of a modern m-banking system should be based on the standards and contemporary achievements in the development of mobile networks, technologies and applications. According to the smart phone vendor market share in 2015 (IDC, 2015), most clients are equipped with Samsung mobile phones (with a 21.4% share), and then with Apple iPhone (with 47.5 million units shipped, and a 13.9% share). Android operating system still dominates the market with an 82.8% share in 2015.

Broadband communication is fundamental for the entire economy (Kumar *et al*, 2011). Today, among the hierarchy of human needs, behind food/water and shelter is voice and data connectedness i.e Internet/Mobile

phone (Meeker, 2011). To support the ever growing mobile users, and increasing demands for high data rates, ITU (International Telecommunication Union) has provided the International Mobile Telecommunication (IMT) Advanced standard for 4G generation mobile network. This network enables seamless connectivity, mobile communication within heterogeneous networks (PSTN, LAN, 3G, WiMAX, sensor network, and other), high data rates, high quality mobile services, user-friendly applications and so on. However, the next generation of mobile networks is coming, called 5G. It is defined as an end-to-end ecosystem that will enable a fully mobile and connected society. The 5G network relies on Cloud RAN (Radio Access Network) with software-centric network architecture that will use cognitive radio techniques to allow the infrastructure to automatically decide which type of channel to offer (Gopal *et al*, 2015).

To deliver m-banking application there are usually four stakeholders involved: a bank, mobile network operator, a mobile banking vendor, and the consumer. Mobile banking vendor plays an integral part that provides the mobile banking platform which facilitates the integration of the bank system, mobile network operator channel and the end consumer.

The existing theoretical and empirical research about mobile banking has mainly dealt with its importance, effects, impact, and issues, but mostly about factors that affect the user adoption of mobile banking services. Very little or almost no research has dealt with comparative analysis of mobile banking services among financial institutions. Bagoria (2014) in his research related to the comparative analysis between private and public sector banks in mobile banking in India, has concluded that mobile banking ratio is very low compared to ATM banking or other channels, and that the average value of mobile transactions is higher in public sector banks than in private.

3. MOBILE BANKING IN SERBIA

According to the data of the National Bank of Serbia, provided by the Ministry of Finance - Treasury administration Republic of Serbia and Banks, in 2015 (Figure 2), the number of clients using Internet banking is much higher than the use of mobile banking, but with a significant increase of m-banking users. The total number of clients who have signed contract with a bank on the use of certain types of banking services is 8.9 million (NBS, 2015b).
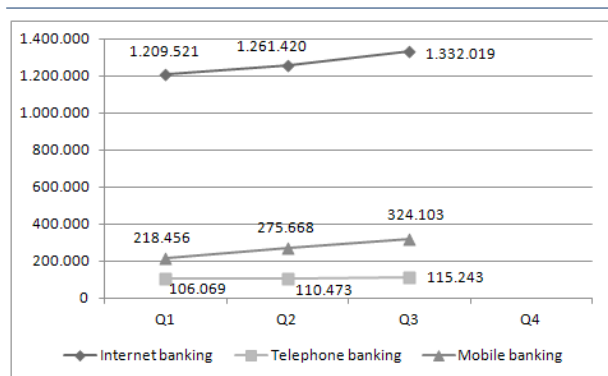
Figure 2. Number of clients by type of services per quartal in 2015 (NBS, 2015b).

The first bank in Serbia that introduced m-banking service is Banca Intesa (in 2010). Its mobile application called "Intesa Mobi" is available for Android and iOS devices, and offers almost all the features that a client has in bank branches. The next service that Banca Intesa will offer is Wave2Pay application, based on Host Card Emulation technology that will enable contactless payments. In 2013, telecommunication company Telenor Group, one of the leading mobile operators in the world, bought the license from KBC Bank, and opened the first bank for online and mobile banking in Serbia in 2014 (without branches). Telenor bank, owned by Telenor Group, is digital/direct bank with a multichannel platform as the single point of contact between Core Banking System and all channels.

There are currently 33 banks in the Serbia market, of which only four are domestic banks with star capital: Komercijalna (Commercial) bank, Poštanska štedionica (Postal Saving) bank, Srpska (Serbian) bank and Jubmes bank. However, Commercial Bank is already in the process of privatization, and there are forecasts that in the next three years, the other banks will also be privatised. Banks which implemented m-banking in their business, and key features of their m-banking application, are listed in Table 2. Data were collected from websites and available documents, and manuals, from considered banks.

After the analysis of available m-banking services by Serbian banks, the comparative analysis is done, in order to observe which bank offers wider range of m-banking services. Even though there has been a lot research papers conducting m-banking, there are few studies carried out in Serbia. Banks involved in this study are selected based on two criteria:

1. the most successful ones in implementation of alternative channel management products (ACMP), which includes modern m-banking solutions

2. according to the total assets criterion, and highest profit in the segment of ACMP (NBS, 2015a)

Bank	M-banking application	Key features
Banca Intesa	Intesa Mobi	◆ Check account balance ◆ Review transaction details ◆ Insight into the balance and turnover on payment cards ◆ Transfer of funds within accounts, locally and abroad ◆ Exchange operations (sell/buy of foreign currency) ◆ Make Payments (monthly bills, taxes, *etc*) ◆ Personal finance management ◆ Editing of personal data ◆ Activation/deactivation of SMS or e-mail notifications.
Commercial Bank	PlatiMo	◆ Transfer of funds between accounts ◆ Monthly bills payments ◆ Internet purchase
Raiffeisen Bank	Moja mBanka	◆ Locating all branches and ATMs via Google Maps ◆ Status and turnover of accounts and payment cards ◆ Transfer of funds between dinar accounts, and foreign currency accounts without currency conversion
ProCredit Bank	mBankar	◆ Insight into the balance and turnover on payment cards ◆ Transfer of funds between accounts ◆ Exchange transactions ◆ Bill payments
Societe Generale Serbia	SOGE m-bank	◆ Insight into accounts, funds on credit cards, loans ◆ Transfer of funds between bank accounts ◆ Exchange of foreign currency ◆ Locating the nearest branch or ATM
UniCredit Bank	m-banking	◆ Insight into balance and transactions for all accounts including loans ◆ Transfer of funds between bank accounts ◆ Payment for all account types ◆ Currency Convertor (from foreign currency to RSD) ◆ Locating the nearest branch or ATM
Erste Bank	m-banking	◆ Locate the nearest branches or ATMs ◆ Review of all debit, credit and savings accounts ◆ Payments with "Scan&Pay" functionality ◆ Currency exchange ◆ Discover the best possible savings mode
OTP Bank	m-banking	◆ Insight into current, deposit and credit accounts, and payment cards ◆ Internal/external transfers in foreign or local currency ◆ Overview of the transfer and payment ◆ Review of currency exchange rates ◆ Use locators to find branches/sub-branches and ATMs
Telenor Bank	Telenor bank	◆ Opening accounts ◆ Insight into accounts, payment cards and loans ◆ Transfer funds ◆ Payments of credit cards, monthly bills ◆ Currency exchange ◆ Limit and control consumption ◆ Managing cards: activate, block, replace and so on.

Table 2. Key features of m-banking application per banks

Comparative analysis of mobile banking in Serbia

Because of its specificity in m-banking service implementation, two banks were added: Telenor Bank and Erste Bank. Telenor Bank is the first online bank (no branches) owned by mobile operator in Serbia. Erste Bank is the only bank in Serbia that has the service "Scan&Pay" that was awarded for innovation in 2014 (service invoices per click). Banca Intesa, Unicredit Bank, and Raiffeisen Bank are top three banks according to the highest profit in 2015 (NBS, 2015a). Among top 5 banks, according to the total assets criterion is: Banca Intesa, Commercial Bank, Unicredit Bank, Raiffeisen Bank, and Societe Generale Bank (NBS, 2015a).

It should be noted that the level of offered services, shown in Table 3, is not fixed, but is prone to change due to the fact that banks constantly upgrade their m-banking services. The comparative analysis is conducted in January 2016.

The comparative analysis reveals that Societe Generale bank, Erste bank and Telenor bank offer most m-banking services to their clients. Poor design and environment for performing m-banking is given by Commercial Bank. A pleasant design and intuitive environment is offered by Banca Intesa, Unicredit bank, Societe Generale bank, Erste bank and Telenor bank. Raiffeisen bank and Unicredit bank offer essential services, but the colors (black and yellow) of Raiffeisen bank are not suitable for longer work.

Technical background of m-banking applications

Upon analyzing the features of available m-banking applications, it is observed that behind all these m-banking solutions stands Asseco Group Company, one of the largest software vendors in Europe, with 20 years of experience in banking software and more than 60 references in the banking sector. Some of their solutions for

Services \ Banks	Banca Intesa	Commercial Bank	Unicredit Bank	Raiffeisen Bank	Societe Generale Bank	Erste Bank	Telenor Bank
Online opening a bank account							✓
Online opening of savings account					✓		✓
Insight into accounts and payment cards	✓	✓	✓	✓	✓	✓	✓
Review transaction details	✓	✓	✓	✓	✓	✓	✓
Transfer of funds between accounts	✓	✓	✓	✓	✓	✓	✓
Payments	✓	✓	✓	✓	✓	✓	✓
Review of exchange rate	✓		✓	✓	✓	✓	✓
Currency exchange	✓				✓	✓	✓
Savings and loan calculator	✓				✓	✓	✓
Online savings					✓	✓	
Scan&Pay						✓	
Locate the nearest branch or ATM	✓		✓	✓	✓	✓	✓
Total offered services	8	4	6	6	10	10	10

Table 3. Comaparative Analysis of m-banking services in Serbia in January 2016

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banking are ASEBA iBank SMS, ASEBA Web2.0 iBank, ASEBA OfficeBanking, and ASEBA iBank Electronic Banking. More then 20 banks in Serbia are using at least one of their solutions (http://www.24x7.rs/srp). The most challenging one was the solution developed for Telenor Bank that connects two industries in one place - telecommunications and banking. The architecture of this solution incorporates ASEBA Multichannel Hub, ASEBA core banking, SMAP (Secure mobile application platform), and different mobile platforms (Android, iOS, and Windows phone) (Mihaljek *et al*, 2014).

ASEBA Multichannel Hub has set of services for all channels, such as branch, call center, ATM, web, social network, mobile *etc*. The basis for channels integration is ASEBA Banking Process Suite (BPS) which is an enterprise content management solution built on EMC technologies (EMC, 2012). ASEBA Multichannel has several modules, such as: CRM (integrated with Telco's system); Online sales (campaign definition, conducting and evaluation); and online helpdesk (using chat, compliant management options).

CONCLUSION

The rapid development of mobile technologies has completely changed the way people interact and work. Many companies are changing their business models and becoming more flexible to the user's needs. Even businesses themselves have a lot of benefits from the use of mobile technologies, some of them are: reaching customers globally, engaging customers and gathering insights on customers, besides cutting the cost and efficient work. The banking industry is a leading implementer of the latest technologies. This study analyses the extent to which Serbian banks keep pace with the newest mobile banking technologies. The comparative analysis of available m-banking services has shown that Serbian banks do not lag behind the latest trends. The fact that supports that is the opening of Telenor bank, owned by one of the largest mobile telecommunication companies, operating in 14 countries, with 189 millions of subscribers. According to the comparative analysis, three banks offer the most m-banking services to their clients: Telenor bank, Erste bank, and Societe Generale bank. Not far behind are Banca Intesa, and Raiffeisen bank, and Unicredit bank. However, it is noticed that they have something in common, and that is technology developed by one company called Asseco. This study also considered the main issues in introducing m-banking to the market. However, there is a slight shift from security issues to the functionality, and available features of mobile applications.

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POSSIBILITIES FOR APPLICATION OF ELECTRONIC PAYMENT SYSTEMS IN RETAIL

Nenad Tomić,
Violeta Todorović

University of Kragujevac,
Faculty of Economics,
Kragijevac, Serbia

Abstract:

Electronic payment systems have come into focus of theoretical debates and business practices at the turn of the 21st century. They have arisen due to the migration of business processes in a new high-tech environment, as a result of the rapid development of information and communication technology. With an open global communication network, such as the Internet, e-commerce has become the dominant form of remote trade, creating an ideal field for practical application of electronic payment systems. Although the first association for electronic payment systems appliance is electronic commerce, these systems in different conditions may also apply in retail. The subject of the paper is the assessment of possibilities for electronic payment systems application in retail transactions. The paper aims to demonstrate the multifunctionality of electronic payment systems applications, and the variety of options they offer in modern trade.

Key words:

electronic payments, retail, digital wallets, paywave,
near field communication.

1. INTRODUCTION

Permanent development of information and communication technologies (ICT) in the second half of the twentieth century led to changes in the business model of a large number of manufacturing and service companies. Communication networks such as the Internet, initially used to create presentation of company's services and improve its relationships with customers, eventually became commercial channels. This means that a large number of products could be offered through the Internet, where the buyer and the seller can directly communicate in the process of trading. With the creation of software products, as a very important category within the overall ICT products, the Internet has also become a distribution channel, which solved the delivery problem to the end customer, which is one of the key problems for sale of physical products. This setS conditions for offering a wide range of services via the Internet, from translation and graphical design, to lecturing and programming.

In addition to the delivery of physical products, the method of payment has become the key problem of e-commerce as a new commercial paradigm of 21st century. Cash payments were physically impossible; payment through cash on delivery carried a big risk to the seller because the buyer could deny the transaction instead of receiving products.

Correspondence:

Nenad Tomić

e-mail:
ntomic@kg.ac.rs

Transfer order was slow; its execution was interrupting commercial flow, and was expensive. Credit cards payments were unattractive to consumers due to the fear of data misuse. Electronic payment systems (EPS) incurred as payment systems in electronic commerce, and are particularly specialized in transactions via the Internet, in which the buyer and the seller have no physical contact.

Shortly, different categories of EPS have been created, specialized for particular types of transactions, or trade of certain products. Although primarily intended for online use, EPS can also be applied in retail even when the buyer and the seller are physically present (Rigopoulos, Psarras, Askounis 2005). Although retail is dominated by cash and credit cards payments, an increasing number of ERS has recently become compatible with the existing payment infrastructure. The meaning of EPS application in these circumstances is in the added value that their application provides to users.

The subject of the paper is the assessment of possibilities for EPS application in retail, , when the buyer and the seller are physically present. The paper aims to demonstrate the multifunctionality of EPS application, and diversity of opportunities they offer in the modern trade, as well as to highlight the added value that their application provides to users. The notions of EPS will be discussed in the first part of the paper, along with typology of these systems based on the payment channels. In the second part, the technological foundations of EPS will be presented, including the analysis of contribution of each technological feature for the functioning of the system. In the third part, the case studies of the EPS applications in retail will be carried out, with the examples of two mobile digital wallets and two applications that are used not only for making payments, but also for ordering a product/service.

2. THE CONCEPT OF ELECTRONIC PAYMENT SYSTEMS

Electronic payments represent the exchange of monetary value, with partial or complete use of electronic media. In practice, this means that at least one of the elements of the payment process migrated to electronic basis, and that is not executed in paper form (ECB,2004). Cash payments are the only non-electronic payments today, while for all forms of non-cash payments, ICT is used to a lesser or greater extent, in the initiation of payment, transfer of payment instructions or in the process of settlement, so that in the domain of non-cash payments one can discuss semi-electronic payments,

or fully electronic payments (ECB, 2007). An example of semi-electronic payment is paying bills for different types of services that are executed in the bank or at the post office, and initiated in paper form (physical transfer of paper bills to the payment provider), but further transfer of payment instructions and settlement are performed electronically through a computer system that is connected to the payment provider's computer.

A fully electronic payment should be initiated through electronic channels with the use of adequate payment instrument. The electronic payment channels include the access point where the first contact of instrument and the system takes place, and where the initiation of payment transaction begins (Vuksanović, 2009). The most widespread contact channel is the point-of-sale (POS), which can be found at the cash registers in supermarkets, shopping centers and gas stations. Increasingly widespread contactless electronic payment channels are the Internet and mobile phones, which allow users to access the payment process without physical contact with the seller. As a payment instrument, payment cards are most commonly used in both cases.

The use of plastic cards at POS terminals is a classic form of card payments, which requires the presence of the card, physical contact between buyer and seller and is authenticated by the PIN number. This payment method has practically not been changed for decades, and for this reason will not be the subject of analysis in this paper. On the other hand, in the payment process where the Internet is a channel of initiation, the seller is not provided with an insight into the buyer instrument. These transactions are referred in the literature as the card-not-present transaction (CNP). Due to the absence of physical contact, CNP raise a number of safety issues, from the issues of security and privacy of customer data, to the question of authentication of both parties in the transaction. It is this type of transactions that has given space for creation of a large number of EPS, which not only solve the security and authentication problems for both parties in the payment process, but also offer added value through customer support services. Thus, some systems do not allow the buyer to take over the money until the goods are delivered, while others allow automatic application of discounts or loyalty programs in the process of payment. The EPS that can be applied in both e-commerce and traditional retail will be the subject of analysis.

With high applicative power of smart phones, a large number of applications previously available only on desktop computers have been developed, including

digital wallets. It is the EPS application that securely stores information, passwords and PIN numbers to be used in a variety of payment methods, and can contain address for delivery of purchased goods, membership cards and consumer information about loyalty programs or collected points for discounts or sweepstakes. Although these applications can be used for CNP transactions (hence the address for delivery of purchased goods), the main purpose of the digital wallet applications is in retail.

3. TECHNOLOGICAL BACKGROUND

Modern achievements in ICT domain, both hardware and software ones, form technological basis of EPS, along with payment cards, which create the monetary basis for the system functioning.

Payment cards are the main payment instruments in almost all EPS. The payment instrument is defined as a medium that carries monetary value in a transaction. Most EPS use the existing payment cards accounts as the basis for sending or receiving funds. The owner's personal data, account number and security figures are hidden, and are not exposed on the Internet or other communication network used for payment execution. During the exchange of payment instructions, user accounts communicate without sending sensitive personal data.

Mobile phones entered commercial use in the mid-nineties of 20th century. The basic functions of these phones were calls and text messages, although the producers soon began to expand the range of services by equipping phones with cameras and software bringing entertainment content. With the advent of smart mobile phones, the operating systems have become almost as powerful as those on computers. This has enabled the development of a large number of applications, of both entertaining and business nature. In addition to the previously mentioned applications of digital wallets, mobile phones have become a kind of payment emulators, because in one place, in one application, customers are now able to keep data on different methods of payment, addresses for delivery of purchased goods, the membership and consumer cards, information on loyalty programs or collected points for discounts or sweepstakes. Opportunities offered by the smart phones applications made them suitable for payments in retail, so some authors emphasize mobile payments as the "next big thing" in the field of payment services (Smith, 2014).

Internet is the next important factor in the EPS use. With its commercial application in the early nineties of the 20th century, the Internet has revolutionized business models of various traditional activities. Electronic trade takes on a whole new dimension, since it was the first time interaction of the participants was possible through open networks, where administrative borders posed no obstacle. The payment method remained the only serious obstacle for further development of e-commerce. Combined with computer technology, the Internet not only allows remote access to the consumer online store, but also a way of making payments with the use of EPS. Leaving aside the very important issues of security and privacy of such transactions, the Internet and computer technology have contributed to the creation of opportunities for consumers to purchase smooth without leaving home. Wireless Internet access (Wi-Fi) offers additional value Internet users, since they can access resources without the need for a wired connection of their devices and access point. Wireless signal provides particular benefit to users of portable devices - laptop and tablet computers, and mobile phones, which can maintain permanent Internet connection even in motion, with less frequent use for desktop computers.

Bluetooth is a wireless communication network, which is used to exchange data between two static or mobile devices at closer range. It was originally designed to make easier and faster connection establishment between mobile phones and desktop computers, but later became a standard for data exchange between portable devices. One device can communicate with up to seven other devices, provided that the quality of communication links decreases with the number of paired devices. Unlike NFC technology, which serves a similar purpose, Bluetooth works on wider distances (up to 15 meters between devices) and allows higher data transfer speeds at optimum connections. The flaw is slower pairing, which requires the approval of both sides to establish a connection. Although its great application in the field of electronic payments was originally expected, NFC technology has taken its place in this domain.

Near Field Communication (NFC) technology is a wireless short-range communication technology used to transfer data between two devices equipped with appropriate sensors. Vasković (2012) points out that for communication of two NFC devices it is necessary to have at least one active device (equipped with NFC signal reader, which can also broadcast and receive signal) and one passive device (can receive NFC signal, but cannot broadcast it), or both devices can be active. For a successful data transfer, to the two devices must be at a distance of 10 centimeters or less. Mobile devices can

easily be set at this distance, paired, separated again after use. The first advantage of NFC technology is automated pairing devices without requiring user name recognition for connecting and receiving data. Another advantage is safety - unlike Bluetooth connectivity, NFC connection is due to the short-range harder, but not impossible to eavesdrop on, and perform data theft (Weiss, 2011). This technology has quickly found application in payments in retail with the support of the largest card institutions. Visa developed payWave terminals for contactless payment cards based on NFC data exchange technology, while MasterCard did a similar thing with PayPass terminals (Pasquet, Reynard, Rosemberg, 2008).

4. APPLICATION OF ELECTRONIC PAYMENT SYSTEMS IN RETAIL

An increasing volume of funds is effected without the use of cash. The household sector has predominantly used cash payments for a long time, but during the last few decades, the share of non-cash payments have grown even in this sector, primarily in developed countries, and then in developing countries as well. Nowadays, for example, in the Scandinavian countries, cash payments account for only 5 % of total payments.

Mobile digital wallets

Below is a case study of two most popular digital wallet applications, their performances, achieved results and their potentials.

Google Wallet (GW) is the first functional digital wallet, created by today's largest Internet company Google (since the end of 2015 known as Alphabet). The idea behind GW was to take advantage of the growing potential of smart phones with integrated NFC readers, and the increasing diffusion of contactless POS terminals based on payWave and PayPass solutions. GW as an application could be installed exclusively on new Android mobile phones, equipped with an NFC reader (but at the time of occurrence, there was only one model, Google Nexus S, which supported application). The user would connect application to his current account or credit card account to add a certain amount of money on application balance. Within the limits of the available balance, the user would be able to pay at contactless POS terminals.

At the very beginning GW faced many organizational problems. First of all, apart from a small number of mobile devices that could support it, GW was the exclusive feature of mobile provider Sprint (Chae,

Hedman 2013). This means that although a user would possess a supported mobile phone model, he would not be able to use the application if his number is maintained by another carrier. Google decided to make it Sprint exclusively, as the other three major carriers in the US - AT&T, Verizon and T-Mobile US – were working at the same time on developing their own digital wallet called ISIS (today Softcard). In addition, the problem was the low compatibility with financial institutions. In the beginning, customers were able to use only Citibank's MasterCard cards for adding funds to their balances, while payments could be made only on PayPass terminals (on payWave later, when Visa joined project). This resulted in a much lower applicability in practice than expected. Ozcan and Santos (2014) explain this problem with difficulty of forming a consortium of companies from different sectors. Companies that are among the most dominant in their sector hardly accept any other role but a dominant one when called to enter a new market.

In late 2015, Google has separated the GW functions into two new applications - Android Pay, which took over the functions of the old GW, and from now on will be used for retail payments, and the new GW, which will be used only for P2P sending money between two users. The main difference is that Android Pay becomes the exclusive Android application, whereby Google wants to compete with Apple.

Apple developed its own digital wallet application for mobile payments known as Apple Pay (AP) in 2014. This application works only on iOS devices, version 8 and later, and can be used for payments in retail, thanks to NFC antenna, which latest generation Apple devices are equipped with, and also for online shopping. Two features that distinguish AP compared to similar applications are high acceptance of applications, both by vendors, as well as by financial institutions, and steps taken to ensure a high level of security through two-factor authentication system.

AP can be used on iPhone 6 and later models, as well as combined with AppleWatch smart watches for payments at retail, while on tablets iPad Air 2 and iPad Mini 3 and later models can be used for online payments. Common to all devices above mentioned is the existence of Touch ID function, a fingerprint sensor used as a form of authentication in transactions. Devices that are used for payments in retail are equipped with NFC antenna, which in addition to communication with contactless POS terminals provides an additional form of authentication.

The setup process starts with entering data on payment instruments (debit and credit cards). The first and simplest way is to download data from user's iTunes account, if there is already active payment instrument. Regardless of whether there is a payment instrument or not, the new payment instruments can be added later, by entering the required information, or taking a photo of a card through the app. After entering the card information, it needs to be authenticated by the issuing bank (in March 2016, 1,069 banks in the US, and a few dozen of banks in other countries have joined the program, Apple Support, 2016). All instruments will be visible in the main application menu, where one of the cards is chosen as the default payment instrument, which can be changed afterwards. The application uses customer data for delivery address in case of purchase through the Internet.

The advantage that the Apple stresses when paying in retail is privacy. Personal information on payment instruments is not uploaded to user's iCloud account. The data is visible in the application itself, but is not shared with the seller. Instead of real card numbers, and PIN/CCV number, AP uses the principle of tokenization (MacRumors, 2014). When a user enters their payment instruments, the data is stored in the so-called secure element, while in a transaction a unique Device Account Number is used instead of real card number. This number is not even known to the Apple, and it replaces cards numbers in all transactions executed via given device. To confirm the transaction, the device creates one time dynamic security code that serves as an additional form of authentication (MacRumors, 2016.) NFC antenna, used to establish the connection to POS terminals, does these authentication activities. Anyone who succeeds to intercept communications between Apple device and terminals, or to read the contents of a terminal database, will find tokens for single use only, which are unusable after the transaction, and cannot be used for deriving real account number.

All mentioned forms of authentication executed in a period less than a second, helped by the Touch ID. Fingerprint is provided in the initial device setup, and is used to help unlocking the device. The transaction process can be performed even if the device is locked. The user brings the device near contactless POS terminal, which wakes the device using NFC communication, and automatically activates AP. By placing a finger on the Touch ID sensor, the user confirms ownership, allowing the transaction to be performed. A short beep and a mild vibration indicate that the transaction is executed, and if the device was previously unlocked, the payment is confirmed visually by checking the bill in the application. If the user wants to change the default instrument before payment (say, to switch an insufficient funds debit card to credit card), he double clicks on the home button (which is on all devices at the same time a fingerprint reader) to *get al*l accepted payment instruments among which he can choose a new default instrument.

Since October 2015, the AP accepts store payment cards, which can be added into the application, and set as automatic choice, so that one store card is used as the default payment instrument in the objects that belong to the specific store. Another advantage of using AP in retail is in collecting points in the promotional activities of a particular retailer or product lines, which can be used in further payments.

In assessment of the mobile digital wallets prospects, their limited applicability is often cited. As Rosenblum (2013) explains, users would remain indifferent whether they use payment card or mobile phone as long as they have to stop and take something out of purse to make payment. In this sense, AP does not make difference – the user has almost the same movement mechanics as when paying with contactless payment card, with difference that AP pose no limit for the amount of the transaction (limit exists in the UK, not in other countries). However, the essential advantage is in a higher degree of security and privacy that AP offers. The real card numbers are never shared with the vendor, so there is no fear of theft or misuse. Apple is committed not to follow the user transactions, not in location nor in content, so the only party that knows your purchase, as before, is the bank. Also, the Find my iPhone function can block the use of AP in case you lose your phone, so even if the thief succeeds to break the password for unlocking the phone, he would not be able to use the application for payment nor to read confidential data.

AP can be used at over 2 million locations in the US, and in the UK and China it is supported by a few dozen of banks. In Canada and Australia, the AP can be used only with American Express cards. In the coming period, Apple targets closed systems, such as airlines (in-flight shopping) and university centers for spreading its application usage.

Applications that integrate ordering and payment

There is a growing popularity of applications that combine the possibility of electronic ordering products/services with electronic payment upon receipt or payment in advance. In the following chapter, the world

phenomenon for ordering transportation Uber is introduced, along with successful domestic service for online food ordering known as Donesi.com.

Uber is a mobile application for ordering transportation, where everything except driving is done electronically - ordering transportation, driver selection, monitoring the arrival of the selected driver on the map, estimation of price, payment, driver rating. In March 2016, the application was usable on all continents in over 390 cities. It implies total absence of cash, and relies on electronic payments, where the payment cards are used as a basis.

The user downloads and installs the app on his smart phone, where all relevant mobile operating systems are supported. Transport ordering is done simply by opening the application and selecting ordering in the menu. Prior to ordering, it is necessary to choose address that ride starts from. It can be entered manually, by typing the address, from which user wants transfer, or with the help of GPS and Wi-Fi locating, when the user is found on his the current location (Uber Help). To order transport, user is required to select a payment instrument (if more than one instrument is available). Also, it is necessary to enter the destination address so the driver who takes the ride knows in advance how long the drive will be, and at what price. Once the system accepts the order, the nearest available driver is contacted and sent to the address. The user can see the driver in advance and also can follow his movement with estimated time of arrival, but the driver cannot be changed. The user can also obtain the driver's phone number for direct contact in case the starting location changes. The application supports cancellation option, which is charged for cancellation fee.

Once the passenger enters the taxi, a price of a ride can be estimated based on the destination address and expected time of ride. Final price may vary depending on traffic density, but also on whether the trip goes through the sections where access must be paid (highways, tunnels with taxes, airport parking). The total amount is paid via the selected payment instrument. The user can file a complaint if he deems that the total cost of trip is not calculated appropriately. Finally, after completing the ride, the user rates the driver. Uber aims to retain only those drivers that are evaluated positively, which in turn requires the responsibility of the user. If the drivers are constantly given bad reviews, Uber will terminate the contract with them, so next time there will be fewer available drivers in the offer, and it will take much time for a ride. If there is no complaint, the user receives a

certain number of credits that would be deducted from the total cost of the next ride. In the user wants to pay trip with his own money and to collect credits, he can disable the use of the credit in application.

As a payment instrument, the user can input some of his payment cards, pre-paid card, or a digital wallet account. Using a pre-paid card is not recommended, because a large number of issuers are not support in the application, although itself it is possible. Apple Pay is available on iOS devices, same as Google Wallet on Android phones. Also, Uber account can be linked to a user's PayPal account in a number of countries.

Donesi.com is domestic application for online food ordering from restaurants. In addition to the major cities of Serbia, the app is functioning in several cities in Montenegro and Bosnia and Herzegovina. The basic idea of this service is the online food ordering, with the precise amounts of meals, portion sizes and spices, where one electronically sent order arrives within seconds to the desired restaurant. The service first started to work as a classic web site, and today there are applications for different mobile phones operating systems. When registering, users leave information about their address, based on which service filters only those restaurants that deliver to the given address. If the user is currently located in a different location, he can change a neighborhood or even the city and look at the offer. In addition to the search based on restaurants, Donesi.com offers search by meal (for example, one can search pancakes only or burgers only in all restaurants in the offer).

Basically, this service does not require mandatory electronic payment (Donesi.com FAQ). Given that it only works as a mediator of order, and that it charges percentage of total price from the restaurants it cooperates with, Donesi.com is indifferent to payments in cash or electronic payments. For a large number of restaurants card payments are supported, as well as QVoucher payments. It is an electronic voucher purchased from the issuer - Lanus company (see option where to buy online qvoucher.rs). The idea is that online transactions can end up in an efficient way via the Internet without the use of payment cards. This is very important for those targeted groups that do not have the conditions for possession of a payment card - say student (Vuksanović, Tomić, 2014)

Since the beginning of 2015 Donesi.com is owned by Foodpanda, the German service for online food ordering. It can be expected that the future activities would be focused on more intensive computerization of operations, and possibly introduction of new payment methods.

The essential difference between Uber i Donesi.com, is in the particular role of service. Uber does not own vehicles, but signs contracts with free cab drivers, who agree that Uber charges for their services, and receive salary on previously set conditions. Uber undertakes distribution of rides to the closest drivers, charges passengers and takes into account the quality of service. Donesi.com also owns no restaurants and does not prepare meals, but accepts the orders and forwards them to the desired restaurants. However, Donesi.com does not accept payment, does not process the transactions and does not affect the final price of the restaurants' services. It has a contract to charge a fixed percentage of total prices but cannot affect the price or the quality of service. If the customer is not satisfied with services provided, Uber will react by changing the driver, while Donesi.com cannot change anything in the restaurant. Hence their current differences in payment automation.

5. CONCLUSION

Electronic payment systems have completely different roles in e-commerce and traditional retail. While they are practically a necessary condition for proper functioning of e-commerce activities, in terms of the traditional retail electronic payments are still viewed as a touch of exoticism. With the exception of the classic payment card usage at POS terminals, all other methods of electronic payments in retail still do not have the sufficient scope that would point them out. The figures that show the trend of growth of various mobile payments applications in the last two to three years are indeed impressive, but it must be taken into account that they are resulting from low basis, practically close to zero.

Among mobile digital wallets, AP shows greater potential than others. This time Apple gave up the innovator role, leaving other consortia to offer their own versions of the digital wallets, and learning from their mistakes. Apple behaved less dominant than Google, and therefore had a better starting point in negotiations with banks and credit card organizations, and retailers. The high brand loyalty of Apple users has been materialized, and thus Apple Pay has quickly gained huge popularity. The problem of this service may be the same as its biggest advantage – no matter how loyal users of Apple products are, insisting on iOS exclusivity prevents application from winning a larger market share. Apple elitism may rapidly slow the growth of AP use in the years to come in the same way it sharply accelerated its acceptance in 2014 and 2015.

As for applications that combine the possibility of electronic ordering products/services with electronic payment, there are still a lot of possibilities. From enclosed can be seen that innovators come from developed economies, where the culture of consumption is such that customers quickly adopt new services when it tends to save time by automation of all processes that are subject to standardization. Essentially, transportation and food ordering are the services that customers need daily, and ways of ordering can be easily standardized. One of the services that is possible, and what is realistic to expect in the future is electronic shopping in supermarkets, where user could purchase certain products in advance based on the electronic catalog, which would later be delivered to his home. It is a service that is also needed to a large number of users on a daily basis, but in a similar form, it would be possible to provide a huge mass of similar services.

The evidences of business processes migration to the electronic base in the second decade of the 21st century are obvious. The real problem that may slow down these processes in the coming period is the division of responsibilities and benefits, as it is obvious that the business conditions and the relative importance of specific companies have changed. To fully evaluate the role of electronic payments, and in particular their penetration in the traditional retail sector at least 5-10 years will be needed.

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STATISTICAL MODELING OF OPTIMAL DEVELOPMENT STRATEGY AND UPGRADE OF INTERNET TRADING QUALITY SYSTEM IN TRANSITION COUNTRIES

Mirjana Landika[1],
Radmila Bojanić[2]

[1]Paneuropean University „Apeiron"
Banja Luka,
Banja Luka, Republic of Srpska, B&H

[2]M:tel a.d. Banja Luka,
Banja Luka, Republic of Srpska, B&H

Abstract:

Observing and studying the economic system as a totality of business entities at a global level is justified. The constitution of such a system implies that the events in one system segment reflect on the system as a whole.

The inspiration and challenge for numerous researchers encompasses the attempts to comprehend forms, directions and nature of correlation of the phenomenon within the global system. The economic system goes through the phase of global connecting through the World Wide Web, where, among others, a new form of goods for cash exchange has developed, known as electronic trading or internet trading.

The stochastic character of development processes of individual market segments is visible both in the degree and direction of quantitative matching of variations of certain appearances and processes, in reference to connectivity of certain appearances and processes in individual system segments.

According to Marc Porter, development and upgrading of the quality system, as a set of adequate development strategies of business systems are realized, among other things, by market focusing (Todorović, 2001). The aforementioned implies that the optimal strategy for development of operations of individual system elements must be adjusted to the earning conditions in the observed market segment.

Identification of factors that set the conditions for the intensity, form and direction of correlation of processes and appearances, their quantification and interpretation, deduced from empirical structure, enables establishing, maintaining and upgrading the quality level in business processes, such as internet trading in transition countries, such as Bosnia and Herzegovina.

Key words:

internet trading or online trading, global system, stochastic processes, statistical modelling, development and upgrading of quality system.

1. INTRODUCTION

Efficient functioning of business systems implies minimization of differences between the desired and realized results of the selected activity, whereby conditionality of the business result is determined by numerous factors, whose manifestation, even in identical business fields, displays significant differences in various segments of the global economic system.

The achieved development of internet trade on the global level is becoming ever more present and current, with the transition countries lagging significantly behind the development countries. This also represents the hypothetical framework of the research project.

Correspondence:

Radmila Bojanić

e-mail:

radmila.bojanic@mtel.ba

Factors affecting the concept of functioning of internet trading have a stochasticity dimension, which makes their explicit expressing more difficult in the sense of form and measure of their quantitative matching. The ability of a manager is to recognize through empirical analysis and to interpolate their impact of certain factors through adequate metrics into the business result calculation, in order to optimize the business result adjusted to system units within the global system, despite their stochastic specifics.

Measuring of process performances implies adequate application of methodological procedures of correlation analysis which is used to test the reactivity of achieved satisfaction level of users. Methodology efficiency implies consideration of harmony between user satisfaction, as a dependant variable, and factors, which may be justly assumed to determine the user satisfaction level, as independant variables. The methodology implies calculation and statistical testing of the coefficient of correlation between frequency rank of using internet trading and user perception concerning internet trading quality level.

Experiment design starts with the assumption that in the total population of potential users on the territory of Bosnia and Herzegovina, there is a small number of those who opt for internet trading despite its competent advantages and global development. Examining the samples of such a local trend enables its efficient elimination, through minimization of the gap between the desired and realized result level in the selected system segment, with necessary maximization of user satisfaction, based on the adequate empirical analysis.

2. UNDERSTANDING THE QUALITY OF SERVICE IN INTERNET TRADING PROCESS

From the competition perspective, value is an amount that the users are prepared to pay for something offered by internet trading. Value is measured by total profit, which reflects the price dictated by the product of internet trading and quantity it is able to sell. Internet trading is profitable if the value it dictates exceeds the costs. The aim of any generic strategy is to create value for the user which exceeds relevant costs. Value, rather than costs, must be used in the analysis of competitor position, as the internet trading often increased their costs intentionally in order to dictate the premium price on the basis of differentiation.

The activities creating internet trading value represent special elements of competitive advantage. The manner in which each activity is performed together with its economy, determine whether internet trading has high or low costs in relation to its competitors. The manner in which

each of those activities is performed will also determine its contribution to the user needs, thereby determining the diferentiation. Comparison of competitor value reveals the differences which determine competitive advantage.

The internet trading services, presented through the purchased product and product price, are value for the user. If that value does not meet the demands and expectations of users at first glance at the time of takeover of the purchased product or its later use, we have a shattered value chain and a negative user experience.

The news about of negative user experience spread fast and users become more cautions with a change of perception towards this manner of trading.

In order for internet trading to maintain the quality level of its services, it must work constantly on its basic operational functions defined through trust, speed, data safety, availability and user satisfaction. Its differentiation results from the relation between its and user understanding of value in all contact points between the buyer value chain and internet trading value chain. Any of the contact points may be the source of differentiation. "Quality" is not a wide enough term for what makes internet trading unique, as it focuses the attention on the product instead on a line of activities which create value and affect the user.

Therefore, differentiation basically results from the value which is created for the user on the basis of impact of internet shopping on its value chain. Value is created when internet trading creates a competitive advantage for the user - reduces his costs, improves his efficiency or predicts future needs, through the analysis of his previous purchases. However, in order to reach a premium price, the user must realize the value is created for him. This means that the internet trading should explain its value to users through advertizing on its internet page and through direct contact with users. The manner in which this value is divided between the internet trading (premium price) and the user (larger profit, more satisfaction for the paid money, higher level of service quality), reflects on the quality and further use of this form of shopping.

3. ADJUSTING QUALITATIVE METRICS AND ASPECTS OF DISPLAYING BY LEVEL OF SATISFACTION AND USER AFFECTION TOWARDS SERVICES OF INTERNET TRADING

Probabilistic judgements of inferential analysis of stochastic processes require a subtle approach to selection of sample for passing judgements and conclusions based on incomplete information. The efficiency of conducted

analysis is determined by "planned reliability and precision of obtained results of the analysis, as well as by the degree of variability of appearances and processes whose behaviour we are examining" (Landika, 2015).

Expressing the causality of preference of choice of interned trading as a distribution channel, and subjective perception through the quality of realized service, as a dependant variable value, is achieved relatively easily, simply, at a low cost and up-to-date through surveying the population of the wider Banjaluka region as potential users of internet trading.

The questionaire used to collect adequate empirical structure is formed in such a manner to include questions which will adequately clarify the problem being analyzed. The potential users of internet trading, as distribution channel, include active internet service users in business or private correspondence, as the testing population from which a sample of 95 respondents is selected. The

selected sample is adjusted to the variability of tested phenomenon, desired reliability and precision of judgements and conclusions resulting from the used models of descriptive and inferential statistical analysis.

The survey questionaires are delivered to survey respondents through electronic mail, where the coverage of space of elementary events is achieved through a concise approach to question formulation procedure, by offering clear and comprehensive answers.

The survey questionaire was made on a sample of 95 respondents from the wider Banjaluka region, and it was conducted through e-mail. The choice of e-mail as the instrument was justified by focusing on active internet users. Through processing of the collected empirical structure, we attain the structure of respondents according to the frequency of received answers, with the following layout:

Distribution of received answers presents a platform

Answer / Question		Up to 25	25 - 35	35 - 45	45 - 55	55 - 65	65 and above	Total
1		6	27	25	18	12	7	95
Answer		a	b	c	d	-	-	Total
2		47	25	18	5	-	-	95
Answer		a	b	c	d	e	-	Total
3		4	16	21	37	17	-	95
Answer		a	b	c	-	-	-	Total
4		59	32	4	-	-	-	95
Answer		a	b	c	d	-	-	Total
5		17	22	13	43	-	-	95
Aswer		a	b	c	d	e	f	Total
6		9	18	7	3	2	13	52
Answer		a	b	c	d	-	-	Total
7		34	8	4	6	-	-	52
Answer		a	b	c	d	e	f	Total
8		5	17	6	13	2	9	52
Answer		a	b	c	d	e	f	Total
9	I	3	11	6	13	17	2	52
	II	13	5	3	7	6	3	37

Table 1. Cumulative survey result - distribution of frequency of respondent answers through questions; distribution of answers to question no. 9 is divided into two groups, as follows: I - respondents who had used the internet trading service and II - respondents who had not used it (multiple answers to question no. 6 include answers (a+b) from 4 respondents, answers (b+c) from 5 respondents, answers (a+c) from 3 respondents and answer (b+e) from one respondent, where the one answer under e refers to Aliexpress in the additional explanation; multiple answers to question no. 8 include answers (b+d) from 5 respondents, answers (a+b) and (a+d) from 2 respondents each; multiple answers to question no. 9 in both cases include answers (b+e), in group I, and in group II two times (a+e) and once (b+e))

for the analysis of potential consumers in reference to frequency of chosing internet trading as the preferred distribution channel and perception of the realized or desired quality through the interned trading service. The important aspect of analysis refers to adequate insight of a portion of the conquered available market on one hand, as well as the realized level of user satisfaction from the consumed service, and the cause-and-effect connection between the source of (dis)satisfaction of the respondent through perception of realized quality of provided service and the preference of consumer determination.

The initial analysis foundation refers to comprehending the representation of internet trading, as a distribution channel, The participation of respondents who used the internet trading service is shown in Image 1.

Image 1. Structure of respondents according to personal preferences in reference to internet trading as distribution channel

The logical continuation of the analysis includes overviewing the realized satisfaction level for the provided service, displayed in Image 2.

Image 2. Distribution of respondents according to subjective perception of the respondents in reference to the realized satisfaction level for the quality of realized internet trading service

Having in mind an extremely low percentage of users with high satisfaction preferences for the realized internet trading service, it is justified to shed some additional light on the causes of such a result. Distribution of causes for dissatisfaction of respondents with the quality of internet trading service may be illustrated through the following pie chart:
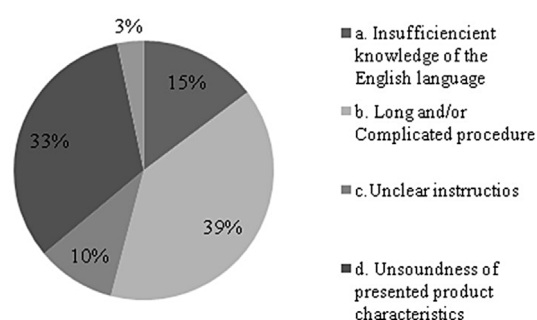
Image 3. Structure of respondents according to the cause (source) of dissatisfaction with the quality of realized internet trading service.

Previous illustrations of respondent distribution according to frequency of received answers, enable their adequate appreciation in the procedure of formulation of optimal development strategies.

4. STOCHASTIC CORRECTION OF THE LEVEL OF QUALITY OF INTERNET TRADING SERVICE

Measuring and expressing the degree and direction of alliance between two appearances presented by couples of rank variables, presents the platform of application of Spearman's coefficient of rank correlation. The analysis starts with the precondition that there are no linked value couples for which the intensity of interdependence is calculated, which refers to harmonization of shopping frequency with the proposed measures for increasing of the satisfaction level with the service users.

An important aspect of this research also refers to examining the compliance between forms of distribution of sources for upgrading the quality of service with its existing and potential users. The aforementioned analysis is realized efficiently by the use of χ^2 test for independence of insignia in the contingency table (Šošić, 1998).

5. THE DEGREE AND DIRECTION OF QUANTITATIVE MATCHING OF VARIATIONS OF THE PERCEPTION OF THE SOURCE OF (DIS) SATISFACTION WITH INTERNET TRADING SERVICE DEPENDING ON THE FREQUENCY OF ITS USAGE

The value of Spearman's coefficient of rank correlation, as the measure for stating the perception of source of dissatisfaction of service users depending on the frequency of its usage, in the specific case is 0.734388, which indicates a significant uniflow degree of quantitative matching of variations of the aforementioned appearances, whose statistical significance we test through the following protocol:

a. Statistical hypotesis is formulated through definitions: H_0 : rWe determine table value with 99% reliability, *i.e.* error risk 1%, by using the Student's t distribution of probability, which in the observed case carries the value of : $t_{0,005;90}$ = 2.6316 (Lovrić, Komić, & Stević, 2006)

b. Calculated test value is: t = 3,091 (Landika & Bojanić, Research and analysis, 2016);

c. Bearing in mind the fact that the table value is below the test value, we reject the precondition contained in the null hypotesis, with 99% reliability (Šošić, 1998).

6. COMPLIANCE OF PERCEPTION FOR SOURCES OF POTENTIAL UPGRADES OF INTERNET TRADING SERVICE QUALITY WITH RESPONDENTS WHO HAVE (NOT) USED THE LATTER

a. Metric comparison of perception of realized and/or assumed sources for upgrading the internet trading service is realized efficiently by application of the cStatistical hypotesis is formulated by definitions: H_0 : distribution of frequency of source of (dis)satisfaction is not different between users and those who do not use the service; H_a : distribution of frequency of source of (dis)satisfaction is different between users and those who do not use the service;

b. We determine the table value with 99% reliability, *i.e.* 1% risk, amounts to $\chi^2_{0,01;4}$ = 13.277;

c. The calculated test value is calculated by the use of the following formula: t = $r_S \cdot \sqrt{\frac{n-2}{1-r_S^2}}$. (Landika, 2015), and it amounts to t = 3.091, with the Spearman's coefficient of rang correlation is calcuated

by using the following expression: $r_S = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n^3 - n}$, while its value is r_s = 0,734388 (Landika & Bojanić, 2016)

d. With appreciation of the fact that the table value is below the test one, we reject the precondition contained in the null hypotesis, with 99% reliability (Šošić, 1998).

7. FINAL CONSIDERATIONS

The research framework of the used descriptive - inferential statistical analysis, grounds the management platform with the following strategic contents:

- Representation of internet trading amongst distribution channels results (Image 1) is not at a satisfactory level with users at the chosen market segment. There is a high percentage of respondents, 59% of them, who never or rarely use this distribution channel;

- On the other hand, there is a high portion of 70% of respondents with a high degree of subjective perception of the realized quality level of internet trading service, which results from the structural circle of empirical series (Image 2). The aforementioned findings can and need to be exploited in the process of formulation of development strategy for this distribution channel.

- The previous quotation and conclusion can be ammended by sources (causes) of dissatisfaction among users of internet trading services, as is clearly illustrated by the structural circle of empirical series (Image 3), where the "long and/or complicated procedure" and "unsoundness of the presented characteristics" are shown as dominant, with frequency of 39% and 33%, *i.e.* with 72% of respondents. The noted cognition can also and would be usefully exploited in the procedure of formulation of optimal development strategy for this distribution channel;

- Subjective valorisation of the realized level of internet trading service quality displays a direct correlation between 0.734388 strenght degree and frequency of its realization. The direction and strength of the noted causality represents a significant postulate and an adequate tool for managing the behaviour of both existing and potential users;

- Subjective perception of the source for improvement of the realized, *i.e.* assumed level of internet

trading service quality, displays a high degree of discrepancies, thereby opening a possibility for removing and overcoming the actual potential sources of user dissatisfaction.

The utilised tools of descriptive statistical analysis include a *table* layout of distribution of received answers in relation to the conducted survey protocol, and *graphic* layout of distribution of respondent preferences with regards to selection of distribution channels, source of (dis)satisfaction and perception of potential sources for upgrading of internet trading service by using the *structural circle*.

The inferential statistical analysis includes the Spearman's coefficient of rank correlation, and the χ^2 test, whose application enables an objective approach to the analysis of quality of results of tested processes by adjusted metrics, as well as the qualitative adjustment to real systems. Segmented diversity within the global system is emphasized through certain specifics, which require a subtle approach to segmenting and recognition of characteristics of the system units.

The effects of implementation of results of analysis and tests overwhelmingly exceed the costs of obtaining a management platform, which include collecting and statistical processing of empirical structure, while the efficiency degree is greatly alleviated by means of an adequate IT structure.

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THE IMPACT OF VIRTUAL MONEY ON E-COMMERCE

Mirela Redžović,
Jelena Novaković

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The concept of E-business, along with E-commerce, has been developed due to the expansion of communications system. The concept of E-commerce has first appeared in the 1970s. E-commerce represents a portion of electronic commerce, being a multidisciplinary concept of trading in products and services, as well as paying for them, using the Internet via virtual market. E-commerce has expanded on a global level significantly during the last decade, and it still shows great potential in growth and development. One of immediate consequences of growth of electronic commerce is a greater need for a type of virtual money that can be used as an instrument of payment. The year 2009 marked the appearance of a revolutionary virtual currency named Bitcoin, a decentralized digital cryptocurrency. Bitcoin is actually the first virtual currency that has gained the trust of its users and in that way managed not only to survive, but to secure a significant presence in the place of online market transactions. This paper aims to point out both positive and negative effects of Bitcoin on e-commerce, as well as its influence on the greater macroeconomic and political plan.

Key words:

e-commerce, virtual money, bitcoin, impact.

1. INTRODUCTION

E-commerce represents a portion of electronic commerce, being a multidisciplinary concept of trading in products and services, as well as paying for them, using the Internet via virtual market. E-commerce has expanded on a global level significantly during the last decade, and it still shows great potential in growth and development. One of the consequences of the growth of electronic commerce is the greater need for a sort of virtual money that can be used as an instrument of payment. In this paper we will represent the main problem about the impact of virtual money on E-commerce. The year 2009 marked the appearance of a revolutionary virtual currency named Bitcoin, a decentralized digital cryptocurrency. Bitcoin is actually the first virtual currency that has gained the trust of its users and in that way managed not only to survive, but to secure a significant presence in the place of online market transactions. There wes a virtual currency, before Bitcoin, which was used only in gambling, betting and video games. This paper aims to point out both the good and bad aspects of influence Bitcoin has on E-commerce, as well as its influence on the greater macroeconomic and political scheme of things. The subject of

Correspondence:

Mirela Redžović

e-mail:
mirela.redzovic.12@singimail.rs

the paper is the use of a virtual currency in electronic commerce. The first part of the paper will expound the general characteristics of electronic commerce, including its development. The second part will deal with the digital cryptocurrency, Bitcoin, the operating process and transfers, while the positive and negative effects of virtual currencies and the future of electronic commerce itself will be explained in the final, third part.

2. ELECTRONIC COMMERCE

E-commerce has developed due to the process of globalization and the Internet. The advent of a website called Amazon.com in 1995, gave way to the appearance of electronic commerce. In it is early stages, Amazon only sold books while CDs and DVDs came later on. To this day, Amazon serves as a world leading e-commerce website. E-commerce can be defined as a commercial transaction between the provider and consumer of goods, based on an online digital technology. It is based on modern telecommunication, computer science, information technology and cryptology. E-commerce is actually a part of E-business. The global significance of electronic commerce lies in its easy access, with no limitations in regard to time or space. Access to commerce can be gained no matter where the user is, as long as they are using a computer. E-business technology is able to provide easy access to suppliers, prices and terms of shipment of any product. Because of the existence of E-commerce, product prices have become lower thanks to the smaller costs of online business as well as the presence of a huge variety of products.

The most common five types of E-commerce are presented in Table 1.

Types of e - commerce	
B2C – Business to Consumer	Selling of products to buyers – Retail (Amazon.com)
B2B - Business to business	Trade between companies (eSteel)
C2C - Consumer to Consumer	Trade between consumers (Limundo.com)
P2P - Peer to Peer	Online information exchange without an intermediary (Bitcoin)
M-commerce	Transactions via cell phones

Table 1. Five common types of E-commerce

The size of E-commerce equates to the size of online population, which amounted to 3,3 billion users, a staggering 40% of the world population in 2015. Since the online population is rapidly growing, the growth of E-commerce is considered imminent. It is estimated that by 2050 the whole of global commerce will convert to E-commerce.
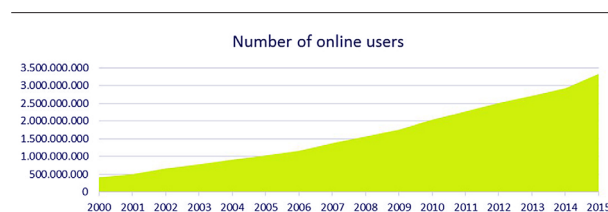
Graph 1. Number of online users

3. BITCOIN

The production of money started with golden coins. Due to the impracticality of payment in coins, banks started handing out gold receipts as proof of the existence of golden coins in the bank vaults. Furthermore, Fiat money was introduced, intrinsically valueless money used as money because of government regulation and thanks to that, it could be used in transactions and valued by the amount of numbers written on the paper. Moreover, this money had not gold reserve, and actual value. So it did not inspire citizens' trust. However it's still used these days and nobody is questioning whether that is a good or a bad thing. E-money exists thanks to the development of information technology and the growth of E-business.

Electronic (or digital) money signifies the consequence of the growth of E-business. E-money is an innovation that is currently in its early phase of development, but it already strives to assert dominance in the future, as in becoming the primary instrument of payment and perhaps completely replace paper money as well as other noncommercial instruments such as checks. Its use is far more practical in payment and transfers. Business banks are issuers of electronic money which is used in online payments. It has the same characteristics as paper money, and its usage is anonymous. The development of E-money depends primarily on the willingness of beneficiaries to accept new technology and readiness to pay the fee of usage.

Bitcoin currency has been launched in 2009 under the pseudonym of Satoshi Nakamoto. It is assumed that companies such as Toshiba, Samsung, Nakamichi and Motorola stand behind the pseudonym. Bitcoin represents a virtual cryptocurrency, an effect of the digital age,

based on open source peer-to-peer internet protocol. The base idea is the same as in Fiat money, *i.e.* to make payment easier and to provide a universal currency that can be applied worldwide. Furthermore, it is a private currency without the central monetary authority that is in charge of overseeing the currency. Moreover, cryptography is the protection mechanism of the currency. Finally, Bitcoin network consists of a great number of computers, where a single computer acts as a node in the network.

Bitcoin can be acquired in two possible ways: via mining or via buying:

- Mining – Miners represent group of computers that are joined together in order to create a bigger operational strength in solving complicated mathematical problems. It leads to a more efficient and a faster way of acquiring new Bitcoins.
- Buying Bitcoins – Buying Bitcoins serves as a traditional way of currency converting via E-currency exchange. There are two ways they can be bought: from an individual or from stock exchange. Buying from an individual is simple and it is performed on the Localbitcoins.com website, which includes Serbia, meaning that Serbian dinars can be exchanged for Bitcoins. Buying Bitcoins from stock exchange is expensive and it's a much more complicated process. Commission fees are high, considering that Bitcoins can only be acquired using dollars this way. The most famous world stock exchange that sells Bitcoins is Bitstamp. Currently, 1 Bitcoin (BTC) = 373.31$.

Bitcoin Transfer

In order to get their own personal digital wallet, an E-wallet, Bitcoin users must register on an official website. E-wallet is software that the user installs on their device, whether it is a computer or a smart phone. The user with it contains a unique Bitcoin address or a bar code that's made up of 32 numbers and letters – similarly to a bank account.

If the user wants to make a Bitcoin transaction, the transfer gives them a warrant transaction, similarly to sending e-mails, except that instead of an e-mail address, the user uses their unique Bitcoin address as well as their private transfer key. The private transfer key is a secret code, known only to the user, completely obscure to others. The transfer is made by using a digital signature. A digital signature is made of an asymmetric encryption and a public and private key and is sent via encrypted file until it is incorporated into a block, which is then incorporated into a chain, and the user gets the notification that their Bitcoin transfer has been successful.

4. IMPACT OF VIRTUAL MONEY

The upside of Bitcoin as a virtual currency is that it increases the total number of electronic commerce service users. Young people are being introduced with the process of electronic transactions in a fun and innovative way, which is a good thing. Another good thing is that there is no intermediary in the transaction process, meaning that

HOW TO USE BITCOINS

Download software to your computer or phone to set up a Bitcoin wallet. This gives you the basic facilities to send, receive and store Bitcoins

Your software will generate a unique string of letters and numbers: your Bitcoin address. The address isn't tied to your name or any other personal data, but it identifies you to the Bitcoin network. Give this address to anyone who needs to pay you

31uEbMgunupShBVTewXjtqbBv5MndwfXhb

Buy Bitcoins with a standard offline currency, either from another user or through a dedicated Bitcoin exchange. Your new digital funds are added to your wallet

The Bitcoin network authenticates transactions by recording them in the 'block chain' – the underlying code that preserves the integrity of the currency

Use your software to send payments to other addresses. Divisions as small as 100,000,000th of a Bitcoin are possible - a unit called a 'Satoshi', after the currency's enigmatic inventor

Picture 1. How to use Bitcoins; www.canadabitcoinpharmacy.com

the transactions are safe. The entire system is defined by an original algorithm that can not be changed by anybody. Many of the world's big companies, such as Microsoft, Victoria's Secret, Amazon, Subway, Apple, Tesla *etc.*, have accepted this currency as an instrument of payment.

The bad side of Bitcoin is that it is a deflationary currency. Its exchange rate is fluctuating, and stirring stock speculations. It is traded in order to make a profit on spread. Furthermore, without a central authority to supervise the currency and its transactions, crime has become a problem and Bitcoins have frequently been used to finance illegal services and commodities. As it is mentioned, there is no trust in the currency. Moreover, absence of regulation is the obstacle in wider acceptance of the currency.

People usually do not pay attention on safe side of the currency. This question is easily understood by looking back at 1971, USA, when President Richard Nixon ended the convertibility of the dollar into gold, making the dollar a currency without safe coverage. Since that time, the dollar is virtually -a form of a virtual currency. In fact, currencies around the world are practically virtual money, but under control of central banks *i.e.* stability of prices and money in circulation is provided.

Virtual currency	
Pros	Cons
No intermediary	Deflationary currency
Anonymity	Malpractice in terms of illegal transactions
Transaction safety	Absence of laws and regulations

Table 2. The pros and cons of a virtual currency

Bitcoin features encourage people to think about earning big amount of money to an illegal way. Websites like Silk Road, Silk Road reloaded, Amora Marketplace and Evolution Marketplace represent illegal online markets that use Bitcoin as payment for illegal commodities and services. They were introduced at the same time as Bitcoin. Silk Road has been a number one website of the acquisition of illegal products and services online. Silk Road offers stolen products, illegal pornographic material, drugs, guns and even contract killing. It goes without saying that these markets are illegal and completely illegitimate. The US Federal court in Manhattan prosecuted

the Silk Road website founder, Rose Ublert, confiscating 144,336 Bitcoins (31 million Euros). The website has been shut down, and Rose Ulbert found guilty, sentenced to life imprisonment. However, there are more websites that still continue to engage in illegal transactions.

5. CONCLUSION

This paper showed the development of electronic commerce in the last twenty years, as well as its prospects for further growth in the years to come. Considering the evaluated positive as well as negative impacts of Bitcon on E-commerce, it is the authors' opinion that this currency will not reach a greater global expansion in the market. Bitcoin may seem like a good replacement for real money, but it simply is not safe enough to be widely accepted. However, the authors consider that there will be an absolute need for virtual money as a result of technological development worldwide. Furthermore, the existence of the currency depends on organized institutional control of its issuance, rates and circulation. Finally, it is only in way that the currency will become globally accepted.

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E-COMMERCE

ELECTRONIC TRACKING OF POSTAL SERVICES

Žaklina Spalević[1],
Miloš Ilić[2],
Milan Palević[3]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2] University of Pristina,
Faculty of Technical Science,
Kosovska Mitrovica, Serbia

[3] University of Kragujevac
Faculty of Law,
Kragujevac, Serbia

Abstract:

In modern times, posts worldwide are using new technologies to improve the existing services, develop new ones, and improve the delivery of mail, package, express and financial services. Such improvements have been achieved over years, based on different market demands and customers' evolving needs. In the era of electronic devices, the Internet and the possibility of real time monitoring has created a need for development of different electronic services that will be used in postal services. Electronic tracking of packages from the costumer and postal side is one of the most important postal services. This kind of service provides useful information about the current location of the package to both sides. This information can accelerate the package delivery process. This paper summarizes and presents different uses of electronic postal services for package tracking through technical and legal observation. The paper also presents different illegal uses of postal services and solutions for better protection in accordance with the law.

Key words:

electronic package monitoring, electronic postal services,
postal abuse, GPS tracking.

1. INTRODUCTION

Over the past twenty years, significant steps have been made to improve postal services as well as increase trust in online postal transactions. While the impact of digitization is not new, the digital economy is entering a new phase that presents new challenges and opportunities. Digital tools are changing how companies are structured and how they communicate and sell. This has triggered the digital transformation of the postal industry. Some of them, such as broadband Internet, mobile and social networks are long-term trends that started at the turn of the century. Others, such as the "Internet of Things" or big data, embody a new wave that will increasingly impact e-postal strategies in the upcoming years.

In one study published by the Universal Postal Union (UPU) about four years ago, fifty-five different types of postal e-services were identified. All of them are currently offered worldwide (Corredera, 2012).

Correspondence:

Miloš Ilić

e-mail:

milos.ilic@pr.ac.rs

Different postal services work in different ways, and demand different use of new technology solutions. One of them is Express Mail Service (EMS). EMS is a global brand designating the postal product with the fastest delivery. That is an international express postal service offered by postal-administration members of the UPU. These administrators created the EMS Cooperative in 1998 within the framework of the UPU to promote the harmonization and development of postal services worldwide. Posts in around 200 countries and territories worldwide offer this premium end-to-end service for documents and merchandise. Many transportation logistics firms offer similar accelerated services. Express and standard package and mail transportation must be finished in advance of the defined time period. All shipments must be preserved and delivered in their original form.

Another electronic service provided by postal institutions, which is connected with mail and packages transportation, is package tracking. Package tracking or package monitoring is the process of localizing containers, bags, and package post at different points of time. This process is important because it provides information about package origins and could predict time of delivery. Necessary information is collected during package sorting, storing in the warehouses, and delivering to the recipient. This kind of electronic or online service provides customers with the information about the route of a package and the expected date and time of delivery (Esser, 2011). Mail tracking is made possible through additional postal services. Those postal services require that the identity of a mail (packages) be recorded during various points of delivery. Such information provides proof of delivery to the sender, but it also enables the receiver to predict the time of delivery. (Joyce, 1893). To identify the location of the mail, two methods are in use worldwide. The first one involves reporting the arrival or leaving of the package and recording the identity of the package. Location, time, and status are parameters that represent package identity. The second approach is based on Global Positioning System (GPS) of vehicle tracking. This system is in use to locate the vehicle that contains the concrete package and record vehicle position in a real-time database (Dignan, 2007).

With development and massive use of the Internet and mobile devices, web-based package tracking is in use to automate customer service. Web-based tracking system provides the ability to track the status of a package in real time. Appropriate evidence of online tracking popularity is registered during the period from 1995 to 1999. The number of web tracked packages in 1995

was 3.3 million a day (TNYT, 2000). Online package tracking became available for all major carrier companies. It was significantly improved by the appearance of websites that offered combined tracking for different mail carriers (Basu, 2010). With the rise of smart phones, package tracking mobile apps are used to send tracking info to customers' cell phones. Furthermore, mailing services are able to automatically detect tracking numbers in messages and provide real time location of the package to the user (Pogue, 2012).Package transportation is a complex and precise task for each postal company. The quality of service and customer satisfaction must always be on a higher level. Customers transport many illegal materials and products by this kind of services. Drugs, weapons, smuggled goods are just some of the products that can be found in packages that are transported through the postal transportation service. This and many other abuses of postal service are the problems for transportation companies. Because of that, posts must improve their services with each new day, and protect themselves and their customers from people who abused this type of service.

The first goal of this research is to provide information about postal tracking system from the customer and postal side. The second goal is to present the most important and most dangerous abuse of postal services. The third goal is to provide legal regulations in the fight against this kind of postal abuse.

2. E-TRACKING OF POSTAL PACKAGES

Package tracking is an integral part of a package delivery service that allows a customer to track goods that they have shipped or that have been shipped to them. The advent of the Internet has allowed commercial carriers to make it possible for customers to track their shipments online using a web-based service. Some businesses have taken package tracking a step further and integrated the package tracking functionality into their internal business systems. Based on the tracking system, the client could get information about delivery date and time, name of the recipient, the visual appearance of digitized signature of the recipient and *etc.*

For the most part, package tracking services operate on a package-by-package basis and require that a customer queries a carrier database with a package tracking number associated with the package to be tracked. Tracking number is alpha-numeric code, and this code consists of thirteen alphanumeric characters. This numeric code is divided into three groups of characters:

- The first group consists of two characters, and these characters represent the type of a postal shipment.
- The second group consists of nine alphanumeric characters, and this group represents ordinal number of shipments.
- The third group consists of the last two alphanumeric characters, which represent a country where the package was shipped.

Some of examples are EE123456785US, RR123456785US and CP123456785US. This code contains check digit which shows whether EMS tracking number contains a mistype. A block of characters representing the country indicates the origin country of the shipment. Bags and containers in which the packages are dispatched must also be marked with code. This code consists of seventeen alphanumeric characters, which are divided into four groups.

- First six alphanumeric characters represent the ordinal number of bags or containers.
- Seventh alphabetic character represents the type of the bag or containers.
- Characters from eight to twelve represent ZIP code of dispatching post office.
- The last five numeric characters represent ZIP code of the receiving post office.

Different states can be assigned to the shipment which is being electronically monitored. Some of them are: reception, awarded, dumped report, return to sender, next delivery, *etc*. Each of the states provides information for all sides to whom the information is of importance. Three main participants can be observed in this kind of tracking or monitoring. Those are the sender, the receiver and the carrier. Each of them has specific reasons for package tracing. Other users include Transport Broker, Packaging Services, Collection and Delivery Services, Depot/Hub/Terminal operators, and Vehicle Drivers (Jakobs *et al.*, 2000). Senders can be either companies or individuals. Individual senders will typically take the package to a collection office. Home collection could also be possible, and it should be possible to arrange this service though internet/WAP access. The sender would like the options of email confirmation of package delivery, and internet/WAP access to transit status and estimated time of arrival. Company senders want to receive as much status information as possible because this can be then provided to their customers, providing value added to their service. Likewise, delivery time reliability is important, as would be the ability to confirm that the package has been received by the appropriate individual.

All receivers should receive advanced shipment notification with the packages in transit given a numeric code to be used by both sender and receiver. In the case of individual receivers, the numeric code will usually be assigned by the sender. Individual receivers want to know when a package will arrive so that they can ensure that someone is there to receive it. Internet/WAP access and email messages can provide an attractive customer service. Depending on the nature of the business, size of companies and the supplier-customer relationship, the level of detail of package movements and status can vary as agreed between the sender and the receiver.

Companies providing express delivery, freight-forwarding and logistics management will be the main proximate users. Their customers may have certain data requirements, ,but they will mainly want a high level of performance and services to be provided to them seamlessly and transparently (Jakobs *et al.*, 2000). The carrier also requires regular feedback from moving transport units where possible. This information will comprise location and transport unit status, along with all the packages carried and their routing, destination and estimated time of arrival.

Improvements in postal tracking systems

Each post office worldwide has one important task, to provide the best possible service to its customers. New technologies are used to create location tracking systems to provide better quality of packages transportation. One of them is GPS. On a large scale, companies must track their vehicle fleets across the country or the world. GPS is the ideal tracking technology for tracking over large areas. To do this, every vehicle needs to be equipped with a GPS receiver. As the vehicle crosses the country, the GPS satellites track the truck's position. With GPS, the operator can request positioning at any time. In this way, the posts base station may contain information on the current shipment location and the expected time of arrival. This information will accelerate the delivery process. As a replacement for traditional bar codes on the packages, Radio Frequency Identification (RFID) tags can be used. RFID are small microchips that can be attached to consumer goods, cattle, vehicles and other objects to track their movements. RFID chips are passive and only transmit data if prompted by a reader. The reader transmits radio waves that activate the RFID chip. The chip then transmits information via a pre-determined radio frequency. This information is captured

and transmitted to a central database (Stanivukovic and Markovic, 2014). In the past, RFID was used for little more than the evaluation of postal performance. This kind of tags is used in a small percentage of letters, and for the tracking of a small number of conveyances and vehicles. International Postal Corporation now monitors mailflow and mailboxes with RFID in over 50 countries (Stanivukovic and Markovic, 2014). There is even a postal RFID system that completely automates the whole process of mail delivery from accepting the package through classification and dispatching. This system has been successfully tested in Korea on the mailboxes. Another example of RFID use for the postal services is RFID posts stamps. Stamps RFID project is based on the implementation of passive RFID tag on the traditional postage stamp in order to establish RFID technology in function of stamps. Symbiosis like this provides an increase in the quality of postal services, and opens new opportunities for development of postal services (Stanivukovic and Markovic, 2014).

3. ABUSE OF POSTAL SERVICES

Package transportation companies and postal offices must provide high quality of service to customers so that they could be able to send whatever they want and where they want. In most cases, employee in the post office does not check the contents of the shipments. The customer has an obligation to report what he/she sends and what is the value of the shipment. This fact provides the space for different abuse of postal services. Some abuses are minor, while some can be classified as criminal offenses. Offenders use the government and private postal companies transport prohibited goods. Different examples of postal service abuse shall be further presented.

Drugs transportation via postal service

Every day, smugglers all over the world develop different ways to transport and distribute narcotics. Postal transportation service is just one of them. They use different ways for this kind of job. One way is to pack narcotics in small packages and send them to different locations for redistribution. In some cases, narcotics are packed in packages that look like different medications. Some of the examples of narcotics transportation via postal service are presented in continuation.

The transportation of narcotics using various packages systems has been exploited, and it continues to be a popular method of transportation, because it is relatively safe and inexpensive. These packages systems are occasionally monitored by law enforcement, but not sufficiently enough. This type of investigation is difficult to prove and takes extensive investigative effort (DWN, 2014).

One example of drugs transportation via postal service is recorded in Philadelphia. Two brothers were distributing methamphetamine via Express Mail between the two cities. Inspectors discovered the men were secreting methamphetamine inside caulking tubes and transporting the tubes to Philadelphia via Express Mail (IDAT, 2002). As with many drug networks, dealers used the U.S. Mail along with other transportation methods to distribute narcotics and narcotics proceeds. After taking the brothers into custody, inspectors identified their conspirators who drove the methamphetamine from Winston-Salem, North Carolina, to Philadelphia. Inspectors additionally arrested another two conspirators.

Postal Inspectors and San Diego Narcotics Task Force agents arrested a man on May 16, 2002, for distributing anabolic steroids, ketamine, and other controlled substances via the U.S. Mail. The suspect advertised products and received orders via the Internet and then distributed the products by Express Mail or Priority Mail (IDAT, 2002). He allegedly distributed approximately $5,000 worth of controlled substances per day to more than 300 customers across the country.

The discovery of large quantities of drugs being trafficked through the mail in Peru and Ecuador have led to crackdowns and mandates for reform, while in Florida authorities reported an unusually high level of drug interceptions in the mail in 2011 (Bargent, 2013).

Since recreational use of marijuana became legal in several countries, the number of pot-filled packages sent through the mail increase rapidly. In some cases, pot was packaged inside cans of corn and bags were hidden inside a hand-held vacuum. Others were shipped in heat-sealed packages to disguise the smell. The U.S. Postal service handles more than 155 billion pieces of mail a year and more than a billion of that in Chicago. Forty thousand pounds of pot were seized nationwide from the mail in 2014 (Goudie and Markoff, 2015).

Traffickers use the postal service for narcotic delivery because it is relatively cheap, timely, and the volume of packages works against detection. A large number of post offices across the U.S. country handling millions of packages each day. Employees are talking about a massive number of packages to even consider examining. Mailing narcotics also gives traffickers flexibility to

expand their markets to areas where traditional drug-dealing systems are less profitable or practical. Express Mail is the preferred method because dealers can move their drugs quickly and covertly and get the proceeds back in the same fashion.

Illegal weapons and ammunition transportation

Illegal firearms transportation through the postal transportation service is another abuse of this kind of services. For this kind of job, offenders use different techniques to mask firearms inside the packages. In some cases, they packed weapons or ammunition in specially designed packages in order to reduce suspicion on the interior of the package. The package must look like some familiar object, and be of the same length. The description of the contents of the package usually responds to a metal object. This is because the package goes through metal detector checks. If the weapon is huge, it will be disassembled into parts. Each part will be sent into a different to the same or different addresses. At the destination, recipient will receive all the parts, and will assemble a weapon.

One example from Seattle shows two brothers arrested in June for a scheme to ship firearms parts to Thailand have pleaded guilty in U.S. District Court in Seattle to conspiracy to illegally export firearms parts (Brock, 2013). In plea agreements, the brothers admitted that one of them, while living in Thailand ordered firearms parts he wanted to send overseas. Investigators say the gun parts were first sent to his brother's home in Bellevue. He then tried to disguise the shipments and send them on to Thailand. Brothers in one case shipped magazines for .45 caliber handguns, while labeling them, "vented steel case for electronic components" or "replacement springs and metal caps for bottling machine." Other shipments were labeled as "hobby parts" or "glow in the dark marker sets." The group is believed to be responsible for more than 240 shipments of restricted firearms components. The defendants did not ship any assembled firearms.

In Canada, criminals are using postal system to transport illicit goods including guns, grenades, dangerous chemicals. Pistols, rifles, ammunition, body armour and hand grenades are being shipped to Canada from abroad (Bronskill, 2013). Each of presented examples shows that illegal transportation of weapons via postal service is not so uncommon, and criminals will use this kind of service for their illegal jobs regardless of the consequences.

The use of postal services for the delivery of sold goods

In most cases, posts provide package delivery between private individuals. One of the most common abuses of postal services in such cases is that the user not specifying the appropriate shipment value, especially when the value of shipment is large. In many cases, the customer does not state the regular name of the item in the package. For example, customer could send medicals, or some chemicals which need to be appropriately packed and transported. In such cases, because of the price for such kind of transportation, customer states that the package contains some books, plastic or metal objects. Another problem appears when packages containing breakable things are not properly marked. In the case of damage on the items inside the package, the customer could not refund the money in the value of the object inside the package. From other hand reputation of the post may be compromised. One more common abuse of postal transportation services, especially the express mail services, is related to delivery of sold products in online shopping. In cases like this, posts do not have mechanism to check what is in packages and if the item in the packet is object of some illegal purchase. Buyers purchase some products online or by telephone shopping. That product can be smuggled or stolen by the other side. For such product customers pay the agreed amount to the seller's bank account. After transferring the agreed amount to the seller's bank account, the seller sends the purchased object through the postal service. It is not so unusual that seller sends smuggled object to the buyer, and demand the price for an item is paying to postal worker at the time of receipt.

4. LEGAL REGULATIONS BEHIND POSTAL SERVICES

All postal services and activities assigned to the posts are regulated by the law of postal services. Each country has adopted this law in accordance with their needs. In the Republic of Serbia, law of postal services regulates the provision of postal services [1]. Article three declares that postal services are services involving the receipt, transmission and delivery of postal shipments. The transfer of postal items means technological processes in the postal operator from the receiving stations to the city of delivery of postal items. Packages are the shipments packaged

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1   The law of postal services, „Official Gazette of the RS", № 18/2005, 30/2010 and 62/2014. Retrieved 20.02.2016; from http://www.posta.rs/dokumenta/lat/o-nama/zakon-o-postanskim-uslugama.pdf

in a prescribed manner, which contain goods and other items and have the item or document accompanying the shipment, and description of contents inside the package. Pursuant to the Article 6, all postal operators are obliges to act in accordance with their specific conditions, to provide inviolability of postal items and confidentiality of data. The principle of inviolability of postal items may be violated only in cases and under conditions stipulated by law. This means that if the some shipment or data about some customer are under the criminal investigation, those data must be forwarded to the legal authorities.

Article 29 stipulates which postal shipments are forbidden for sending or receipt, transmission and delivery This article bans shipment of narcotics, except in the case when the recipient and the sender are authorized by law for drugs traffic, or are authorized for their use. In special cases, in our country and abroad, different government services and agencies could define rights and obligations applicable to postal services. Posts have the right to create their policies about the work and service provision, which must be in accordance with the law. In the U.S., the United States Postal Inspection Service (USPIS) is one of the oldest law enforcement agencies. Its mission is to protect the Postal Service, its employees, and its customers from crime and to protect the nation's mail system from criminal misuse. Postal Inspectors apply over 200 federal laws in investigations of crimes that may adversely affect or fraudulently use the U.S. Mail, the postal system or postal employees. The USPIS has the power to enforce the USPS monopoly by conducting search and seizure raids on entities they suspect of sending non-urgent mail through overnight delivery competitors. The Postal Service in U.S. and other countries demands an unwavering commitment to strong ethical values and principled decision making from all of its employees. All postal employees are required to place loyalty to the Constitution, the laws and ethical principles above private gain. To ensure that every citizen can have complete confidence in integrity, each postal employee must respect and adhere to the principles of ethical conduct set.

5. CONCLUSION

Posts all over the world provide different services to their customers. Posts have advanced in the provision of services over years. Different new services have been introduced with the aim to provide better. In today's modern world, many of the postal services are related to the Internet and different other electronic devices. The purpose has remained the same, to provide as much as possible better and faster service to their customers.

Electronic tracking of packages during the transportation of the shipment provides different advantages to the customer and to the posts. Posts in different countries have different demands and technical solutions for electronic packages monitoring and tracking. Their common feature is that they cooperate with ICT technicians to provide better shipment tracking system.

On the other hand, malicious users, criminals, drug dealers and arms smugglers use postal services in their illegal activities on a daily basis. To prevent such criminal abuses, posts must provide better package control, and must cooperate with legal agencies and police offices. Only under such conditions, it is possible to ensure full security of their services.

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T-LEARNING VIA INTERACTIVE DIGITAL TELEVISION

Andreja Samčović,
Svetlana Čičević

University of Belgrade
Faculty of Transport and Traffic
Engineering,
Belgrade, Serbia

Abstract:

This paper presents the prospective use of interactive digital television (iDTV) in the process of learning via television (T-learning). The T-learning (learning by television) is reaching a considerable importance and is exploiting the available technologies of iDTV to allow opportunities for learning on every location and whenever users need. Following the description of T-learning opportunities and applications, the key elements of an interactive digital TV chain are described.

Key words:

T-learning, smart TV, digital TV, digital divide, IPTV.

1. INTRODUCTION

In the last forty years, television (TV) has shown a strong educational impact. Broadcast video content was stored on video cassettes and later on compact disks (CDs) and digital versatile disks (DVDs). With the introduction of digital television (DTV), new possibilities emerged for the use of television in education. DTV provides many technical improvements, such as, for example, better picture and sound quality. These properties are not the true contribution from the standpoint of education. The another promising potential of the digital TV is interactivity between the user and TV. Furthermore, additional content can be included in the broadcast signal, besides audio and video content (Crinon *et al.,* 2006).

Probably the most essential reason for the introduction of digital techniques, as a prerequisite of the distribution of television signals, is a high degree of efficiency (efficient coding) in meaning the capacity of the transmission channel and control interference and noise. The broadcasters, as well as users, facilitate the process of reception, storage and content archiving. It is also important that the digital television (DTV) offers much greater flexibility in services compared with analogue television, because the available content is not limited to that what a producer wants to or wishes.

Correspondence:

Andreja Samčović

e-mail:

andrej@sf.bg.ac.rs

In DTV the broadcast sound and the image are digital, which have several advantages: simpler archiving, better use of frequency spectrum (within the same channel capacity the content amount is higher), better picture and sound quality, different services, supervised resistance against record interference and noise.

We gain the ability, as spectators, to have the influence on the content shown on our TV receivers. With the advent of this technology, the development of interactive content is not limited on the narrow professional circles and TV production houses. Viewers interaction with TV is a prerequisite for their active participation in the learning process. If the system is followed by the interaction of the viewer with TV, the system can also offer to the viewer personalization of content. In the context of interactive digital television (iDTV), we understand the interaction and the use of remote control to request additional information on the broadcast program. This feature allows the selection of additional content (Atwere *et al.,* 2003).

Depending on where the additional content is stored, interactivity can be divided into the local and global interactivity. In the local interactivity, the user can only access the content which is stored on the device called set-top-box (STB). On the other side, the global interaction takes place when a user accesses content over the return channel, which is stored by the content provider or a broadcaster. We are interested in interaction and associated additional related options offered by iDTV, making advantage of the most effective way of learning. While in the case with classical television the viewer can just watch a program and cannot interact, iDTV brings undoubtedly new potentials in education. The main advantage of television is that it is accessible to a wide audience, users accept TV technology as familiar and easy (Andrealis *et al.,* 2007).

Interactive digital television combines two technologies: DTV and interactive applications. It can be used as media service in addition to voice and images. This technology allows to raise the level of interactivity between the viewer and the TV screen to the higher level. A viewer is no longer limited to a narrow set of functions (change channel, volume, switch on/off).

The television basically remains the medium that will be based on the video content. Video is the main advantage of television within learning process, differing from other electronic media. This is probably the main reason for implementation of television as a teaching tool. However, if only the video content was sufficient for the education process in the past, the introduction of electronic media has changed the situation.

The iDTV has a potential to become an important tool of informal learning through integration of education into the entertainment environment (edutainment), because of the familiarity of TV, easy utilization using the remote control and particularly, due to the power of upcoming interactive technologies. To be able to reuse this potential, it is necessary to develop new formats, applications and methodologies for delivery of educational content to target users.

The article is organized as follows: some aspects of T-learning are presented in the next section while the following part is dedicated to the digital divide. The description of the available technologies of iDTV used in T-learning are discussed in the final part.

2. T-LEARNING OPPORTUNITIES AND APPLICATIONS

The term T-learning is defined as learning through interactive television, which refers to having interactive access to video-rich learning materials by a TV or other device that looks like a TV receiver with computer (Aarreniemi-Jokipelto, 2005). This device has to be reliable and easy to use (Lopez-Nores *et al.,* 2004). The internet tools are often used to support virtual education. However, this scenario has a limitation, especially in the case of developing countries. TV penetration is much higher compared to internet worldwide. That is why new possibilities are explored for online education, now using television as a means to reach learners.

In recent years, there has been a considerable increase in the amount of educational content and support platforms for online learning or e-learning. This represents a final approach of citizenship education. The e-learning allows education to cheapen and facilitating access to everyone regardless of their geographical location and even temporary availability (Cassalino and D'Atri, 2005). The ability to access knowledge and training offered by high-level international experts is a fact which is highly enriching and democratizing. People with specific kinds of impairment in general, and persons with disabilities in particular, especially benefit from the new technologies. The persons with moving difficulties, disabled and those with problems in access to "conventional" education can enjoy this kind of learning.

Traditionally, analogue television offers viewers a passive attitude to the content features. The iDTV, however, give the opportunity to access the learning courses at study places, homes, school or work. Produced content for iDTV

covers the interdisciplinary process, bringing together knowledge experts from various areas: computing, design, pedagogy, journalism, communication *etc*. Digital TV includes data and interactive applications in addition to transmitted audio-visual content (Piesing, 2006).

The general requirements for developing a T-learning course are the following: the interaction and communication must be feasible through the technology; the technology should support the the pedagogical content and the tasks presented to the students, as well as learners assesment; the possibility of content reusability through various subjects on different devices; and the opportunity to support learning for adults and elderly.

The aim of teaching and learning using digital TV promises to be of great value for education. The production of content oriented to T-learning is a challenge. The phase of pre-production stands for planning of requirements for a course available at iDTV platform. The challenge is to adapt the content with less text than a web page and to motivate the different audiences watching the television in the form of entertainment, for educational purposes. At the pre-production, there are three types of requirements: human, technological and pedagogical. It is noteworthy that the human and technological requirements can also be used for any application, such as e-government (T-government), T-commerce, T-health among others. However, teaching requirements are specific for the domain of T-learning.

3. DIGITAL DIVIDE

It should be remembered that there is a digital divide, which is not configured in only a technical problem of access or possession of technological tools, but in a much broader sense. It refers to some aspects related to each other: education, technological literacy, intellectual and practical skills of individuals, minorities and the disabled, technological innovation, the production of content, the quality of life, the expansion of specific communities, as well as the transition into the working world. It is easy to imagine that those who have access to the internet and know how to use it can be considered as more informed citizens, and more involved in social and political life. One aspect of digital divide can be the gap between those who have access to the internet and the information that can be found there and those who do not have such opportunities (www.elearningpapers.eu). Figure 1 represents internet use compared to age.
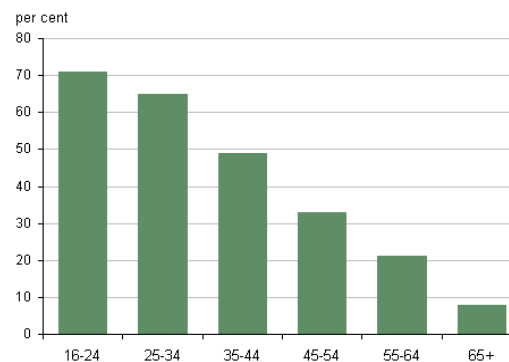

Fig.1. Internet use compared to age (Statistical bulletin: Internet access - households and individuals, 2011)
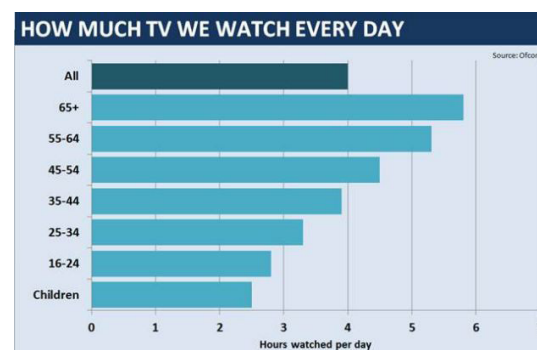

Figure 2. Television use compared to age
(http://stakeholders.ofcom.org.uk)

Another possibility to overcome the digital divide is by using digital television. There are several benefits that digital communication provides to TV and one such benefit is interactivity. That means the ability of the user to interact with the elements displayed on the screen in uni-directional or bi-directional manner. The most important reason for useing digital TV in the context of learning is its accessibility both in a formal and informal manner. Television use compared to age is shown in Figure 2. We can see that older persons watch TV most compared to other age groups. Older persons and children can be the potential users of T-learning technology (Recchioni *et al.,* 2007). On the other side, users of e-learning technology are predominantly younger students.

4. INTERACTIVE SYSTEMS FOR T-LEARNING PLATFORM

The realization of a T-learning platform requires from the content provider the planning and development of a specific architecture based on digital interactive tech-

nologies. Technologies that can play a significant role in implementing T-learning platform are the following:

- Internet Protocol TV (IPTV);
- Video on Demand (VoD);
- Network Personal Video Recorder (NPVR).

Internet Protocol TV (IPTV)

Development and investment in interactive multimedia systems, such as IPTV system, have been increasing in the last years. When there is user interaction with the system, such services are called interactive services. If they wish to provide such services to users, service providers need to offer programs that will be broadcast according to the popularity of the content or they can offer a service in which content will be arbitrarily selected by the user. Interactive IPTV service will provide new users, and of course, more profit. In the development of interactive multimedia services, despite all benefits, many new technical problems must be resolved.

Specific interactive services that can be used via TV screens are already in use, while others are still being developed. Some of the more interesting interactive services that can already be used, or commercially expected in the near future are the following:

- IP video on demand;
- Internet browsing via the television;
- Notification of incoming calls on a television screen (showing caller ID), which the user can accept or reject;
- Creation a list of friends who are subscribers of different operators and correspondence with them;
- Information about the location or the currently selected TV channel of a friend;
- Sending invitations to friends to switch to the same channel;
- Transfer of paid content to a friend as a gift;
- Remote control for parents;
- Participation in the quiz with our friends;
- View to missed calls for mobile and fixed telephone lines;
- Electronic Program Guide;
- The possibility of skipping or selection of specific advertising.

Interactive characteristics allow many other things like skipping some TV ads, displaying only the desired. One can see the details of different events, buy from

their own homes, book travel, *etc.*, all with television. It is therefore clear that the boundaries between computers and television are increasingly disappearing. The development and installation of infrastructure that will enable all of these services and functions, of course, requires a lot of planning and effort. While most of the attention is devoted to what interactive multimedia system offers, little is said about how these systems will be compiled and at what price. Some technologies to support and guarantee the functioning of such systems already exist and are in function. However, it definitely needs more effort and extra work that would be actually able to talk about the functioning of the end-to-end system.

An interactive video system (*e.g.* IPTV) invoked many changes in the field of television. In traditional TV broadcasting systems, all channels are transmitted at the same time. The result is that sometimes the user has to choose between more interesting shows, because they are emitted at the same time. Because TV service providers do not want this scenario, interactive systems enable users to view favorite content to the user's personal schedule, *i.e.* when he wants to do. The user is thus able to not miss any of the content. The result includes more satisfied customers.

A set-top-box (STB) is a device based on IP protocol, which is used to connect IPTV head-end with a TV set, which is illustrated in Figure 3. The main function of a STB is to interpret and translate customer's requirements into IP messages sent to the head-end. These requirements represent the user's selection of specific content or services. In the response, STB will receive the encrypted content that needs to be decrypted and decoded in order to be properly presented on the TV.

Figure 3. Set-top-box for IPTV

Video on Demand (VoD)

Video on Demand (VoD), as the most important IPTV interactive service system, offers to users a lot, but the most interesting is certainly the ability to play video content on

demand. The service video on demand in the IPTV system allows users to select the video content and the time of its reproduction. This option currently represents a significant advantage compared to conventional television. The users of telecommunication services, due to faster lifestyles and increasing liabilities, less and less are able to watch a film, series and other audiovisual content in a pre-determined fixed terms.

Previous offer of classic television content is no longer adapted to the needs and desires of the user, *i.e.* it still offers the so-called linear audio-visual content. It is tailored to the way of life as twenty years ago. The way of life of today's users implies new demands. Today, there is no time to look at the content of the program schedule of the service provider. Therefore, there is a need to adapt the service provider program scheme to each individual user. VoD permits users to do so. This service is now also necessary because of the increase in the amount of available audio and video content. Therefore, due to the aforementioned reasons, it is necessary to develop smart system for storing, sorting, searching and playback of content, which is of importance in the process of T-learning (www.iptv.com.au). One example of smart TV which can be used for VoD service is shown in Figure 4.

Figure 4. Smart TV (http://itcafe.hu/cikk)

Technically speaking, the provision of content that users can view on-demand over IP (Internet Protocol) network is somewhat more complex than the usual distribution of TV programs. Problems arise in providing content that our telecom provider can offer. The copyright in movies, shows, series is a key element in the implementation of the distribution system using new technologies, such as IPTV.

IPTV system can be broadly divided into two subsystems:

- LIVE TV system (channels that broadcast live);
- VoD systems (play on demand).

Network Personal Video Recorder (NPVR)

Network Personal Video Recorder (NPVR) is a technology that allows users to program a video recording and view the same content over at their own discretion. For a supply of NPVR, users specify in advance which programs provided by TV service with linear programming they want to save for later broadcast. A network provider copies the required content and archives them online. In fact, NPVR service is a type of VoD service, in which all of the content that has been identified by one or more users is recorded for later broadcast. One possible example of the NPVR is shown in Figure 5.

Figure 5. Network Personal Video Recorder
(http://www.cs-sunnetwork.com/svod.html)

The watching rights over a NPVR can be different: one watch, more viewings, unlimited number of viewings. The program support for digital rights management is very important. The time shifted allows more flexibility in content viewing to end users. The content is recorded and stored inside a network and not on a user's device, which is the difference compared to classical video recorders. That possibility offers access to more advanced video services for users, and for operators to re-allocate storing capacities inside the network. Time shifted TV is a service which permits capture of live video streams and their storing in real time, which is important for a TV-learning system (Bijnens and De Gruyter, 2008).

Because in this case there are clear user requirements for the recording of certain content, provider has a fair view on the popularity of the content, so it can adapt optimal archiving strategy. Consumers can use a standard video recording controls, such as fast forward and rewind, pause and record. When NPVR platform is deployed, the desired content of subscribers is stored on the central server, which eliminates the need for expensive STB hard disk.

There are several different approaches in implementing NPVR:

- *Hosted NPVR space* - provides to subscribers a space on the hard disk of VoD server. The space on hard disk varies between operators. When there is a request by IPTV interface, software captures certain content (content sections), whereby the recorded content is stored on hard disk server where it will be available to the subscriber.

- *Recording of linear channels* - another approach involves taking of a linear program as a whole and making it available to users in a fixed period of time, usually for a week.

5. FINAL CONSIDERATIONS

Television is still the medium present in almost every household, and therefore more opportunities exist for learning at our homes in much more relaxed situations. A relatively new concept of T-learning, which means learning by using television, can be a challenging tool to complement distance learning and e-learning.

T-learning employs the advanced technologies of interactive digital television and it can exploit those techniques by invoking new needs and requirements. The important technologies involved in the process of T-learning are discussed and described in this paper. These technologies are still evolving in order to support more efficiently T-learning and other interactive services for TV. Interactive digital television (iDTV) is a promising platform for education since the technology can reach a large number of people and provide users with computing and communication interactivity.

There still remains a lot of questions that need to be answered in the near future, such as: What are the approaches that different manufacturers are taking? Which new features will be improved? What are the market place realities? How many people will have smart TVs in the next few years, how many actually use them, and what opportunities are available for learning providers? In this context, we can conclude that the real potential of T-learning is promising.

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THE EFFECTS OF HOTEL WEBSITE STIMULI ON CUSTOMER'S COGNITION, EMOTION AND INTENTION BASED ON THE EXTENDED SOR MODEL

Angelina Njeguš,
Radmila Živković,
Lidija Ilijevski

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:
The research objective of this paper is to identify and verify the effects of the hotel website stimuli on users' emotions and behavioral intentions by applying the extended Mehrabian and Russell's Stimulus-Organism-Response model. Based on the online survey, the findings are that website design has significant impact on service quality perception. Hotel interior produce higher PAD emotions than hotel exterior. However, the users' emotions are affected by an additional factor - hotel reputation, that is not previously considered under SOR model.

Key words:
hotel website design, Stimulus-Organism-Response model, pleasure-arousal-dominance emotions, behavioural intentions.

1. INTRODUCTION

The guest will get the first impression about the hotel via its website, or by reading any information available on the Internet. According to the European Commision research (2015), 46% respondents consider Internet websites as the most important tool when making decisions about their travel plans. Therefore, the quality of hotel website, and profile on social networking websites, visibility and good search engine positioning, positive reviews on OTA (Online travel agencies) are only one way to grab the customer's attention. In comparison to the traditional dimensions (Zeithaml *et al.*, 2006), the online service quality (SQ) attributes are summarized in Table 1 (Njegus, 2014).

Traditional dimensions	Online SQ dimensions	Online Service attributes
Tangibility	Website design	Accessibility, Usability, Navigation, Attractive
Reliability	Website content	Funcionality, Information quality, Accuracy, Timely, Relevance, Understandable, Complete, Current; Dynamic, Multilanguage, Fulfilment
Responsiveness	Responsive	Communication, Efficiency
Assurance	Security	Credibility, Trust building, Privacy
Empathy	Personalization	Customization (intelligent tools)

Table 1. Website service quality attributes as stimuli

Correspondence:
Angelina Njeguš

e-mail:
anjegus@singidunum.ac.rs

The question that arises from this point of website design and SQ attributes: Are these online service attributes enough for user to react? What impression does the website design leave on the end user? What are user's emotion when interacting with the website? Does this emotion, caused by design, have influence on user' purchase intention? Therefore, it is inevitable to introduce behaviouristic psychology when designing the website, or more specifically, social psychology, color psychoogy, visual hierarchy, emotional triggers, pattern recognition and other.

Mehrabian and Russell's Stimuli-Organism-Response (SOR) model, introduced in 1974, was the first to suggest a link beween the physical environment and human emotions and response behaviors. However, with advancement of information and internet technologies, this model has been expanded on virtual environment, since any stimuli factors, such as: social, design, and ambient, could be also applied virtually (Kim *et al.*, 2012) (Chehimi, 2014). Kotler (1973) also introduced environmental atmospherics as an important marketing tool. Bitner (1992) introduced term "servicescape" that describes how physical environment (layout, design, decoration, aesthetics) influences users' internal states and behavior. The term "e-servicescape", as natural extension due to the internet expansion, applies the qualities of physical servicescapes into the online environment (Koering, 2003) describing how the user feels when visits a web site (Lee *et al.*, 2012).

Previous studies, related to tourism and hospitality, have analysed the influence of website features on attitude, satisfaction, and purchase intentions (Tang *et al*, 2012; Bai *et al*, 2008; Rasty *et al*, 2013). However, these studies do not investigate the mediating role of emotions between website stimuli and purchase intention. Mehrabian in 1996, illustrated that when a user enters an environment, the three emotions are induced: pleasure, arousal, dominance (PAD). According to Zimmerman (2012) research, pleasure, and arousal affects the user to revisit the website, and dominance produces purchase intention, and brand loyalty, and is leaded by good interface design, and interactive services.

The main goal of this paper is to examine the effects of the hotel website stimuli on the users' cognitive and affective states that influence their response behaviors (*e.g.* purchase intention).

The paper is structured into two main parts. In the first part, SOR model, website design trends, and previous research about the effects of website stimuli on user behavior, are discussed. In the second part the research, methodology is given through discussed data analysis and results.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

SOR model

SOR model, firstly applied to traditional retail stores, is recently used in the online context. Website stimuli (S) refers to aesthetic and sensory perceptions of a website, that includes website design, security/privacy, services. In more detail it refers to images, sounds, colors, words, features *etc.*

The organism (O) refers to emotional and cognitive states that users experience when visiting the website. Therefore, organism is made up of the affective (hedonic attitudes) and cognitive (utilitarian attitudes) mediating variables. Affective variables include pleasure, arousal, and dominance. Pleasure involves joy, happiness, satisfaction. Arousal refers to the degree a person feels stimulated, excited or active. Dominance refers to an user feeling in control, autonomous and free when visiting website. It is the degree of influence and power on the service, realization, and outcome (Loureiro, 2014). When interacting with the website, users try to understand the environment before making any judgment, decision, or evalution. Thus, the website stimuli causes a change in the user's internal state of mind.

Finally, response (R) refers to final attitude, and behavioral reaction (eg. purchase). All positive previous actions can lead to the intention to stay, explore and affiliate (Sarkar *et al.*, 2013).

Website design trends

Website design trends are largely dictated by developments in information technologies, but also from user behaviour research. Since users often develop an initial impression of a website, within two to seven seconds, the greatest attention is nowadays assigned to aesthetic features of websites. Aesthetic features are visual items such as pictures, colors, clear readable text, organized layout, changing look, proper use of fonts, multimedia, style consistency, and other (Nevarez *et al*, 2012). Since information through visuals is processed faster, photos are still dominating in web design, especially natural looking photos that connect with people on a different emotional level. Colors are influencing the perception of an object and communicate a certain emotional energy. Good examples in tourism industry are Airbnb (www.airbnb.com) or Uber (www.uber.com). Micro-interactions, material design, minimalism, full screen videos, responsive design, correct typography, card based interface design, storytelling design, hover animations, and many other trends are

just a few that attract the user's attention. Visual hierarchy of website elements that influence user's point of entry is given in Table 2 (Djamasbi *et al*, 2010).

Website element	Description
Motion	Animated elements draw attention before any other
Size	Larger objects attract more attantion
Images	Attract more attantion than text
Color	Elements with brighter colors drive more attention than darker
Text style	Typographic serve as effective non verbal tool
Position	Top elements attract more attention than those on the bottom

Table 2. Website visual hierarchy

The effect of website stimuli on organism and response

According to the previous research, there are several website stimuli that have the strongest impact on PAD. Interface design and product presentation have bigger impact on pleasure (Zimmerman, 2012; Menendez at al, 2010). Arousal intensifies pictures, and custom options. According to Law *et al.* (2003) and Huang *et al.* (2013), enjoyment and playfulness, play an important role. Dominance and trust have the biggest impact on purchase intention. Trust is built upon security/privacy, personalised services, previous guest reviews and reputation (Kim *et al.*, 2012). Overall satisfaction is influenced by interface design and security/privacy. On purchase intention the biggest impact have dominance, and trust. According to Qui *et al.* (2011), website security and price are the most important factors for e-buyers. Intent to revisit the website is affected by pleasure and arousal. According to previous research, conceptual SOR model is drawn (Figure 1).
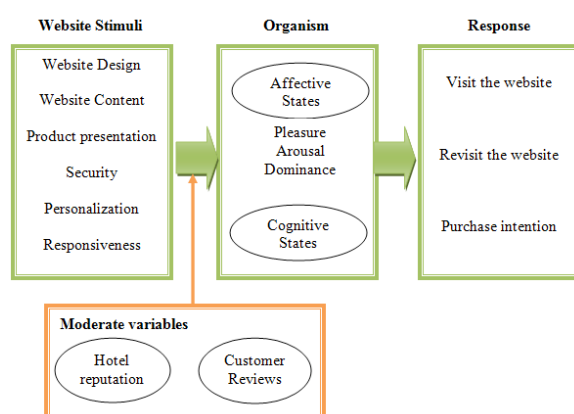

Figure 1. Conceptual SOR model

3. RESEARCH METHODOLOGY

Quantitative research was conducted through an online survey in November 2015. The goal of the survey is to analyze to what extent website visual stimuli have influence on customer attitude, emotion and purchase intention. The study included 102 respondents. Respondents of this online survey were, master students at Singidunum University. Online questionnaire consists of 18 questions, open and closed.

Data Analysis and Results

According to demographic characteristics shown in Table 3, the majority of respondents are employed women aged between 25-34.

Attributes		Number of respondents (N)
Gender (N=102)		
	Female	63
	Male	39
Age		
	18 to 24	15
	25 to 34	71
	35 to 44	12
	45 to 54	4
Working status		
	Employed	78
	Student	15
	Freelancer	2
	Unemployed	7

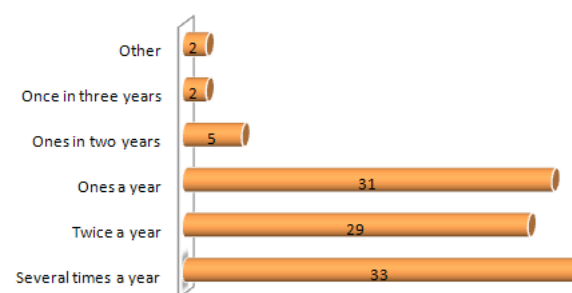Table 3. Demographic characteristics

Figure 2. Travel frequency

They usually travel several times a year (Figure 1), using private accommodation within local host. However, if they choose hotel, it is usually a 3 or 4 star hotel (Figure 2). Internet is the major source for information searching and booking (97%).

Design of the hotel website has major influence on emotion and purchase intention, more then 70%. Brighter colors are preferable, as well as intuitive navigation through site (Figure 3). The content on the website, as well as hotel exterior and interior, shown on website, greatly affect the service quality perception (more then 85 %).

Having analyzed the respondents' answers related to the best hotel website design, it can be concluded that the hotel reputation affects user's emotions, and therefore plays a major role in choosing a hotel. This indicates that if users perceive a hotel reputation to be high, they will tend to experience more positive emotion, and vice versa. This constatation confirms the assertion of Lennon (2013).

According to respondents' answers, hotel interior is more relevant and important than exterior. This statement is confirmed from more than 70% of respondents. Respondents were also provided with a list of available rooms within different hotels. According to the results shown in Figure 5, the minimalism, with bright colors, modern furniture, and simplicity, is still the trend that the website should reflect. This attribute has a significant positive influence on pleasure emotion.

Figure 3. Type of accommodation used
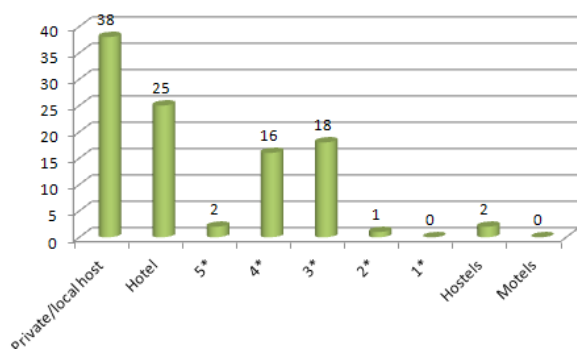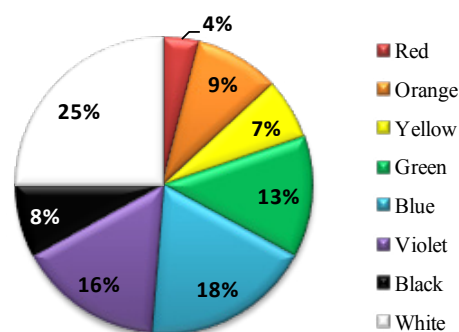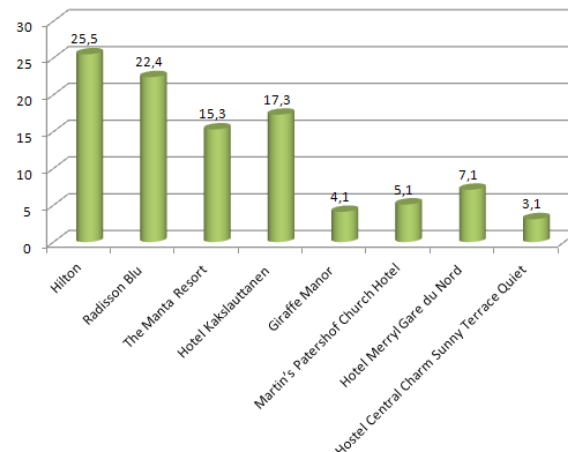

Figure 5. The most preferable hotel website design

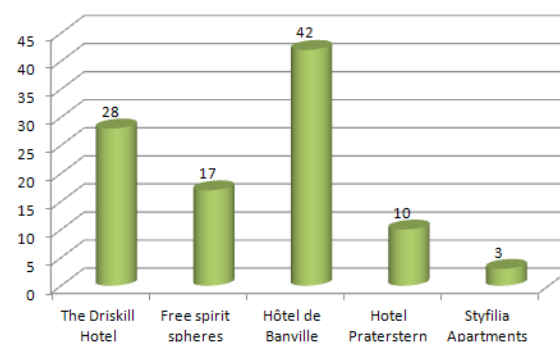Figure 4. The most preferable colors for the hotel website design

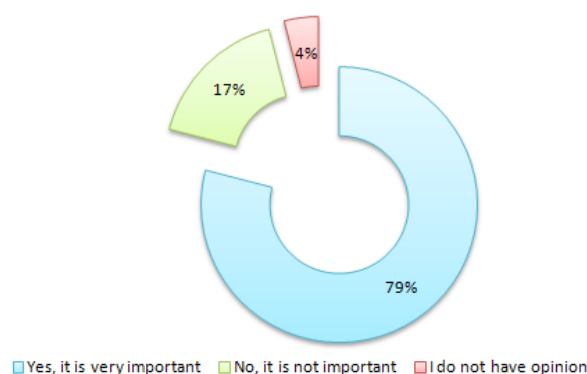Figure 6. The most preferable hotel interior

Figure 7. The importance employee appearance on the website

The appearance of employee on the website, welcoming or explaining the services, has the big impact on emotional arousal.

4. CONCLUSION

Equal attention should be devoted to hotel design and the overall quality of service, in reality, as well as in a virtual environment. The lack of one of these two elements may have the strong influence on the consumer perception. This study is based on the previous research on the implementation of SOR model in website design, and measurement of direct effects on user's response. The results indicated that perceived users attitude on the website design directly affects their response behavior. With respect to the changing trends in website design that obviously change users' emotions and intentions, there is a need to follow the latest trends and implement them to the website.

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E-MARKETING

ONLINE SHOPPING IN SERBIA AND ITS CONNECTION WITH LEADERSHIP COMPETENCIES

Slavko Alčaković[1],
Nada Arežina[1],
Valentina Bošković[1],
Maja Samardžić[2]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]University of Belgrade,
Faculty of Philosophy,
Belgrade, Serbia

Abstract:

The environment in which consumers can buy has changed and companies adjust their products and inform their consumers about them online. In this manner, the usage of the Internet in Serbia is increasing, which has a positive effect on the increase and improvement of online shopping. It is assumed that consumers will make even more progress in 2016, where the main products will be clothes, footwear, accessories and transport tickets/ booking accommodation. Since the leaders affect the trends of behavior, there is the assumption that they affect the trends of online shopping too. This paper will explore online shopping in Serbia and its connection with the leadership characteristics such as organization, persistence, self-confidence, enterprise and social skills with online behavior.

Key words:

leadership, online shopping, leadership traits.

1. INTRODUCTION

The Internet has affected the way consumers consider brands and change of the shopping process. Due to the level of visibility and the possibility for discussion, as well as the availability of useful information, consumers gradually change their habits and turn to online shopping. As consumers choose online shopping, companies need to adjust and personalize. Nowadays, more and more people avoid traditional shopping and spend more time online, both shopping and searching for information.

The Statistical Office of the Republic of Serbia conducted the research for the year 2014, which has shown that around 3550000 people use the Internet, which is about 42,3% of all population in Serbia. The same research has shown that 22.7% of examinees used online shopping in the last 3 months, 10.6% of them used it in the period of previous 3 months or one year, and about 9% of examinees have not bought anything online for more than a year. Based on the results given by the Statistical Office, we can conclude that 57.7% of examinees have never shopped online (Statistical Office of the Republic of Serbia, 2015).

The usage numbers increased in the year 2015. In the publication of the MASMI company and e-business portal, 52% of examinees use the Internet every day, 8% use it 2-6 times per week, 9% use it once per week, and 31% do not use the Internet at all. The examinees who use the Internet every day mostly use it on their computers and laptops (90%), but also on their

Correspondence:

Slavko Alčaković

e-mail:

salcakovic@singidunum.ac.rs

cell phones (57%). Those who use the Internet are usually younger and educated men who live in cities.However, only 34,9% of those men use the Internet for online shopping, while 65,1% use it for other purposes. Consumers who shop online are usually younger, educated, and have salaries above average. The products that are usually bought online are: clothes, footwear, accessories (49%), electronics, technical devices and computers (34%), books and magazines (15%). The results have also shown that products that are usually not bought online include toys, food and clothes for babies (8%) (MASMI, 2015).

It is assumed that leaders should be the drivers of online shopping trends, due to the fact that they try new activities all the time, regardless of whether this implies new projects or new people (Ibarra, 2015).

Leadership represents the process when a person influences other individuals to achieve the common goals and objectives. When leaders influence others using their knowledge and skills, they are using the process leadership (Jago, 1982). Howerever, every person has personal traits that can influence their action and change their leadership style. This is called Trait leadership (Jago, 1982).

While we have two beliefs that "leaders are born" (Trait leadership) and that "leaders are made " (Process leadership), the truth "lies" in the combination of these two types; leadership can be learned, but a leader's skills and knowledge can be influenced by his or her attributes or traits.

The opinion of the leader is respected and has a significant influence on individuals. As they lead by example, their usage of new technologies should affect the behavior of those who shop online. But what happens if they have different personal traits such as organization, persistence, self-confidence, enterprise and social skills, does this influence their online shopping behavior?

Therefore, the authors of this paper have decided to analyze the behavior of consumers during online shopping and to examine the connection of certain types of behavior with leadership traits.

The authors have defined the following hypotheses:

1. Online shopping activities keep increasing in the Republic of Serbia.
2. Clothes, footwear and technology are the products that are usually bought online.
3. There is no huge discrepancy between domestic and international web sites for online shopping.
4. Methods of payment online are still underdeveloped.
5. Leadership characteristics can affect the behavior of consumers who shop online

2. METHODOLOGY AND RESULTS

The research was conducted in Belgrade in the period from 29th February till 10th March 2016. It was conducted in the form of questionnaire given to students (aged 18-25: 89.8%, and 25-35: 11.2%; 69.4% male and 30.6% female students) who filled it out on a voluntary basis. There were 44 questionnaires, but only 39 were suitable for the analysis. There were three types of data:

1) Demography
2) Online shopping
3) Leadership characteristics of examinees

The results have shown that there is still a growing trend in the number of users who shop online. Based on the results of the analysis, 71.4% of examinees shop online, while only 28.6% do not.

Chart I shows that examinees usually shop clothes, footwear and various accessories (52,8%), transport tickets and booking accommodation (25%) and parts for cell phones, computers or any other type of electronics (22.2%). They usually do not buy toys and baby equipment, house decoration equipment, furniture and beauty products. The results have also shown one interesting information- about 30% of examinees buy very specific goods, which is why the authors would like to analyze which specific issues are bought by the consumers in Serbia in the future.
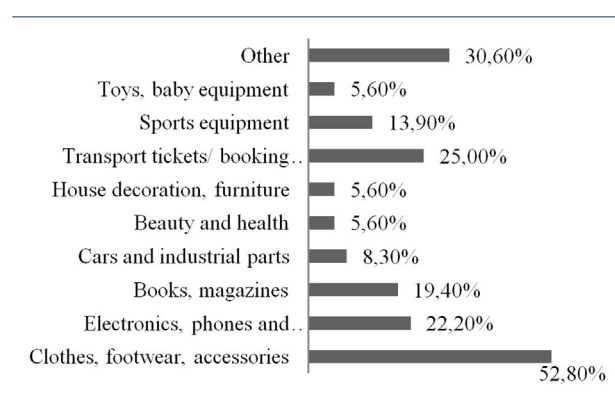
Chart I. Products and services bought online

The results (FIGURE I) have also shown that examinees mostly shop online using domestic web sites (38,1%), while there are also examinees who buy both from domestic and international websites (33,3%), and the lowest number of examinees buy only from international web sites (28,6%). When comparing the results, there is no huge discrepancy between the usage of domestic and international websites for shopping.

Figure 1. Types of web sites used for online shopping
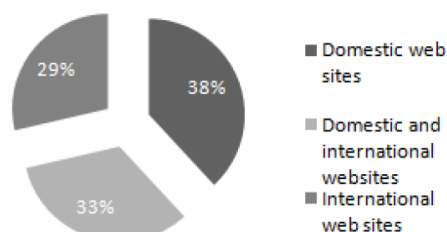
The results have also shown that examinees mostly shop online using domestic web sites (38,1%), while there are also examinees who buy both from domestic and international websites (33,3%), and the lowest number of examinees buy only from international web sites (28,6%).

Methods of payment are still underdeveloped (Chart II), as consumers order the goods online, but pay for it offline. The results have shown that the biggest number of examinees still pay cash on delivery (69,4%), *i.e.* they pay when the goods are delivered to their home address, or they pay by money order (11,1%), while only 36,1% of examinees pay online by cards or using e-banking, mobile banking and Pay pal.
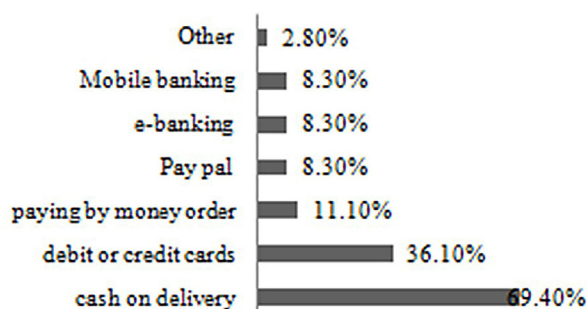

Chart II. Method of payment

As one of the main premises, the authors have given the hypothesis that online behaviour has some connection with leadership traits. Leadership traits are measured in several scales, with every scale referring to one leadership characteristic. There were 48 statements in Likert Scale, divided into 5 indicators: Organization (9 statements), Persistence (15 statements), Self-confidence/ Ambition (9 statements), Enterprise (7 statements), Social skills (8 statements).

However, during ANOVA analysis, with online shopping as independent variable, the results have shown that there are no statistical differences among groups. Even though we can notice in Table 1 that there is a slight difference between means, there is no significant statistical difference which should be taken into consideration.

		N	M	SD	SE
Organization	Yes	30	2.63	0.79	0.14
	No	9	2.69	0.63	0.21
Persistence	Yes	30	3.32	0.31	0.06
	No	9	3.26	0.4	0.13
Self-confidence/ Ambition	Yes	30	3.65	0.4	0.07
	No	9	3.64	0.57	0.19
Enterprise	Yes	30	3.19	0.52	0.09
	No	9	3.46	0.6	0.2
Social skills	Yes	30	3.22	0.39	0.07
	No	9	3.11	0.56	0.19
Overall Leadership	Yes	30	3.2	0.29	0.05
	No	9	3.26	0.23	0.08

Table I. Leadership and online shopping

Also, during ANOVA analysis, there was no statistical difference when it comes to leadership traits and their connection with the type of web site for online shopping.

There was also no statistical difference in the analysis of the type of products bought online, or in the analysis of the reasons for choosing not to shop online.

However, ANOVA analysis has shown that there is statistical difference for the trait Persistence when it comes to methods of payment, where $F_{(6, 39)} = 3,17$, $p=.05$.

3. CONCLUSION

Internet technologies can affect the restructuring of industry, as well as the behavior and opinion of consumers who tend to use the Internet as the main source of information and the main shopping venue. The results have shown that there is still a positive trend of the growth of online shopping, due to the increase in the percentage when compared to 2014, 2015 and 2016.

Regarding the products which are bought and methods of payment, everything remained the same- clothes and footwear are still top products, and the payments are still made by cash on delivery with the low level of development. The reason for this can be the fact that there are still not so many web sites which provide consumers with the possibility of shopping using their cards, *i.e.* the market is still underdeveloped.

What is important for the owners of domestic web sites which offer the possibility for online shopping is the fact that there is still no huge discrepancy between domestic and international web sites for the purpose of online shopping.

One of the most significant results in this paper is the fact that we could not confirm the hypothesis that leadership traits can affect online behavior of consumers. However, since the results have shown that there is a statistical difference for the personal trait Persistence when it comes to methods of payment, it will be the authors next research project where they will try to explain this connection with more detail.

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E-MARKETING

ONLINE SALE AS A SUBFUNCTION OF INTERNET MARKETING

Milan Gašović[1],
Almir Muhović[2],
Nikola Ćurčić[3],

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]University Union - Nikola Tesla,
Faculty of Construction Management,
Belgrade, Serbia

[3]University Union - Nikola Tesla,
Faculty of Management,
Sremski Karlovci, Serbia

Abstract:

In the traditional sense, sales imply a set of activities and tasks undertaken by companies to realise the selling of products and services. According to the marketing business orientation, a sale is the final marketing program of the given company. Modern companies implement marketing activities, including sales over the Internet as a powerful global media. This has led to a theoretical and practical shaping of Internet marketing as a new marketing form. In accordance with the concept of Internet marketing, selling becomes a sub-function of Internet marketing, that is, online sales.

Key words:

online sales, internet marketing; online presentations, online negotiation; sales web site

1. INTRODUCTION

A sale as an operational business function, either independently or in the context of marketing sector, provides companies with previously established market segments. It connects marketing system with the customers it serves. From it derives its ability to survive, develop and grow.

In accordance with the marketing way of business and sales, it adjusts the efforts of seller to the needs of customers and indicates to customers that sellers are ready and willing to meet their demands.

In recent decades, traditional marketing concept has received support in the form of Internet marketing or online marketing. Internet marketing includes online sales, as its sub-function through which the needs of online customers / consumers are met

In fact, online sales use the approach that offers direct, traditional sales, dependent on the growth and development of telecommunications and information technology (IT). Thanks to the strong technical basis, companies can achieve more direct relationship with their customers. Companies can now contact their customers directly – without intermediaries, so that they can respond to their needs, wishes and special requests. The point is that these consumers are not just anybody. They have been reached through online research, so they have been identified as potential buyers or services users, enabling the creation of their data base. The offer to which the precisely defined target customer can answer is created on this basis.

Correspondence:

Milan Gašović

e-mail:

mgasovic@singidunum.ac.rs

The sale, as a sub-function of Internet marketing or online sales, assumes the maximum automation of the sales process with the use of information technology. The goal is to enable customers and service users to select all the items of their order through the Web site, in an easy and simple way, at time that suits them, so they can then settle their financial obligations through electronic payments.

An online sale assumes the creation of a company's Web site on the Internet. At the same time, it is necessary to meet a number of primarily marketing demands. By completing the given requests, it is possible to achieve the effectiveness of the Internet marketing as a whole and raise online sales to a higher level in that context.

The whole process of online sales, viewed from the aspect of IT support, can be viewed through the phases such as: online sales presentation, online sales negotiation, integration of online sales with storage and delivery, connection with other online activities, *etc.*

2. INTERNET MARKETING AS A FRAMEWORK FOR ONLINE SALES

Modern companies perform a lot of activities on the Internet, among which it is not difficult to identify those that belong to the field of marketing. These are: communication and promotion, marketing research, distribution, sale, *etc.* There are also two specific activities for a new form of marketing called Internet marketing. These are the activities offering content (Content Providing) and enabling networking (Network) (Jović, M., 2012).

Traditional marketing concept also receives support in the form of Internet marketing. As the Internet is an interactive medium that relies on two-way communication in which all stakeholders can participate actively, it can be said that the support to the traditional principles of marketing is achieved through the use of methods of interactive marketing. The result of such a combination is the fourth principle of the marketing concept, which complements the three already widely accepted concepts of value creation for customers, competitive advantage obtention and guiding objectives, resources and activities on a strategic basis.

A part of the overall marketing efforts invested by companies in order to meet the three traditional requests should be directed towards fulfillment of the fourth principle, which is to satisfy the specific demands of online customers. Thus, Internet marketing is integrated into the overall marketing concept of the company. Starting from the given approach, the total marketing concept of the company consists of traditional marketing concept (offline), and modern marketing concept (online).

Those principles are compatible with the so-called Internet marketing model, known as the 4C model. Model 4C is based on the four pillars of Internet marketing: content (Content), users' path (Clickstream), Communication (Communication), Conversion (Conversion). (Mayer, D., Johnston, K., Eliis-Chandwich, F., 2000)

- ◆ Content (Content) on the Web site, its setting and the concept form the basis of quality online performances of companies. The peculiarity and the designed setting of the content provide easier achievement of the Internet Marketing objectives.
- ◆ The Users' path (Clickstream) allows monitoring of activities of companies' Web sites visitors. The analysis of the visitors' path reveals where the visitors came from, where they were moving and when they left. It allows the interaction with potential customers or service users.
- ◆ Communication (Communication) is aimed at more efficient realization of the key objectives of online marketing activities, such as finding new customers / clients and improvement of direct sales. It is based on the content and users' path.
- ◆ The conversion (Conversion) enables precise expression of conversion of Web site visitors into the users, *i.e.* customers.

An online sale as a sub-function of Internet Marketing has the support from other online sub-functions such as online marketing research and online promotion and online aspects of distribution.

The main objective of online research is identification of current and potential customers based on the volume, dynamics and quality of completed purchases, domain of interest, announced shopping, *etc.* Information technology supports all forms of marketing research. Questionnaires are sent electronically as e-mail surveys.

On the basis of the given information, it is easier to define the target groups for promotional online campaigns. Online advertising may be appropriate to send adequate messages to interested buyers. Companies connect their e-mail addresses with standard search engines (Yahoo, Google, Northlight), thus increasing the number of visits to their Web sites.

Online sales, through information technology, are integrated with the storage and delivery of products sold, *i.e.* with the online aspects of distribution. In other

words, verification of inventories, orders from customers and monitoring of deliveries to customers is performed automatically.

All of these sub-functions of Internet marketing provide support to online sales and directly contribute to its performance.

3. THE NATURE OF ONLINE SALES

A sale as a sub-function of Internet marketing or online sales assumes the maximum automation of the sales process with the use of information technology. This allows customers to select all the items for their order in an easy and simple way, at the time it suits them, and that they can settle their financial obligations through electronic payments. In doing so, the given company is directly or indirectly associated with a financial institution, that is connected to the financial system. This way of sales is very important because the online market is an inexhaustible source for finding potential buyers.

Informatics also supports automatic management of the process of delivery, providing sales staff with the ability to monitor the status of the stock, and providing customers with the ability to monitor implementation of their orders and transportation of goods that were ordered and paid for.

Information technology support enables forming the customers' database, as well as detailed and accurate profile of each customer, which remains available to all employees in the given company.

Online sales allow reduction of costs of sales while increasing sales volume, which significantly affects the profits of companies. First of all, there are no costs of visits to remote customers.

The effectiveness of online sales depends heavily on the quality of products and services offered, as well as on ancillary services such as guarantees, the possibility of refunds, advice and recommendations to customers, *etc*.

Potential retail market which can be accessed via the Internet is huge. In addition, there are no number of market segments that are poorly covered with the traditional sales activities. They can offer more adequate products, *i.e.* the specific requirements of target customers or target groups can be met.

Prices of products and services are the most sensitive elements of the marketing mix on the Internet. The most suitable products and services for online sales are those of mid-level price, as well as those whose price is rapidly changing.

From the aspect of online customers, the most reliable supplier is the producer itself, *i.e.* a company that sells its own products. The second best option is some kind of exclusivity in the sale. If there is none of the two variants, then it is necessary to have a reliable supplier and solid agreement on the price, quality and delivery.

The convenience of online sales is tied to the costs of storage and delivery, which must be small compared to the prices of the products.

Online sales increase the number of customers of a company and create customers' community. Community is created by an e-mail, by sending electronic news (newsletter) to interested buyers, communication with newsgroups, *etc*. The famous slogan which can be heard or read in the media in recent years reads: "Create a community and then do the sales". (Mayer, D., Johnston, K., Eliis-Chandwich, F., 2000).

Ideal products for online sales are those that are rich in information (information rich product). It is necessary to create a company's website, as an effective instrument of online sales.

4. DESIGNING THE SALES WEB SITE

Designing the Sales Web Site is the last stage in the preparation period before the announcement of the presence of the company on the Internet. It is necessary to meet a number of requirements, as to structure a clear path from the initial to the final Web page with the purchase order for the purchase of products.

Article requirements for creating a selling web site are marketing requirements. By meeting the given requirements, it is possible to achieve the effectiveness of Internet marketing as a whole and increase the sales to a higher level within this framework.

Creating a web site aligns with the marketing profile of Internet customers or service users. At the same time, it is necessary to know their needs and their "Web soul." (Pocajt, I., Tošić. B., 2003) Therefore, we must take into account the following:

- A large number of visitors leave the web site, if its appearance is slow
- Disconnect and bad telephone lines adversely affect the mood of visitors
- Vast web site refuses visitors
- The visitor usually saves Internet time and wants to perform as much work on the given web site.
- Also, it is necessary to:

♦ Facilitate finding of the desired information - offer article mechanism for the search of web pages (local Search Engine)

♦ Offer complete information about products or services, in terms of comparative list of prices, quality competition, information on procurement, *etc*.

Web communication is impersonal because the visitor does not see the seller. It is therefore necessary to create the impression of natural communication. Therefore, the web page text should be informal, meaning that it should be written as they talk to customers in a direct confrontation with the seller. Specifically, through the website, the visitor has to "see" the real, everyday people, not an abstract company, without the emotional colouring. To choose the right words for texts means to avoid fatigue construction of expression. It should also omit redundant adjectives, highly specialized, academic, jargon words and similar.

Words are the primary means by which the Web site "sells". A visitor usually hurries, so usually passes over the headlines by sight and highlighted parts of the text. The titles are most read, so they can make an important contribution to the potential of selling through the web site. It should be borne in mind that the computer displays a small "shop window" where lots of things need to be presented. Each web page should indicate and call to action that leads to sales.

A basic, introductory page of the sales Web site should inform the visitor on the content of the site and persuade the visitor to look at other web pages. Therefore, it is necessary to complete each web page with the text that calls for viewing the following web pages.

One of the techniques of writing texts for sale sites is asking questions and providing answers. The reason is that questions stimulate interest and attract more attention. Answers contained in the text of a Web page should express the benefits for the customer related to the purchase of a product.

Internet visitors are distrustful by nature, considering the intangibility of the products created by this global medium. It is therefore necessary to gain their trust. The first step in attracting visitors is a well-designed, attractive site design and pleasant atmosphere it emits. Providing your own domain name and clear Web address, simple and compelling, is easy to remember and inspire confidence. Web address should be original, without words and characters that are difficult to pronounce. Balanced, evocative name as the main part of the site, is an important part of the image of the company (Gašović, M., 2010)

This web site contains useful information representing the value for visitors. High quality and rich content builds trust in the web site and makes the given company competent in the eyes of visitors, giving them a chance to learn something new and return to the web site again.

Visitors of the site need the content that will make them satisfied. Web content which is seen as valuable by the visitor must be very versatile. The main content is the concise text that represents the product or service. Necessary part of the content is the text that explains the benefit the customer has of a product and the advantages in relation to the relevant competition product.

In the context of content related to the presentation of the company itself, there are also data on its management. At the same time, it is not recommended to write the best about your company, but one should avoid boasting and empty, propaganda phraseology. Also, one should not brag about these things that are not their possession and should not promise what cannot be fulfilled.

The part of a good Web content is the opinion of the customer about the product being sold, because it is convincing praise of others. Product photos are an important part of Web content.

By organizing Internet forums, iChat rooms, visitors of the site have the opportunity to exchange experiences and to bring them closer to the decision on the purchase of the product. (Milićević, V., 2002).

Once a visitor views a web site and, guided by quality content and a pleasant atmosphere, make a decision on the purchase online, the question is how to realize this? In this regard, it is essential that web site has a form that the visitor fills out and thus, directly orders the product. The form should be clear and concise, with a minimum of required data. Upon receiving the confirmation that the form is received and processed, it is mandatory to send a brief e-mail to the visitor. In the case that the customer decides to buy a larger quantity, it is possible to introduce the so-called virtual consumer shopping cart. Call for online purchase on each side of the web site and shopping cart, as a way of selecting the type and quantity of the product with only one click on the mouse, ensures sales success. (Pocajt,V.,Tošić,D.,2003)

If a company decides to make a web site, it can provide the ability to pay the ordered products by credit card. It is necessary to install a system for secure electronic exchange of critical data (secure server) on the web site. It is about data such as credit card number, customer authorization codes and online financial transactions.

Online sales provide detailed product information, accurate product selection, ease of operation, *etc*. Cus-

tomers should always be allowed to withdraw from the selection of a product or shopping in general, to change the selected quantity and similar. Also, they must be provided with a clear insight into the cost of products. In this way, they are encouraged to shop online rather than be forced to buy the product immediately.

It is very important that customers can check numerous testimonies on web pages. They must be sure that any information from the site content can be checked by phone, e-mail, or in the traditional way.

5. ONLINE SALES PROCESS

The whole process of online sales, in terms of IT support, can be viewed through the following phases:

- Sales presentations of products and services
- Online sales negotiations
- Integration of sales to storage and delivery
- Connecting to other online marketing activities
- Connecting to other stakeholders in the electronic form

This process of online sales must possess the customer service (Gašović, M., 2010).

Online sales presentation of products or services consists of: a set of products/services, prices, incentives, exchangeability, structuring and search.

A set of products/services is provided by their quantitative expression, display, and monitoring, recording and daily automatic update of assortment that is offered to online customers.

Price indicates the manner in which they are formed, such as according to groups of customers or otherwise. Different customer groups respond differently to price: there is a possibility of forming a promotional price, discounts and similar.

Stimulations suggest that members of a club can have certain benefits, additional packages of products with reduced cost and similar. When selling wholesale, there is a possibility of providing discounts on the amount or quantity rebate.

Exchangeability expresses the intention of the seller to make a substitution of one product for another, if it suits the customer.

- Structuring allows categorization of products.
- Search provides the browse of online product catalogue.

Online sales negotiation include: personalization of sales, sales automation, dialogue with customers, 24-hour availability, diversity of modalities of sales, *etc.*

- Personalization of sales indicates that the company addressed the buyer as a persona, which means that the ratio of 1:1 is formed.
- Sales force automation means accepting and processing orders through the shopping cart, shopping basket and similar. At the same time, the maximum amount of items per order is defined. Also, there are financial transactions, such as the calculation of taxes, transportation costs, methods and types of payments, *etc.*
- The dialogue with customers provides the possibility of communication between buyers and sellers, thereby securing the additional information.
- 24-hour availability of the use of the site gives customers the option of ordering products when it suits them.
- The diversity of modalities of sales means that it is possible to create online shops, auctions, sales, *etc.*

Integrating online sales with storage and delivery provides inventory checks, which creates automated ordering and delivery tracking.

Checking the inventory provides the offer of products that are available. Bids must be established in the minimum and maximum amounts.

- Automatic order allows alert, *i.e.* the fastest response of the company - supplier.
- Monitoring of delivery provides an update of delivery, information on the state of delivery, delivery planning, *etc.*
- Customer service enables: technical support, localization, feedback, *etc.*

Processing of all data created in the process of online sales in terms of: metrics business profile and networking with other actors. Metrics operations generate reports on number of visits, realized turnover; assess the effects of discounts and special offers. Profiles of users / customers include all visitors, sales history, predictions *etc.* Connecting with other stakeholders in terms of exchanging business information and documents may be in electronic form. In this way, the two companies can easily exchange all the documents and information business (B2B). The cooperation with state institutions is possible in the same way (B2G). Through a variety of E-commerce solutions, customers and companies are connecting (B2C, CRM). There are several varieties of electronic payment: Versing, PayPal, Cash Online, *etc.* (Pocajt,V.,Tošić,D.,2003).

6. CONCLUSION

Marketing concept as a most subtly business thread in one company, received support in the form of internet marketing. Part of the overall marketing in modern companies' approaches to deliver the value for customers and achieve competitive advantages which in the last decides has been focused on the online buyers. In fact, Internet marketing uses the approach that offers direct marketing that relies on the growth and development of telecommunications and information technology (IT).

Internet marketing, as a new form of marketing, includes all traditional activities (marketing research, promotion, distribution, sales), as well as two new activities such as offering content (Content providing) and enabling networking (Network).

Sale as sub-function of internet marketing or online sales is based on IT support, *i.e.* Internet technology. The main instrument of online sales is a well-designed web site, through which the whole process of online sales takes place. The key stages of the process are: presentation of products or services, sales negotiation, sales integration with storage and delivery, connections with other marketing activities and connections with other stakeholders in the electronic form.

Online sales negotiation includes personalization of sale or offer or recommendation to customers based on their profile, sales automation, dialogue with customers, twenty-four hour availability and different modalities of sales.

An indispensable aspect of online sales is the user service that provides online technical support and online training, support in different languages, legal support, feedback, *etc.*

For the success of online sales quality products and creative sales promotion activities (guarantees, the possibility of refunds; referrals of satisfied customers, *etc.*) are necessary. Online sales are supported by other online marketing activities. The Internet provides good opportunities to investigate the competition, since the companies can offer their quality products throughout the world. Also, the ability to promote products on the Internet (Internet advertising) is very important to support online sales.

Rich information products and low cost storage and transportation are suitable for online sales.

Online selling allows companies to create customer community. Online sales allow the payment by credit cards, with a pre-installed system for the secure electronic exchange of critical data, such as credit card numbers, customers' authorization codes and online financial transactions.

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E-GOVERNANCE

SUPPORTING M-HEALTH THROUGH ANDROID APPLICATION FOR STORING ANAMNESIS DATA

Dženan Avdić[1],
Aldina Avdić[1],
Petar Spalević[2],
Žaklina Spalević[2]

[1] State University of Novi Pazar,
Novi Pazar, Serbia

[2] Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

In recent years in our country, there are tendencies for using advantages which information and mobile technologies provide in all areas of human activity. We are witnessing the expansion in terms of e-government services, as well as the progress in terms of health and medicine through introduction of health booklets which can be computer-read. It goes in the direction of electrification of medical record cards, which will greatly facilitate the search of data, reduce the amount of paperwork, and make it easier to draw conclusions on the basis of daily saved data in electronic form. In addition, e-health and m-health enables portability of services and decentralization of the health system. This paper describes the application for m-health, intended for medical workers, with the aim to make easier taking and recording of anamnesis data and to alow their storage in a format suitable for further processing.

Key words:

e-health, m-health, medical informatics, storing patient data.

1. INTRODUCTION

Modern health care has become multi-disciplinary in the sense that it is expected that the medical staff, in addition to possession of medical knowledge, also has the appropriate technical knowledge and computer skills. Thus, medical fields such as surgery where robots assist, methods of three-dimensional recording of internal organs, electronic card and telemedicine, automated laboratory research, artificial organs, nano-medicine and others, require much knowledge and skills in the fields of engineering (computer, software, electrical engineering, biomedical and others in the field of technical sciences) and bioinformatics, information and communication technologies [1, 2].

Also, in order to objectively determine the health conditions of the patient and to make the appropriate medical decisions based on the analysis of a multitude of relevant data, it is necessary that the medical data is accurate, understandable, unambiguous and affordable. Therefore, there

Correspondence:

Aldina Avdić

e-mail:
apljaskovic@np.ac.rs

is a need for the simultaneous analysis and integration of different types of medical data (for example: images, text, numerical analysis and results) that were occurred in various stages of testing and therapy. This collection of relevant data needs to be archived and organized with the aim to allow easy data accessing, searching and manipulation for health workers. The data should be in a form that complies with all relevant standards and which allows easy transfer, in order to enable data exchange between different medical systems. The young scientific field, that combines medical and engineering knowledge - Biomedical Engineering (BMI), deals with this problems [3].

E-health is a relatively new term that emrged in the late nineties of the last century that marks a new, more efficient way to provide health services based on modern technologies with a very high degree of integration of the system, increasing the mobility of doctors and patients. The application of e-health in health care systems incorporates ICT processes in order to improve performances of classical medical systems.

More and more countries are introducing information and communication technologies in the health care system through electronic health records, telemedicine, health knowledge management, virtual healthcare teams, mobile health and managing the specialized medical data. E-health includes a range of services that are achieved by using medical and information technology. The aim is to enable easier and more effective treatment of patients and better medical services without administrative restrictions [4].

Benefits of e-health in the strictest sense are: electronic monitoring and recording of medical history of the patient during his life, an access to the patient data anywhere and anytime, bearing in mind the data protection, and rapid transfer of the data to patients using online services and telemedicine.

M-health is part of e-health in the strict sense, which relies on the use of mobile and ubiquitous computing in health care and medicine [5, 6].

Mark Weiser is regarded as the concept creator ubiquitous computing (in the vision of computers embedded in everyday objects in our environment). In his vision, the people at the same time interact with hundreds of computers through wireless communication [7].

Ubiquitous computing is a set of several new elements of IT technologies. It includes computers and sensors in appliances, tools, equipment in homes, workplaces, factories and the clothing items. Devices and sensors can be mobile (wireless PDAs or smart phones), or they can be nested into the environment (sensors and computer chips),

walls or equipment. This includes communication between devices and sensors through an ubiquitous infrastructure of wired or wireless connection.

One of the main features of ubiquitous computing is that the devices are mostly small and contain miniaturized components and also nested on or in the device so that eg., multimedia communication device with a camera, Internet and satellite locating (GPS) can be placed in a mobile phone.

Wireless devices are the basic devices in ubiquitous computing systems. The term wireless refers to a form of telecommunications when the signal is transmitted through electromagnetic waves, ie. using a wireless connection.

Wireless devices that are used in ubiquitous computing can be: mobile phone - provides connectivity of portable and mobile, both personal as well as business applications, PDA - includes a variety of mobile and handheld devices for the storage and retrieval of personal and / or business data. They can be combined with telephone systems and wireless networks, tablet PC - the wireless computer that allows the user to record data using the digital pen to write on the touch screen. The data recorded on the tablet PC can be further edited, searched, indexed or sent using email or mobile phone [8].

This paper describes the mobile application that is intended for wireless devices such as smart mobile phones and tablet devices running an Android operating system.

The paper is organized as follows. The following chapter gives an overview of related research in the field of m-health. Further, technologies which were necessary for the development of the application have been described. After that, there is a description of the application for dynamic creating of templates for anamnesis by using mobile devices. Finally, the conclusion and directions for further research on this topic are given.

2. RELATED WORK

The review of the use of smartphones in medicine has been thoroughly exposed in [9]. The paper [10] describes the limitations and best practices in creating web applications and applications for smart devices for medical purposes. In the same work as an example of an application which allows for random assignment of patients into groups for the purposes of clinical tests. A mobile application for making a management list for transporting patients intended to the medical personnel is described in [11].

The paper [12] shows MobiCare application that describes the importance of the application of wireless networks in order to allow the use of mobile medical applications in the patient's home and outdoors. Then, the paper [13] refers to mobile applications that use some additional devices with sensors that measure body temperature, blood sugar and pressure, as described in the example of application eCAALYX. Mobile applications designed to help the patients with diabetes are described in the papers [14, 15].

Bearing in mind that the data used in applications for m-health are highly sensitive, in the paper [16], applications are divided into two groups, one consists of applications that need to meet the appropriate regulations, while the other consists of applications that are not required to meet those appropriate conditions.

Domestic authors have also dealt with the importance of the medical information systems, so their application in education is described in [17]. The use of mobile applications is describes in [18] in order to improve health care in the region.

The details about the e-government and e-health software requirements in Serbia, in terms of data security, are given in [19, 20].

3. DESCRPTION OF TEHNOLOGIES USED

The Android application Medis is implemented in Eclipse development environment. For its development, knowledge of Java and XML technology was necessary, in addition to Android. The application supports the new version of the Android operating system 4.0 (API 14) to 5.0 (API 21), which makes up about 85% of the total number of Android devices [21].

The operating system Android is based on Linux 2.6 x 3.x version for system services. Android operating system was officially released as an open source under the Apache Software Foundation license.

XML stands for eXtensible Markup Language, and the W3C Consortium has accepted it as a standard for marking documents. XML is simply the most robust, most reliable and most flexible ever invented syntax for documents. XML does not have a fixed set of tags and elements that should satisfy everyone's needs in all areas and for all. Chemists can use elements that describe molecules, atoms, bonds, reactions, and other entities that are encountered in chemistry. Real estate agents can use elements that describe apartments, rents, fees, locations, and other entities needed for real estates. The letter X in the name comes from the word XML Extensible (expand-

able), which means that the language can be expanded and adapted to meet different needs [22].

4. DESCRIPTION OF MOBILE APPLICATION FOR STORING ANAMNESIS DATA

The aim of the application is to facilitate the work of taking anamnesis to medical professionals. With the help of this application, medical workers have the ability to create and fill out the corresponding questionnaire using the mobile device. The forms in this way are not fixed, and they can, depending on the need, have the appropriate number of questions which are different types, thereby significantly reducing data redundancy.

Application users are medical workers. Under templates is meant a series of questions of a certain type (text answer, one of several possible responses, more than more than one answer). When creating the templates, some things should be specified, such as the text of the question, type of questions and possible answers. Based on the template, a document can be created, which is a special case of the template. On this occasion, it is necessary to give answers to the questions. Documents and templates are stored as XML documents.

Thus, the medical worker who uses the application can create the corresponding questionnaire with the questions and save it under a certain template, or fill in the template and save it as document with LBO (personal patient number) number. Search operation can be performed as searching patterns or patients numbers.

Medis (Medical Information System) questionnaire provides to the user the following options:

- creating a new template/document;
- reviewing of an existing templates/document;
- editing a template/document;
- deletion of a template/document;
- search for the template/document;
- the number of questions in the template is determined during design, dynamically;
- the questions within the template are divided into three types (with the text reply, the choice of one unit within a group of choices and the choice of several units within a group of choices).

Some of the possibilities of applications as well as their description are shown in Figures 1 and 2. The appearance of a template is shown in Figure 2, as well as the completed concrete instance of that template.
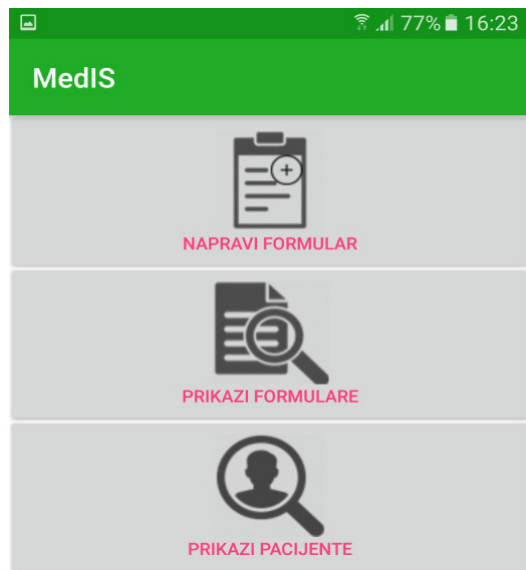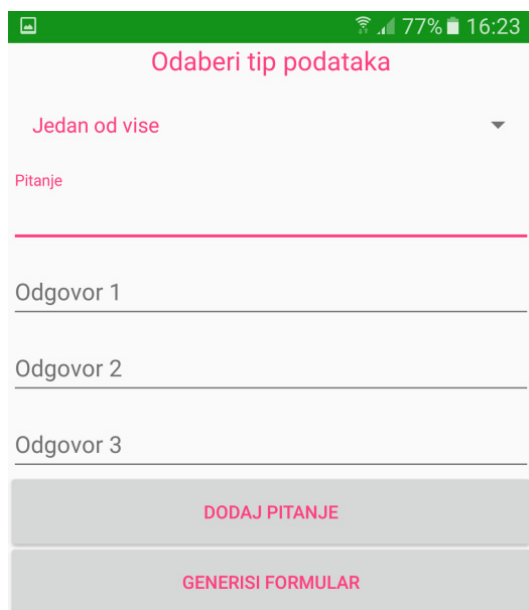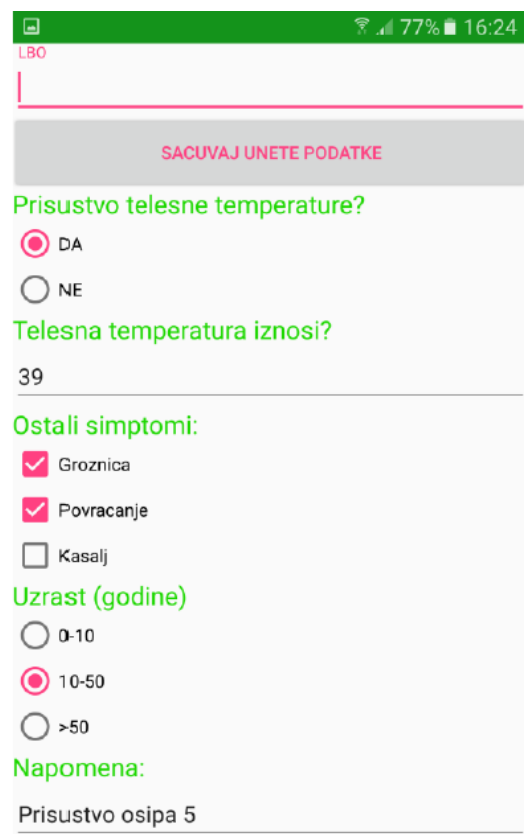
a) Start screen
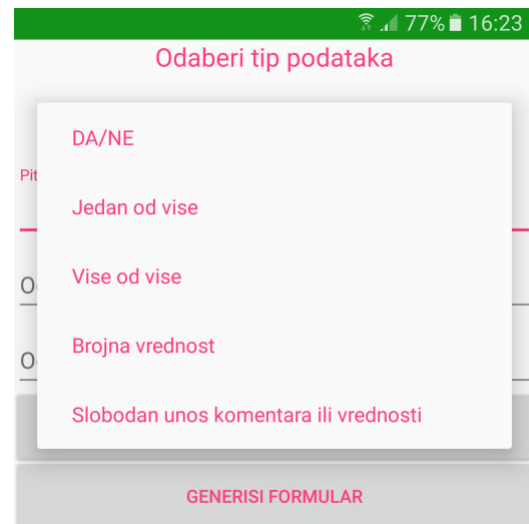
b) Adding a question to the template

Figure 1. A subset of application feautures

a) Creating one question in template

b) Filling the template and saving under patients number

Figure 2. Adding questions and filling the template

A part of XML document that stores the templates and the documents is shown in Figure 3.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<formular>
<polje id="0">
    <tip>0</tip>
    <pitanje>Prisustvo telesne temperature?</pitanje>
    <odgovor1 atr1="1">DA</odgovor1>
    <odgovor2 atr2="0">NE</odgovor2>
    <odgovor3 atr3="0"/>
</polje>
<polje id="1">
    <tip>3</tip>
    <pitanje>Telesna temperatura iznosi?</pitanje>
    <odgovor1 atr1="">39</odgovor1>
    <odgovor2 atr2=""/><odgovor3 atr3=""/>
</polje>
<polje id="2">
    <tip>2</tip>
    <pitanje>Ostali simptomi:</pitanje>
```

Figure 3. A part of XML representation of the completed template

5. CONCLUSIONS AND FUTURE WORK

Mobile computing is becoming more widespread in all areas of human activity. However, we should not leave unexplored the opportunities of its application in medicine.

The paper describes the application made for Android devices which provides easy creation, filling out and saving an electronic questionnaire about the patient health. The advantages of using this application are in the template flexibility to be filled and which are made to meet the needs of the patients. Another advantage is the possibility of multiple use of a template, bearing in mind that users can create a number of documents based on a template. Also, the ability to search documents is facilitated. This application data are stored in XML format so that they can later be easily transformed and used in the context of other software subsystems that are used in a given medical institution.

In the future, having in mind the increasing accessibility and integration of sensors into mobile devices, features of the application could be extended by reading sensor results and their recording.

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E-GOVERNANCE

E-GOVERNMENT IN LIBYA

Aref Busoud,
Dejan Živković

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

E-government represents a coeval model of communication, which is a solution for complicated processes within government, business and individuals. The main goals of E-government are: reducing of government spending and direct cost of services, better coordination and communication between government institutions, private sector and citizens. E-government consists of three types of E-services: government to citizen (G2C), government to business (G2B), and government to government (G2G). Libya is a developing country that attempts to establish e-government services to improve government functions, productivity and efficiency of government agencies as well simplifying complicated procedures for their citizens. In this paper, we will present benefits that Libya will gain from this project and describe e-government initiatives and most significant advantages and disadvantages of this kind of project.

Key words:

e-government, Libya, electronic services, G2C, G2B, G2C.

1. INTRODUCTION

National and local governments from every region of the world, are attempting to put in information on the World Wide Web (W.W.W.), and to use this mechanism for simplifying the operations that were complicated and to interact with citizens and private sector electronically. The main goals of E-government are to reduce government spending and direct cost of transactions. As a results, it reduced costs of services, improved coordination between government agencies and simplified administration. Furthermore, it has led to openness to other countries, identification of new technologies, improvement of services through electronic reports, and achievement of trust and stability among citizens, and making of easiest way to access electronic services through the portals. The main purpose is to keep transparency and accurate information for society and to promote democracy.

Standard types of services include, issuing identity cards, passports, birth and marriage certificates, judicial decisions, request a building permit, paying taxes, duties and new or used automobile registration, public libraries (availability of indexes, and research tools), enrollment in higher education, address change, and health-related services (providing interactive medical advice, taking appointments), voter registration and pay any required fees using credit cards.

Correspondence:

Aref Busoud

e-mail:
arefabosaoud@yahoo.com

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2. DEFINITION OF E-GOVERNMENT

E-government (electronic government) represents a set of services, which are provided through electronic communication to public and private sector.

Services that E-Government is provides include:

1. Government to Citizen (G2C), are services for its citizens.

2. Government-to-Business (G2B), are services for private sector, which are simplified and brought up less cost of transactions.

3. Government-to-Government (G2G) is a set of services, which are representing communication between different facilities of the local government, and international cooperation between high governments of other countries around the world [7].

For efficient use of these services it is necessary that there is coordination of activities and good cooperation between the public and private sector, as well as citizens and government.

Electronic government refers to implementation of information technologies and systems, communication technologies and other web-based telecommunication technologies to improve the efficiency of service delivery to the public sector and government agencies [13].

Advantages over the system based on extensive paperwork and numerous administration staff is: less cost of services and reduce of spent time during their realization. The advantage is offering good efficiency, easier accessibility and lower costs of services.
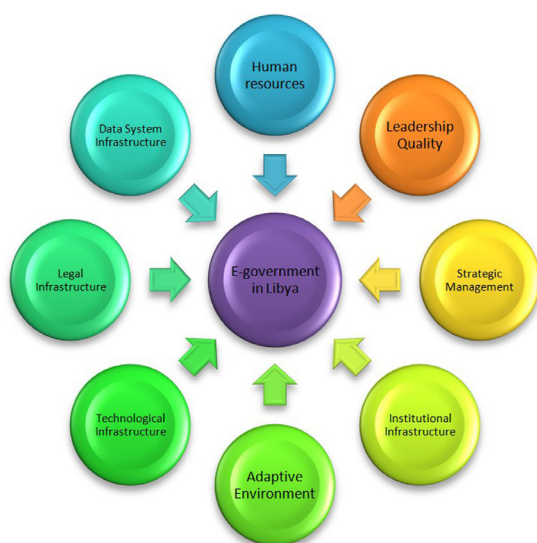
"World Bank" has given the definition of E-government. It refers to implementation of Information and Communication Technologies (ICT) in work of government with the aim to find the easiest way of communication with public and private sector [10]. E-government is represented by web site, which contains relevant information or issues that are important for citizens or businesses [2].

3. IMPLEMENTATION OF E-GOVERNMENT IN LIBYA

Official websites posted by North African governments give excellent opportunities to get access to government's information, such as: Morocco, Algeria, Tunisia, Libya, Egypt, and Sudan [1]. In order to establish strong institutions, and a stable legal framework, the government needs to provide stable economic situation. Desired state for government to make sure that its initiative is efficiently implemented and that the desired goal of process is achieved, is to govern Libya in two mandates.

Population	6,411,776 (July 2015 est.)
Literacy Rate	91% (Ranks 13 in the World) [UN]
International Poverty Line Population	7.2% [UNDP]
No. of Schools (Public, Private, Kindergarten, International, Technical)	6586
Telephones - mobile cellular	10.1 million
Internet users	1.4 million (21.8% (2014 est.) rank 114

Table I. ICT and educattional infrastructure of Libya [5]

After the time that has led to Libyan Revolution, the Ministry of communication and informatics proposed many initiatives to use technology to support government operations and to enhance the services provided to all citizens and businesses in Libya [13]. Despite numerous problems that Libya inherited from the former regime, and new problems that accompany political, social and economic reforms, it created some important websites and E-projects, which have increased the utilization rate and the presentation of the web on Libyan territory. Because of political insecurity and many other problems that transitional country has to overcome Libya has not achieved desired goals. The country hes high literacy

Picture 1. Infrastructure needed for quality e-government

rate among the citizens and that is the great potential for these kinds of modernization processes [9]. Great problem is the security and privacy issue.

Numerous challenges are also encountered in political, economic, social and technological aspects.

By observing the social aspect of Libya, we can notice lack of IT experts, despite high literacy rate that places Libya in the 18th place on the world list. These demanding jobs are usually performed thru experts from other countries. Owing to the lack of IT skilled workforce, there is no competitive environment and therefore the need for continuous knowledge improvement is very small.

Political weakness for establishing good E-government practice is in poor legislation framework for IT sector that is departing potential investments in development of this sector and re-building infrastructure. Another problem is in great number of employees in public sector, which has no motivation to accepting E-governance, because this advanced system brings considerable savings, savings and greatly reduces the need for many employees. Validity of digital signature, cyber protection and acceptance of information from Internet source by government officials are also the problems that need to be solved [3].

Despite the high investment return potential, there is still lack of investors and small budget funding. Technological problems include bad infrastructure and lack of IT standards and software licenses.

The case of E-government in Libya is still in process. The purpose of the project is to reduce time loss in transaction over in all cities in the country, mainly the capital (Tripoli) [3].

United Nation Development Program (UNDP) is a partner with Libyan Government in its E-government strategy of modernizing the systems of the Libyan Government and offering citizen access to government services through technology. UNDP is currently supporting with the E-government team in setting up a Project Management office, and assisting with the assessments and coordination of three line Ministries: Industry, Health and Education [12].

UNDP will also transfer knowledge initiatives where lessons, which will be learned and a range of international experiences will be introduced to Libyan stakeholders. This is the beginning of a partnership with the Libyan government in an effort to modernize and deliver citizen services in a more effective way [12].

Poor access to ICT's and lack of educational possibilities caused by turbulent events in Libya might slow down the development of public services and e-government.

4. PLANS FOR IMPROVING E-GOVERNANCE IN LIBYA

Libya has instruments for developing a detailed strategic plan to make the process of developing stable and efficient E-government system as simple and easy as it is possible. This is especially important for parts of the country that are far from big cities and places that built strong and well organized local governing.

The purpose of E-government is that private and public sector can get easy access to government services.

In addition, e-government usage is important for main systems of the country (health care, education, civil and private sector) [4].

In order to improve the country's state particularly after the "Civil War", Libyan E-government should improve all web sites of the government as well to educate government employees [6].

Currently, Libyan e-government web sites are trying to present the basic information for its citizens and give contribution to reduce gender or social obstacles, as well as geographic distance between administrative centers.

According to the problem motioned above ("Civil War") and economic crisis, the e-government of Libya is still struggling with infrastructure problems. Therefore, the costs of transactions are still very high.

Furthermore, literacy about Internet technologies (IT) is still on very low level, which is a big concern for the government as well for the citizens. There is a future plan for integration of ICT in educational system and Libya is looking for international support [6].

In order to develop a comprehensive strategy and to determine the roadmap for the implementation of key elements of E-government, National Transitional Council (NTC) has contracted with Price Waterhouse Coopers (PwC) [8].

Required work is best implemented in several stages:

- First stage is evaluation stage that represents assessment of the current situation.
- Second stage is creating a new framework strategy of local E-government.
- Third stage is the development of: infrastructure of the country, inter-governmental communication, E-services applications for E-government.

- Fourth stage is the development of a plan for the implementation of E-government project;
- Fifth stage represents E-government management project.
- Sixth stage represents creation of educational system for E-government.
- Seventh stage is representing a creation of basic frameworks for E-learning, E-healthcare and E-commerce systems.
- Eighth stage consists of different issues: education system, project management, quality assurance [8].

5. COOPERATION WITH COUNTRIES WITH GOOD E-GOVERNMENT PRACTICE

Using advanced technologies within E-government services is everyday practice mostly used by developed economics in the world. Accepting this practice from the country that has a stable economic situation and experience like the UK could be extremely valuable for Libya and its people.

Since 2012 Libyan governments have mad a few agreements with Great Britain for developing communications infrastructure in Libya. [11]

Two governments agreed that Libya should accept the model of E-government of Great Britain, which contains three main points:

1. Information and Communication Technology (ICT)
2. Regulatory framework
3. ICT applications, particularly E-government, E-commerce and E-learning [11].

The goals of this cooperation are identifying opportunities for investments in Libya, development of government services, advancing and establishing infrastructure, bringing up technological innovation systems, and improving the coordination of personnel.

These activities between two governments include:

1. Exchange of technical experts, in order to provide technical and strategic guidance, training, and education.
2. Creating better infrastructure mainly, basic access to the internet, designing policies for management of the telecommunications market;
3. Additional tasks in order to finalize the projects [11].

6. CONCLUSION

Libya is a very unstable situation. The country has impressive literacy rate among the population, but the major issue is that there is less personnel with Information Technology (I.T.), skills. Social factors exert considerable impact on implementation of new technologies. A large number of Libyan citizens don't accept this kind of communication system, because of many reasons such as low educational system possibility of using new technology, high cost of implementing new technology. Infrastructure is still developing and there is a vast number of projects that should be done such as electricity, and missing of Internet stations, and communication between south and north, because of vast territory between the cities. Libya is in its early stage of E-government development, and there is much more to be done. Planning, utilization of resources and positive efforts of governance could put Libya in the future with developed countries. Communication and collaboration with developed countries like UK could bring major results to this project.

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ELECTRONIC GOVERNMENT IN THE FIGHT AGAINST TERRORISM

Žaklina Spalević[1],
Miloš Ilić[2*],
Željko Spalević[3]

[1]Singidunum University,
Belgrade, Serbia

[2]University of Pristina,
Faculty of Technical Science,
Kosovska Mitrovica, Serbia

[3]University Donja Gorica,
Podgorica, Montenegro

Abstract:

Electronic government provides different interactions between government and citizens, government agencies, employees and businesses or commerce. All these interactions provide better, faster and safer use of government services. In today's world, electronic government services have one very important role and that is war against terrorism. In this context, terrorism implies traditional and cyber terrorism. Network connections between different government services, use of databases with registered terrorists and terrorist organizations, electronic monitoring and checking of individual on the borders or suspicious web sites can prevent future attacks. This paper summarizes and presents different use of government electronic service in the war against terrorism through technical and legal observation. Besides advantages and disadvantages of the current electronic services, the paper presents ideas for possible improvements and better law support.

Key words:

electronic monitoring, cyber-crime,
terrorist activity activity, border control.

1. INTRODUCTION

Electronic government is being increasingly recognized as a means for transforming public governance. E-government is also known by different terms such as Electronic Government, Electronic Governance, Digital Government, Online Government, e-Gov *etc*. (Gronlund and Horan, 2005). In fact, there are many definitions for the term e-Government and their differences reflect the priorities in the government strategies. Some authors define e-government as a way for governments to use the most innovative information and communication technologies, particularly web-based Internet applications, to provide citizens and businesses with more convenient access to government information and services, to improve the quality of services and to provide greater opportunities to participate in democratic institutions and processes (Fang, 2002). Another definition of e-government is as the government owned or operated systems of information and communication technologies that transform

Correspondence:

Miloš Ilić

e-mail:
milos.ilic@pr.ac.rs

relations with citizens, the private sector and/or other government agencies so as to promote citizens' empowerment, improve service delivery, strengthen accountability, increase transparency, or improve government efficiency. E-government offers services to those within its authority to transact electronically with the government. These services differ according to users' needs, and this diversity has given rise to the development of different type of e-government. E-government functions can be classified into four main categories: Government-to-citizen (G2C), Government-to-business (G2B), Government-to-government (G2G), Government-to-employee (G2E).

E-government has potential for stronger institutional capacity building, for better service delivery to citizens and business, for reducing corruption by increasing transparency and social control (DPEPA, 2002). Measuring the return on e-government investments recommends that any successful e-government program should address at least one of the following areas: financial – reduced costs of government operations with enhanced revenue collection; economic development; reduced redundancy - consolidating and integrating government systems; fostering democratic principles; and improved service to citizens and other constituencies. E-government should enable anyone visiting a city website to communicate and interact with city employees via the Internet with instant-messaging (IM), audio/video presentations, and graphical user interfaces (GUI). This needs to be more sophisticated than a simple email letter to the address provided at the site. Technology was used to improve the access to website, and delivery of government services. Data collected and shared through these kinds of services can be used for many different purposes.

Besides citizens and companies, employees in the government services use these data to apply security measures to secure homeland, government and their citizens from traditional and cyber terrorist attacks. In case of traditional terrorist attacks, police authorities in the country and cross border control could monitor suspicious persons and prevent attacks, relying on the information collected about previous terrorist activity, and the data collected from biometric documents. Also, network of cellphones can be used to track individuals, their locations and conversations. Cyber terrorism must be considered to include the full range of threats, vulnerabilities, risks and technological matters. That could be the use of computer network tools to harm or shut down crucial national infrastructures. By this, energy, trans-

portation and government operations are meant. The premise of cyber terrorism is that as nations and critical infrastructure become more dependent on computer networks for their operation, new vulnerabilities are created (Weimann, 2004). The definition of cyber terrorism has been highly debated since the 1990s, because it is not easy to define how devastating the damage caused by a single computer attack might be. The term itself has been controversial, sometimes inflated and used in different contexts. Today, monitoring of users who visit critical web sites which are considered to be the property of terrorists may lead to useful information. What drives people to terrorism is not easy to determine.

One thing is for sure, the terrorists are not willing to be observed in their activities. Such observation could provide appropriate information and conclusions. To prevent attacks from different terrorist organizations, government agencies must contain appropriate information and good cooperation between themselves. The main goal of this paper is to make the readers conversant with the role of e-government services in the war against terrorism. In continuation, different mechanisms for terrorist monitoring and information collections are presented. One part of the paper underlines their benefits and shortcomings, and the other presents technical solutions and law regulations for improvements for those mechanisms.

2. BIOMETRIC DOCUMENTS

National Identification Documents or eID programs are implemented in many countries by issuance of identity cards to citizens. Stealing someone's identity is a big intrusion of the privacy with major consequences on the legal and financial transactions.. In many cases, stolen ID cards are used for criminal activities. Identity cards can be extended with biometrics data about the user to ensure a unique ID and to prevent identity fraud. Biometric technologies provide protection of multiple registrations by the same person. Different biometric documents are used for different purposes. Each of those documents has specific architecture, and uses some kind of biometrics. Different government services require from citizens to own and use different biometric documents in different situations. Biometrics and security mechanism in biometric documents will be presented on the example of e-passports.

The e-passport contains an RFID chip which holds sensitive information: passport number, issue and expiry

date, issuing country, full name, gender, nationality, date of birth, document type, digital picture of the passport holder, and fingerprint or iris scans. Radio Frequency Identification (RFID) is an automatic identification technology that transmits data through the use of wireless communication using radio waves. An RFID system for e-passport consists of a chip, a reader, an antenna, and a Public Key Infrastructure (PKI).

The international agreements on electronic documents such as passports require a biometric identifier, which is used to verify that the person presenting the passport is really its owner. Biometric parts in electronic passport are digital version of the facial photograph and fingerprints. Facial photograph of an applicant is employed as a basic security element. From a biometric point of view, the face contains information that is invariant in time and can be measured, for example, the distance between eyes, position of chin, position of nose, and so forth. For the purpose of picture data creation, government agency responsible for passport creation must behave and take picture according to the specifications in ISO19794-5 that defines conditions for acquirement of this type of data: format, scene, picture properties, and so forth (Malčík and Drahanský, 2012). Organization of passport chip memory provides appropriate possibility for picture data storage twice on the chip. A chip consists of sixteen memory parts named data group one to data group sixteen respectively. The first copy of picture is encoded and stored in *data group two,* which is predefined for facial photograph in full color.

The second picture copy is stored in so called *data group five* on the chip. This picture is gray scale, and it is designated for laser engraving.

Another important biometric attribute stored on the biometric document's chip is fingerprint. That is an attribute that has been studied intensively. The fingerprint represents the unique skin structure of fingertips. As a phenotypic biological feature, fingerprint is unique, even in the case of identical twins. The characteristic formation of the fingerprint normally doesn't change over a person's life span (Schimke *et al*, 2005). Most fingerprint recognition systems analyze the unique pattern of ridges and valleys, and the arrangement of small unique marks on the fingerprint, which are known as minutiae. They can be recognized and distinguished by their type, by x- and y-coordinates, and by their direction. For storage of complete fingerprint image data on the biometric document's chip, up to 250 Kbytes is needed. Using different compressions, size of data can be reduced. By saving only

extracted information, a reduction to a magnitude of one Kbyte is possible. This can provide the lack of interoperability between biometric systems from different vendors, if these systems use different types of feature data. To avoid fake-finger attacks, some systems employ so-called liveness detection technology, which takes advantage of the sweat activity of human bodies. High-magnification lenses and special illumination technologies capture the finger's perspiration and pronounce the finger dead or alive. To provide more safety for their citizens, all EU countries are working to add fingerprint biometrics protected to the e-passport, and are currently conducting cross-border tests of these more advanced e-passports. For instance, Germany has two fingerprints, one from each hand, in the country's passport.

Registered attacks and vulnerabilities

While a biometric system can be compromised in a number of ways, one of the potentially damaging attacks is the leakage of biometric template information. The leakage of this template information to unauthorized individuals constitutes a serious security and privacy threat. If an attacker can hack into a biometric database he can easily obtain the stored biometric information of a user. This information can be used to gain unauthorized access to the system by either reverse engineering the template to create a physical spoof or replaying the stolen template (Jain *et al*, 2013). The attack can take place at communication network, chip or at backend system. E-passport guarantees confidentiality, consistency and authenticity of information based on some cryptographic tools, but it is not fully protected. The most common hardware and software attacks include the following:

- Eavesdropping. This is an attack where the attacker intercepts the information by using an unauthorized device during the communication between a chip on the passport and legitimate reader. This is mainly due to the fact that e-passports use the communication network of RFID cards (Pooters, 2008). Eavesdropping can result in stolen sensitive information, such as e-passports biometrics, personal information or cryptography information.

- Clandestine Scanning and Tracking. It is well known that RFID tags are subject to clandestine scanning. Baseline International Civil Aviation Organization (ICAO) guidelines do not require

authenticated or encrypted communications between passports and readers. Consequently, an unprotected e-passport chip is subject to short-range clandestine scanning (up to a few feet), with attendant leakage of sensitive personal information including date of birth and place of birth. The standard for e-passport RFID chips (ISO 14443) stipulates the emission of a chip ID on protocol initiation (Sheetal, 2006). If this ID is different for every passport, it could enable tracking the movements of the passport holder by unauthorized parties. Tracking is possible even if the data on the chip cannot be read.

- Cloning. This is copying or duplicating data of a chip found in the Machine Readable Zone (MRZ) to another chip or system without the knowledge of the passport holder. This type of attack occurs to the mandatory feature of passive authentication. Many researchers have identified that cloning is a serious vulnerability and successful attacks can compromise confidentiality of the MRZ e-passport chip data (Sinha, 2011). The cloning poses a threat of data and biometrics leakage contained in the e-passport chip. Besides leakage of biometric data, alteration of biometric data is possible (Nithyanand, 2009).

- Cryptographic Weaknesses. Many services which use e-passports include an optional mechanism for authenticating and encrypting passport-to-reader communications. The idea is that a reader initially makes optical contact with a passport, and scans the name, date of birth, and passport number to derive a cryptographic key K with two functions: it allows the passport to establish that it is talking to a legitimate reader before releasing RFID tag information, and it is used to encrypt all data transmitted between the passport and the reader (Juels *et al*, 2005). Once the reader knows the key K, however, there is no mechanism for revoking access.

- Skimming. A skimming is the act of obtaining encoded data without the consent of users by using electronic storage device. Moreover, the RFID e-passport chips transmit radio waves broadcasting information once the e-passport is either partially or fully open, which makes the e-passports prone to skimming (Sheetal, 2006). The data from e-passport can be retrieved by beaming power at the passport within a few inches or at most a few feet.

Improvement in the use of biometric documents

Biometric documents in different government institutions provide the appropriate citizen identification. To prevent previously numbered attacks and vulnerabilities, each country tries to develop more secure biometric documents. One way to improve this kind of documents is to put more biometric data about the person on the document's chip.

For example, in addition to fingerprint and face photo, scanned iris structure could be placed on the biometric document's chip. The biggest advantage of iris scanning is its accuracy and reliability. Iris scanning is ten times more accurate than fingerprinting. Some research have shown that iris scanning produces around 1 in 1–2 million false matches, compared to fingerprints, which produce around 1 in 100,000. While fingertips are constantly susceptible to damage, the iris in the other hand is naturally protected by the cornea. Iris pattern seems to remain reliably unchanged for decades. Unlike fingerprint scanners, which need direct contact and have to be kept spotlessly clean, iris scans can be performed safely at some distance from the eye.

More biometric data on one document provide better security. Today's government services around the world work to create dual-biometric documents. These documents use different combinations of biometric data in the process of identity verification. One research example combines dual-iris recognition and face capture capabilities. This kind of biometric protection which uses multiple biometric factors is a new solution for biometric documents creation (Counter, 2014). The big deal about this deployment solution is the new technology which uses iris scanning and recognition. This iris recognition system is developed for everyday practical use in real life. Biometric scanners used for this kind of job provide precise iris scanning from a distance. Those scanners do not require from the subjects to stop moving their eyes.

Another dual or multimodal biometric system proposes dual-biometric-modality personal identification, which used both the fingerprint and the Electroencephalogram (EEG) technologies to achieve both high identification performance, and an effective antispoofing capability (Liwen *et al*, 2010). That study represents the first effort to fuse the widely adopted fingerprint technology with a novel biometric modality-EEG. Experimental results suggest that the highest identification performance is obtained in the proposed dual-biometric modality system, compared with the performance of the systems based on either fingerprint or EEG alone.

Different studies about dual-biometric personal documents suggest using different biometric data. All biometric documents provide quite enough data for successful control by government services. Retention time of the people who cross the border is very important. Because of that, frontiersman must… triage suspicious of not suspicious persons. A system which compares citizen's data from the biometric document with data from government database about citizen must work fast as much as possible. If data about some person are suspicious, additional checks must be done. In such situations, biometric data from the document would be checked. If the document is stolen or data altered, matching will not be possible. In order to provide better control, governments must develop and use automated control systems. While personnel do the passport or ID check of the person, automated system for face recognition could compare picture collected from the camera on the border, and one from the document. If there is no match of the pictures, or picture and personal data (name, last name, address…), fingerprint or iris scanning could be done for additional check.

An example from USA shows that the man arrived to New York's John F. Kennedy International Airport and presented a valid passport and a visa (Homeland, 2015). The name and picture on his travel documents were appropriate, but the fingerprints check revealed that he was trying to use the visa which belongs to his twin brother, who had no prior criminal recod or immigration violations. By matching his biometrics, officers found out that this man had been arrested for taking photos of a U.S. military base. Besides that, he had extended the term of his admission on a previous visit to the United States. This and other examples show that the use of a large number of biometric characteristics leads to greater safety, and could provide higher protection against terrorism.

3. GLOBAL NETWORKS AND TERRORISM

Most terrorist groups are now leveraging the Internet to recruit, train and spread propaganda, especially "global brands" such as al-Qaeda. Criminal groups and foreign intelligence services appear to have demonstrated electronic theft and sabotage capabilities. All terrorist groups and individuals find the Internet useful. Today, almost each terrorist organization has websites, and many of them have more than one website created in several different languages (Winder, 2014). Terrorist websites make use of slogans and offer items for sale,

including videotapes, audiocassettes, t-shirts, badges, and flags. All things are offered in order of sympathizing. Terrorist organization will target local supporters through the website in the local language, and will provide detailed information about the activities, politics of the organization, its allies, and its competitors. Terrorist organizations use the Internet in many different ways. Some of those examples include the following:

- Networking and information sharing: The Internet is overcrowded with information that could be used by terrorist groups. Such groups could find different maps, satellite area photos and plans. Besides that, terrorists can use the Internet to find information about communication and transportation infrastructure, water supplies systems, explosives manufacturing, creation of fraudulent passports, and information about different weapons. Terrorist groups share different kinds of information among themselves. They share news events, publishing manifestoes, or logistic and tactical information. In most cases, they are relying on password protected forums, chat rooms and bulletin boards. Lately, a number of large-scale terrorist groups have become less centralized and more extensively networked. They use social networks for communication, and fun group creation.

- Recruitment: In the case of terrorism, recruiting new activists is very important. In many cases, political and/or religious rhetoric is used for this job. Marketing and propaganda are oriented towards young adults, because of the fact that young adults are the most abundant internet users. Because of their age, they are consequently among the most predisposed to propaganda.

- Fundraising: Websites for terrorist organizations often have links which redirect the visitors to another address on which visitors are often monitored and researched. Visitors who visit website over and over and those who stay on the website for longer periods of time will be contacted. They will be offered additional information or asked for assistance.

- Cyberterrorism: It is focused on hacking or cracking into victims computers for the purpose of disruption, privacy data disclosure or misuse. Potential targets are telecommunication systems, defense systems, medical facilities, power grids, transportation, and public persons and politicians.

Terrorist websites and social networks tracking and control

In response to the growing number of extremist websites and social networking sites, government agencies have started to carry out cyber vigilantism. Because of the nature of the counter-terrorism, the government does not provide exactly what technology is being used for. Information on how some cyber protection is being implemented is not in the public domain. However, it is obvious that communication monitoring techniques are at the very heart of the surveillance and interception policy. How terrorists communicate, of course, is also a big problem for the government. One method in the fight against terrorist websites, and terrorist activity on the social networks is website tracing and blocking by government agencies. The authors shall present the examples of different foreign practices.

In an attempt to proactively defend against web based terrorist's tactics, the Metropolitan Police in the UK established a dedicated Counter Terrorism Internet Referral Unit (CTIRU) in 2010 that deals with public reports of online content of a violent extremist or terrorism nature. Since it started, CTIRU has removed some 55,000 pieces of content and 34,000 of those have been in the last year alone. More controversially, the UK government is putting pressure on the Internet service providers to block extremist content at source, so that customers would not be able to see it. This blocking would, if successful, take the form of optional filtering such as is already in place for pornographic content.

A new legal decree that went into effect in February 2015 allows the French government to block websites accused of promoting terrorism and publishing child pornography, without seeking a court order (Toor, 2015). Under the new rules, the Internet service providers must take down offending websites within 24 hours from receiving a government order. The decree implements two provisions from two laws: an anti-child pornography law passed in 2011 and an anti-terror law. According to the law, the department of the French national police is responsible for identifying the sites to be blocked, with the suspected terror-related sites subject to review by an anti-terrorism branch. Once the site is blocked, its page will be replaced with an explanation of why the government took it down.

In 2003, FBI agency decided to explore developing a web application that would monitor user updates on social sites such as Facebook and Twitter for the purpose of tracking possible terrorist activities on social networks (Teeter, 2003). The application is developed so the FBI could quickly vet, identify, and geo-locate breaking events, incidents and emerging threats. FBI agents employed in the communications center, sending out real-time alerts, developing threat profiles and detecting potential threats to the field agents. American people are willing to sacrifice some of their on-line privacy if it helps in the fight against terrorism: 57% of both Americans and Internet users agree that Internet users should be willing to give up some privacy if it helps law enforcement officials to track down terrorists (Jongman, 2011). Thirty-nine percent of both groups disagree, however, saying that the terrorists would ultimately win if people lost any of their civil liberties.

One more technique in the fight against terrorist activities in the cyber space is monitoring of suspicious websites and social networks profiles. Through social networks, government agencies could monitor and cluster all users who walk into any suspicious activity. By this we refer to social network users who frequently comment, like and visit terrorist fan page. The most frequent and active (support comments) visitor can be put on the so called terrorism watch list. Technically, that is the database with all possible information about such user. This kind of databases shared among different government agencies could prevent future terrorist attacks. For example, if the citizen whose name is in some kind of database will be more carefully controlled on the border, or in some important public institutions. In some cases, border crossing or airplane travel will be forbidden.

United States created Terrorist Screening Database (TSDB). If the person is a known terrorist or if there is a reasonable suspicion that the person could be terrorist, it will be included in this database (TSC, 2015). To meet the reasonable suspicion standard, nominating agencies must rely upon articulable intelligence or information which reasonably warrants a determination that an individual is suspected to be a potential terrorist (TSC, 2015). Based on the totality of the circumstances, a nominating agency must provide an objective evidence to believe an individual is a known or suspected terrorist. Nominations to the TSDB are not accepted if they are based on ethnicity, race, religious affiliation, and national origin. Activity such as the exercise of religion, free speech, freedom of the press and freedom of peaceful assembly are protected from nomination for TSDB by First Amendment.

Each person who has some problem with control on the airports or borders could check if his/her name is on some watch list. There is a process called the Department

of Homeland Security Traveler Redress Inquiry Program. This is program which allows a person to make an inquiry if their name is on the list, and why their name is on it. The program rescans person's name and then, if person was wrongly put on the list, they will remove his/her name from the list, but that is not a simple process. For example, if a person have trouble at the airport, that person should contact the Transportation Security Administration and complete the paperwork for redress program. Paperwork will be passed to the authorities that evaluate any necessary changes. The average wait time for resolving a complaint is sixty-seven days (DoJ, 2007). With so many people being identified as possible terrorists, it may seem nearly impossible for a watch-listed person to slip through government screening. However, an audit by the U.S. Department of Justice in 2007 found that twenty people who were on the watch list were not properly identified and detained when they should have been (DoJ, 2007). In many cases, complains are being rejected, and the person being moved on the hider level of protection. In some cases, person being moved on the lower level, but still stay on the watch list.

4. CONCLUSION

Homeland security of each country depends on many facts. Domestic and foreign enemies and terrorists seek a way to comprimise or jeopardise the security of citizens. In order to provide appropriate security level for all citizens government agencies all over the world work to find the best solution in the fight against terrorism. Because of the huge number of possible terrorist methods, agencies must work together in this fight. The one described above are biometric documents, which provide citizen's information transparency to agencies. Although hardly accepted, these documents offer different possibilities to their users. Some of them are digital signatures and digital certification. All those possibilities and basic biometric information from another hand are important for successful citizen protection.

Network connections between government agencies provide faster information sharing. This is important because of the fact that different agencies could have the same information about some possible terrorist activity at the same time. Cyber terrorism and terrorist activities on the Internet are monitored by appropriate government agencies. As we have explained and presented through the examples, finding, monitoring and blocking of terrorist web sites and social networks profiles are three most important activities. This order between

mentioned activities is selected because firstly, it is important to find and mark possible terrorist web site, fan page or user profile. After that and before web site blocking, agencies must collect all important information about the web site owner and visitor through the monitoring process. This kind of information could put some internet user on the terrorist watch list. At the end, web site will be blocked. Internet service providers are responsible for this job by the government order.

Each country has legal directives which provide instruction that must be fulfilled in order to prevent terrorism. Law against terrorism is different in different countries, but targets the same ideas. This law defines rights and obligations of government agencies and defines in which situations some person or organization could be marked as a terrorist threat. Our final conclusion is that in the fight against terrorist threats all government institutions must work together in order for the success to be evident.

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THE INFLUENCE OF MULTI-LEVEL COVERAGE ON EFFICIENCY OF AMBULANCES RELOCATION OPTIMIZATION PROCESS BASED ON THE AVL DATA

Čedomir Vasić[1],
Dejan Rančić[1],
Leonid Stojmenov[1],
Jelena Gavrilović[2],
Nebojša Arsić[3]

[1] University of Niš,
Faculty of Electronic Engineering,
Niš, Serbia

[2] Singidunum University,
Belgrade, Serbia

[3] University of Priština,
Faculty of Technical Sciences,
Kosovska Mitrovica, Serbia

Abstract:

The implementation of emergency vehicles relocation, as part of the overall optimization process, looking for some in advance adopted guidelines. One of the most important issues is to decide between single, double or other multiple coverage of service points. A comprehensive algorithm based on the data extracted from huge archive of vehicle moving history is used to analyze the influence of different types of coverage to the efficiency of obtained solutions. In order to perform comparison and evaluation of the quality of semi-optimal solutions, a parameter named savings ratio is used.

Key words:

relocation of ambulances, multiple coverage, double coverage, location optimization.

1. PROBLEM DEFINITION

A comprehensive project is implemented within the Computer Science department at the Faculty of Electronic Engineering, University of Niš, based on the use of the data generated by AVL (Automatic Vehicle Location) component of the GPS/GPRS (Global Positioning System/General Packet Radio Service) tracking devices. For the purpose of resource allocation in an emergency medical service, a system for tracking and ambulance fleet relocation was brought into operation. During the practical realization of the project, it was necessary to consider several important aspects related to this well-known problem in the field of the locational optimization. Deterministic approach in process of the redeployment of the static ambulance fleet, assume that we already made decision how many vehicles should ensure coverage to the single demand for service. The multiple coverage means that we make a compromise and in clean and simple single-coverage solution, introduce certain lack of efficiency. The aim of this paper is to quantify the extent to which multiple coverage degrades efficiency of initial solution based on the single demand coverage. To that end, the appropriate parameter named "saving ratio", as a unique coefficient of efficiency of the whole process, is proposed.

Correspondence:
Čedomir Vasić

e-mail:
dona@dona.rs

2. MATHEMATICAL REPRESENTATION

As regards the available input data, in particular the main goal of the optimization process, we have several different definitions of this problem. The associated mathematical formulation also differs from case to case. One approach is in the case if we want to find how many of the vehicles are necessary to handle the assigned number of service demands, when the basic limitation is not to extent the presumed maximum time limit to reach the farthest user. MCLP (Maximal Coverage Location Problem) is the model proposed by R. L. Church and C. ReVelle [1] to resolve that kind of problems. Different problem setting is if we want to deploy *p* available vehicles and the main goal is the minimal total distance to serve all demand points. In this case, we deal with the feet of fixed size.

The multiple coverage can be introduced in mathematical formulation in two main ways: static - introducing simple percentage of areal coverage or dynamically - through complex time dependence related to the probability that the observed vehicle will be used in curtain time frame. Frequently cited static model named "BACOP2" is mathematically defined by K. Hogan and C. Revell [2]. In this model, double coverage of destinations is introduced for the first time and the impact of coverage by second vehicle is balanced using the variable named weighting factor. It is up to the operator in "call-centre" to make a choice between different sizes of this parameter in accordance with the predefined business policy.

Dealing with the probability that the vehicle will be busy during the observed time frame, leads us to the probabilistic approach. Unavoidable is the work of M. Gendreau, G. Laporte and F. Semeta [3] in which DSM (Double Standard Model) is defined to maximize the goal that demand is covered by at least two vehicles, implicitly taking into account the fact that vehicles might become unavailable. The model in particular tries to ensure that certain percentage of the population is covered within r_1 time units and all demand points need to be covered by at least one vehicle within r_2 time units, where $r_1 < r_2$.

In our research, we were limited to the deterministic approach, and we focused our efforts on resolving the common problem of location optimization, named as "*p*-median" problem. In a few words, it is a problem to identify *p*-facilities, to minimize distances, required to provide a service to *n*-destinations. According to the fact that this problem is classified as non-deterministic polynomial-time (NP) difficulty, time and memory demands

to reach the final solution are not known in advance. Contemporary meta-heuristic methods are used as the common approach to find the semi-optimal solution. This problem is well defined and probably represents one of the most often considered issues in the field of location optimization. Different approaches in solving this problem range from S. L. Hakimi [4], C. ReVelle and R. Swain [5], M. B. Teitz and P. Bart [6], P. J. Densham and G. Rushton [7], E. L. F. Senne and L. A. N. Lorena [8], P. Hansen and N. Mladenović [9], K. E. Rosing and C. S. ReVelle [10], to the contemporary meta-heuristic methods such as Genetic algorithm, described in the works of C. M. Hosage and M. F. Goodchild [11] and O. Alp, E. Erkut and Z. Drezner [12].

The generally adopted representation of *p*-median problem is given as follows: find minimum of (1):

$$\min\left(\sum_{i \in I} \sum_{j \in J} \omega_j \cdot d_{ij} \cdot y_{ij}\right) \qquad (1)$$

where ω_j is a weighting factor of location *j*, while d_{ij} is distance between location *i* of vehicle dwelling location and location *j* as one of the observed *n* service demand locations. In expression (1), *I* and *J* are upper limits in the range of the integer variables *i* and *j*, and it is obvious that in both cases it is the number *n*, according to fact that each of *n* locations at the same time is a potential candidate for the optimal solution. To gain full and correct mathematical representation of the observed problem, additional constraints are needed and these constraints become an integral part of the definition. In the case of single coverage, additional requirements are:

$$\sum_{i \in I} x_i^1 = p \qquad (2)$$

$$\sum_{i \in I} y_{ij} = 1 \qquad \forall j \in J \qquad (3)$$

$$y_{ij} - x_i^1 \le 0 \qquad \forall i \in I, \ j \in J \qquad (4)$$

$$x_i^1 \in \{0,1\} \qquad \forall i \in I \qquad (5)$$

$$y_{ij} \in \{0,1\} \qquad \forall i \in I, j \in J \qquad (6)$$

Condition (2) is connected with the physical limitations in the number of vehicles and shows that the total number of vehicles needed to be deploed is limited to *p*, but it also requires that we had to deploy all *p* vehicles.

Condition (3) defines the assumption that one destination is serviced by only one vehicle and only one parking place is joined to the one demand. If the parking place selected to cover request from location **j**, does not have a vehicle, we have no possible solution and it is described in expression (4). At the same time, that is a way to introduce a single coverage in the definition. The condition (5) defines simple fact that on the single parking place we can park only whole vehicle. It is physically impossible to split one car into two or more locations. A similar fact is described in the condition (6). The intervention is maintained with one whole vehicle, not with two halves of vehicles from two different locations. Conditions (5) and (6) procedure lead into the domain of integer arithmetic, whereby we only had to be careful and ensure that the interpretation of distance ω_j also remains as integer value.

The double coverage we formulate as follows: find a minimum of (7):

$$\min\left(\theta \sum_{i \in I} \sum_{j \in J} \omega_j \cdot d_{ij} \cdot y_{ij} + (1-\theta) \cdot \sum_{i \in I-1} \sum_{j \in J-1} \omega_j \cdot d_{ij} \cdot z_{ij} \right) \quad (7)$$

Expression (7) is obtained from the initial expression (1) in which an extra double sum is added, but restricted to only **p**-1 available vehicles, to be allocated to **n**-1 locations. Now we have a new requirement, as in one location we can park two vehicles. The conditions (2), (3), (5) and (6) remain, but we had to change the condition (4) and to add new conditions (10) and (11), to define hierarchy between single and double coverage. Relations between single and double coverage are in fact relations between the first and second double sum in expression (7).

$$\sum_{i \in I-1} x_i^2 = p-1 \quad (8)$$

$$\sum_{i \in I-1} z_{ij} = 1 \quad \forall j \in J \quad (9)$$

$$z_{ij} - y_{ij} \le 0 \quad \forall i \in I-1, \, j \in J-1 \quad (10)$$

$$z_{ij} - x_i^2 \le 0 \quad \forall i \in I-1, \, j \in J-1 \quad (11)$$

$$x_i^2 \in \{0,1\} \quad \forall i \in I-1 \quad (12)$$

$$z_{ij} \in \{0,1\} \quad \forall i \in I-1, \, j \in J-1 \quad (13)$$

$$0 \le \theta \le 1 \quad (14)$$

The condition (10) tells that single destination cannot be covered twice, if it is not covered once already, while the condition (11) is extended condition (4). It

specifies that the coverage with the second vehicle follows the same logic about possible or impossible solution, already described with expression (4). The objective defined with the equation (7) is a result of the balance between aspiration to cover the observed destination once and aspiration to be covered twice.

The weight factor θ is introduced to define balance between these two opposite aspirations. Expression (14) says: if value of θ is closer to 1, advantage and greater weight has single coverage. If θ is closer to 0, it is a growing influence of the double coverage. In the limiting cases, when $\theta = 1$, expression (7) is reduced to the formulation (1), and if $\theta = 0$, we have also simplification of the problem and definition is switched to complete coverage with two vehicles.

The triple coverage is only further extension of the expressions (1) and (7) and we add an extra double sum, following the same logic that we used to come from single to double coverage. The following expression is labeled as (15):

$$\min\left(\theta \sum_{i \in I} \sum_{j \in J} \omega_j \cdot d_{ij} \cdot y_{ij} + (1-\theta) \cdot \sum_{i \in I-1} \sum_{j \in J-1} \omega_j \cdot d_{ij} \cdot z_{ij} + (1-2\theta) \cdot \sum_{i \in I-1} \sum_{j \in J-1} \omega_j \cdot d_{ij} \cdot u_{ij} \right)$$

3. DESCRIPTION OF THE APPLIED METHOD

Emergency medical service and problems of the allocation and relocation of ambulances is often considered. Some of the most cited and comprehensive efforts are works of P. Kolesar, W. Walker, J. Hausner [13], S. Budge, A. Ingolfsson, D. Zerom [14] and M. Reinthaler, B. Nowotny, F. Weichenmeier [15]. The well documented algorithm of resolving the appropriate **p**-median problem, related to relocation of ambulance vehicles, is described in detail in the previous works of authors of this paper [16], [17], [18]. We proposed an algorithm which is implemented in four independent stages:

I) The first phase is the process of the vehicle destinations extraction from the database which is an integral part of the vehicle tracking system (AVL). Extraction is maintained through execution of several SQL-queries, defined for limited time frame in which fleet of vehicles is observed. In the applied sequential analysis, we use several pre-defined criteria and, we come to the set of **n** locations which represents destinations of individual drives of ambulances. All these destinations are locations of demands for service in the defined time frame. At the end of the first phase, we construct **nxn** matrix of distances **M(n, n)** and

introduce a weight factor for each destination. In i-row and j-column a matrix element d_{ij} is placed, and that element represents the distance from the destination node i to the destination node j multiplied by ω_j -weight factor of node j.

II) The second phase of the algorithm is some kind of pre-processing of each element of the matrix of distances $M(n, n)$. Pre-processing assumes that Euclidean distances are replaced with the routed distances. For the purposes of this paper, routing is done using the commercial software "Garmin BaseCamp, Ver.4.3.4, 2008-2014 Garmin Ltd." [19], which allows tabular input of coordinates and delivers the route. Routes are based on the road network defined by maps labeled as: "City Navigator Europe NT 2014.3 Ver.17.30 NAVTEQ". The history of vehicle usage analyzed during the first phase of the algorithm contains all information about the routes starting from the Central garage to each destination. However, in the archive there is no information about routing paths between individual destinations. That is the main reason to populate the distance matrix with distances delivered by commercial navigation software.

III) In the third stage of the algorithm, we introduce p service locations as parking places in which we want to set p vehicles. The main objective of this phase is to reach a solution with acceptable quality in an efficient manner. That solution had to be good enough as a starting point for the central pillar of the whole solution and it is the heuristic based on the Genetic algorithm. During the third phase, solution is obtained through direct calculations based on the limited number of iterations where "node-substitution-procedure" is used. During each iteration well known "1-opt-procedure" is performed on the matrix of distances, followed by procedure of finding the nearest neighbors ("neborhooding"). After neighborhooding is done, all destinations become sorted in p subsets, "1-opt-procedure" is used again, but now on every of p-subsets. These steps are repeated in several iterations and in the process of direct calculations, we came to the rough solution to each of the p-medians. The test example described in this study assumes that the III phase of the algorithm was limited to 20 iterations, after which we get a solution which will be input for the IV phase.

Figure 1. Starting sum of the distances to the 218-destinations C_{tot}.

IV) During phase IV, suitable Genetic algorithm is used and semi-optimal solution is delivered. The specific parameters of proposed Genetic algorithm ensure the rapid convergence and reduce the risks of falling in trap known as local minimum. The execution of the Genetic algorithm is limited to pre-defined number of generations, and for the purpose of this study, we adopted a total number of generations to be restricted to 100. To estimate the quality of the offered relocational solution, we defined a unique parameter to quantify the quality of the solution. It is a kind of efficiency coefficient, used to compare costs before and after introducing the process of optimization. We start with the situation as there is no optimization involved, and it is our initial state. If the ambulances each time start moving from the Central garage and visit all n destinations, we deal with total cost C_{tot}, and it is sum of distances illustrated in Figure 1.

If we apply the achieved semi-optimal solution and cover all n destinations staring from the proposed optimal p-parking places, we lowered total distance and total cost is now C_{opt}. We have now the case illustrated in Figure 2.
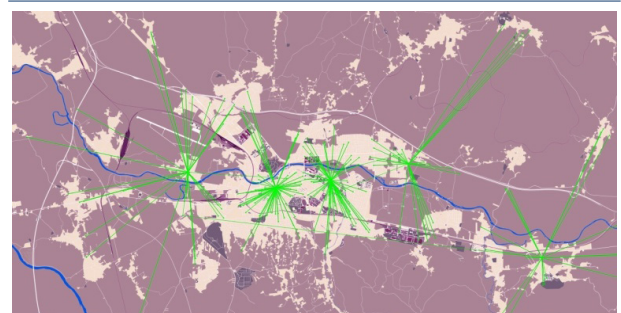

Figure 2. Total sum of distances according to the proposed solution C_{opt}.

The efficiency coefficient had to exclude the direct impact of the absolute values to its size. So, we proposed the following definition of "Saving ratio" as relative value, described in (16):

$$Sr = \frac{C_{opt}}{C_{tot}} \cdot 100(\%) \qquad (16)$$

The saving ratio S_r gives us percentage in which we succeeded to decrease the cost of the initial solution. We assume that the initial solution represents 100% and S_r gives gain in savings after we introduced semi-optimal solution.

4. THE ANALYSIS OF OBTAINED RESULTS

The comparative advantage of approach applied in this work is based on the fact that we deal with data obtained from the archived database connected to the AVL system, which has been in use for several years. Information about destinations in the particular case discussed in this work is extracted from the database where everyday drives of medical emergency vehicles were recorded during the period from September 01, 2014 until September 20, 2014. In that time frame, every step of the fleet of ambulances of the Emergency medical service in Niš was recorded. The analysis and algorithms which can be found in the literature available to these authors, related to similar optimization tasks, are commonly realized on the artificially generated input data, on the data of the population density, data from police reports, phone calls *etc*.

For the purpose of analysis of the impact of multiple coverage to the efficiency of generated solution, we analyzed the archived data and we chose time interval which delivered 218 destinations. We assumed that all vehicles travel from the Central garage of Emergency medical service and after intervention, the vehicles returns, using the same route. The starting cost (C_{tot}) in the case of 218 destinations and the Euclidian distance between destinations is calculated, taking into account the geographical distribution of locations, and it is shown in Figure 3. The amount of total cost is 943.909,00 meters.

After the second phase, we have populated the elements in the matrix with routed distances. We continue with same 218 destinations visited from the central garage, but now with the routed distances between destinations, and the total initial distance is now 990.431,00 meters. As we expected, this value is larger than value of C_{tot}, displayed in Figure 1 because moving by road network assumes longer way in comparison to the moving

by hypothetic straight line. The third stage of algorithm is limited to 20 iterations and after calculations we get solution with the sum of total distances 441.007,00 meters, which is represented by saving ratio approximately: S_r =45%.

During the fourth phase and the heuristic method based on Genetic algorithm, we introduce a single, double and triple coverage using the different mathematical formulation of the objective function represented in the expressions (1), (7) and (15). The construction of the basic elements of Genetic algorithm and structure of the fourth phase is available in [16], [17] and [18]. We had to mention only a couple of important hints: used structure of chromosomes is numerical, length of chromosome is defined with available total number of vehicles and objective function is routed distance needed to reach all destinations. Single, double and triple coverage required additional adaptation of the "fitness"-function, in accordance with the objectives and reached adaptation level of the offsprings.
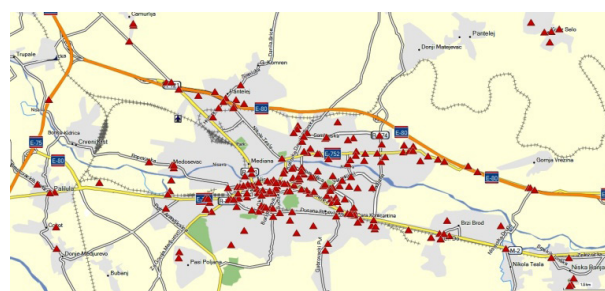

Figure 3. Layout of the 218-destinations (C_{tot}).

At first glance, it is clear that in the case of double coverage, the number of simple mathematical operations required to calculate the amount of fitness-function practically doubles. Also, in the case of triple coverage, the number of operations is three times larger, as it is in the case of single coverage. The Genetic algorithm is limited and stops after 100 generations.

Figure 4 shows the layout of the parking places in the case of a single coverage of 218 destinations and 5 available vehicles. Figure 5 shows the solution obtained by the treatment of the same input data, but with a double coverage. Figure 6 presents the layout of the solution in the case of the triple coverage. Comparative observation of all three cases clearly shows that if we go from the single to the multiple coverage, the proposed parking places are concentrated close to the city core with smaller distance between parking places. This behavior of the

obtained solutions is rather expected, because the largest concentration of destinations was in the city center, as can be seen in Figure 1.
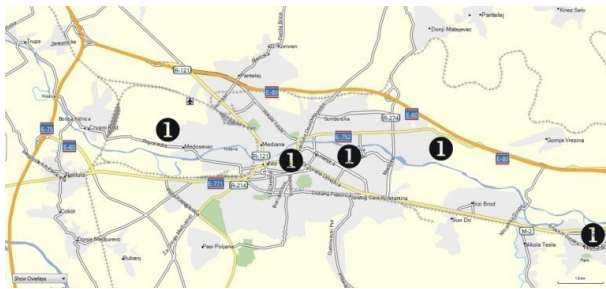

Figure 4. Layout of the p=5 parking places - single coverage.

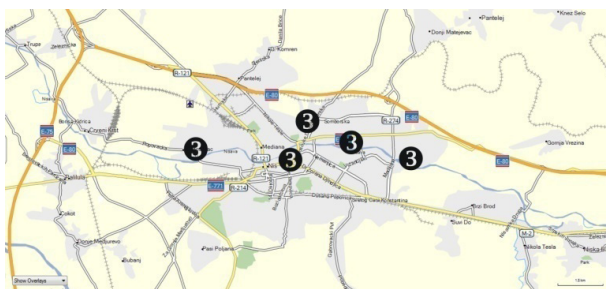Figure 5. Layout of the p=5 parking places - double coverage.

Figure 6. Layout of the p=5 parking places - triple coverage.

Explanation of this trend lies in the simple fact that in the city core area, we find the greatest population density. With the introduction of four or five-fold coverage with p=5 vehicles available, we approach to the concentration of all vehicles in the area of the central garage, and it was the initial set up, from which we started optimization process.

The data in Table I and graphic in Figure 7 demonstrate the behaviour of saving ratio (16) according to the execution of the algorithm in all three cases of different

coverage. In Figure 7, we can see S_r varies during the third stage of the algorithm and rough method of finding the initial solution, implemented during the first 20 iterations.

	Single cover.		Double cover.		Triple cover.	
	d(km)	S_r(%)	d(km)	S_r(%)	d(km)	S_r(%)
No opt.	990.431	100%	990.431	100%	990.431	100%
III phase	441.007	45%	614.067	62%	693.302	70%
IV phase	386.268	39%	455.598	46%	623.972	63%

Table I. Distances and saving ratio (S_r)

After the end of phase III, we enter into the phase in which the Genetic algorithm is executed in 100 generations. With each generation, solution is getting better and the algorithm quickly converges to the semi-optimal solution.
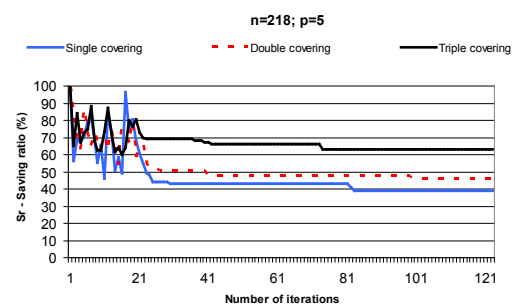
Figure 7. Behaviour of algorithm in cases of different coverage.

As we can see, S_r is 39% for the case of a single coverage, and it is our solution with geographical layout shown in Figure 4. In the case of a double coverage and layout shown in Figure 5, the best S_r is 46%, while in the case of triple coverage and the layout shown in Figure 6, S_r is 63%. Table I shows the behavior of the total distance amount as the algorithm flows through certain stages.

CONCLUSION

If we monitor changes of the saving ratio when different coverage is used in the optimization process, some differences in the efficiency of solutions generated

by differences in approach could be observed. However, if we compare single and double coverage, differences are not so significant in magnitude, and practical usefulness of this approach with double coverage has a lot of sense. This is particularly true if we take into account the statement that double coverage reflects the realistic needs of the observed service users.

Furthermore, multiple coverage does not have too much sense, especially if the size of the available fleet is small, as in our particular case, where we had only 5 vehicles available.

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ICT IN TOURISM & HOSPITALITY

SYSTEM ISSUES AND REQUIREMENTS OF HOTEL MARKETING MANAGEMENT

Jelena Đaković[1]
Angelina Njeguš[2],
Nikola Milović[1]

[1]Square Nine Hotel,
Studentski trg 9, Belgrade, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

In this paper, the main marketing management processes, their changes under the influence of Web 3.0 services and user behavior, information technologies that are currently used in hotels, and the influence of big data analytics systems, are discussed. Many hotels today are struggling with their data. Therefore, the authors want to gain better understanding of the problems and issues the hotels are facing, as well as to gather their requirements for future big data analytic systems. Since problems are arising with the size of the hotel, this paper shall analyze only small-sized hotels. Despite the advantages that big data analytic applications bring, they still did not find wider application in hotels. In order to analyze issues related to the implementation of big data analytic system within hotels, the small-sized hotel located in Belgrade is analysed in this study.

Key words:

marketing, social media, big data, mobile technologies, system requirements.

1. INTRODUCTION

Since marketing is defined as the process that creates value for customers through stronger customer relationships (Kotler *et al*, 2013), the hotel marketing managers are focused on:

- how to improve customer satisfaction,
- how to personalize marketing campaigns and services,
- how to offer the right room at the right moment and at the right rate,
- how to expand on to other markets and reach prospective customers.

Traditional information systems that are installed in hotel environment are not sufficient to cope with these requirements. Today, customers are active on the Internet, using different internet services, such as search engines, social media, mobile applications and games. Thus, massive amounts of data are generated, with the hotels not being aware of that.

Guest database within Customer Relationship Management (CRM) system does not tell much about the guest, except for her/his movement during the stay at the hotel. There is a need to enrich this data with the guest activity and behavior on the Internet. However, these data are generated rapidly, and traditional systems are not meant for processing huge amounts of data in real time (so called big data). Therefore, new technologies and systems are developed in order to collect, process and analyze big data.

Correspondence:

Angelina Njeguš

e-mail:

anjegus@singidunum.ac.rs

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Numerous hotels are nowadays struggling with their data, which is why this paper shall attempt to provide insight into the problems and issues the hotels are facing, as well as to gather their requirements for future big data analytic systems. Since the problems are arising with the size of the hotel, only small-sized hotels (5-50 rooms) shall be covered in this analysis.

The paper comprises two main parts. The first part discusses the main marketing management processes, their changes under the influence of Web 3.0 services and user behavior, information technologies that are used within hotels, and the influence of big data analytics systems. The second part examines the current situation of IT and applications that marketing managers use in their everyday job based on the case study of the hotel Square Nine in Belgrade. The current issues of marketing managers are also discussed herein.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

The marketing management process has changed under the influence of the emerging technologies and changes in consumer behavior (Figure 1). From management perspective it turned to social with an emphasis on understanding consumers and competing behaviors through research, segmentation, 7P and 7C marketing mix implementation, exchange of benefits, and analytics with purpose of constant learning and improvement (Burchell *et al*, 2013). Inevitably, development of information and internet technologies have accelerated this process, but also provide support and assistance in carrying out these activities (Law *et al*, 2009). Today, without adequate tool/system or IT strategy in general, marketing managers may put hotel in at a competitive disadvantage. On the other hand, consumers are increasingly empowered and smart, and come with a number of expectations (Table 1), boosted by mobile, social, cloud, big data and other technologies.

Figure 1. Marketing management process (York, 2015)

The most hotels today are equipped with traditional Enterprise Resource Planning (ERP) systems, so called Property Management Systems (PMSs), such as Fidelio, Protel, RMS and other. Much effort is done on integration of PMSs with other systems, such as: Customer Relationship Management (CRM), Computer Reservation Systems (CRSs), Revenue Management Systems (RMS), Supply chain Management Systems and other. Majority of these systems are nowadays available on the cloud using mobile platforms. However, all these systems are dealing more with management perspective instead of social. As said above, the social aspect includes all user generated content (UGC) available on social media. The issue that arises here is that traditional systems and technologies are not meant for processing big data that are generated every second in different data formats (Xiang *et al*, 2014).

Customer expectations	% of respondents
Access to Services Faster than ever	55%
24/7 Access and connectivity	53%
Access to More Platforms	50%
Personalized Experience	47%
Greater transparency in interactions	38%
Easier collaboration and sharing with other customers	25%

Table 1. Consumer expectations

(Source: Institute for the future, 2015)

Big data can be defined as a new generation of technologies, architectures and analytic systems, that are designed to economically and in real time capture, extract, store, process, discover, and analyze very large volumes of a wide variety of data (Wren *et al*, 2014) (Njeguš *et al*, 2015). Marketing managers can directly benefit from big data analytic systems in a way to (Salkowitz, 2014):

- better track performance of marketing investments
- personalize brand experiences
- improve message targeting
- deliver personalized products/services with personalized pricing
- anticipate new opportunities through predictive analysis
- attract and retain individual customer at the lowest cost
- manage ongoing relationship at optimum levels of profitability.

Big data analytic systems can involve not only social media content, but also other data generated by sensors, mobile phones, and from other digital channels, that are turned into digital signals (Figure 2). By analyzing these signals, we can learn about customers, as follows (Hendrix, 2013):

- Searched data - key words or sentences, entered into search engines, by the customer, can tell about his/her interest, wishes, intentions.
- Location data - mobile phones generate location data, and these data can tell where consumer is, how often, who else is there, *etc.*
- Purchase data - these information tell who buys and almost what is bought.
- Social data - identity data, and the way user interact with others.
- Interest data - what user is interested in, like tweets, checkins, *etc.*
- Content data - what user reads/watches/consumes when, what, *etc.*

Big data analytic systems represent these data in three different perspectives (Figure 2): (a) historical analysis - to better understand what happened in the past (b) real time monitoring of big data - to evaluate what happens at present and (c) predictive analysis - predict the behavior of instances in the future.
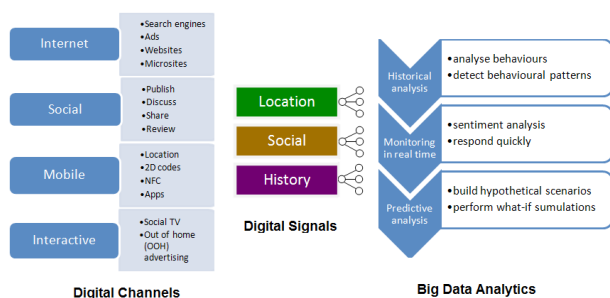
Figure 2. Big data analytics on different dimensions (Baquero *et al*, 2014) (Hendrix, 2013)

According to Hendrix (2013), 4P's can be switched to PEER strategies:

- Personalize - analyzing customer data we should learn and adapt
- Enable - Remove frictions
- Enhance - Surprise/delight customer
- Reward - Reinforce customer

3. MARKETING MANAGEMENT ISSUES AND SYSTEM REQUIREMENTS: SQUARE NINE HOTEL BELGRADE

Despite the advantages that big data analytic applications bring, they still have not found wider application in hotels. In order to analyze issues implementing big data analytic system within hotels, only small-sized hotels are covered in this study.

Square Nine hotel is a five-star hotel in Belgrade. It has 45 rooms and belongs to the category of small sized hotels. It has excellent reviews on social network websites. In a short period of time, hotel management have changed from looking at marketing as a function of sales, to having full-fledged marketing teams with individual specialists for segments such as PR and Social Media. However, it is still predominately one-person job, even with the role of marketing manager changing and growing over time.

The duties of a hotel marketing manager are simply defined as the overall presentation of the hotel and the building of the brand positioning and image of the hotel among the local and foreign public. This is achieved through printed materials, in hotel communication through all available channels, traditional advertising campaigns, positioning of the hotel on Google and on-line sales and distribution channels, on line advertising, social media, trade fairs, specialized events inside and outside of the hotel and sponsorships. The position also requires budgeting for all of these activities, scanning activities of the competition, tracing the efficiency of the activities that are done for the promotion of the hotel and reporting. Finally, the position entails the creation of special packages, designed to bundle hotel products into single, more attractive packages, with an enticing price. These should be designed with a good grasp of the market, target audience, consumer needs, and hotel vs. competition pricing policies in mind. Ideally, the marketing manager should help the sales department draw interested customers towards the hotel, and open a communication process with them, and also position the hotel as great value for the requested price in all segments and aspects.

With the changing world and the growing importance of on-line communication, and especially social media, as well as the growing social aspect in traditional positioning and sales channels for hotels, such as booking.com or Trip Advisor, the role of the marketing manager has started to entail an array of different duties. These duties are to: create an interesting and engaging flow of social media content, keep a line of open two-way communication with follower public, answer all comments

and questions in any channel and form that they are delivered in, make sure that the image of the hotel that is created on third party channels (such as Trip Advisor and Booking.com) is adequate to the image that the hotel wished to portray itself. All of these channels have become the most important and effective tool in image and brand building, as well as more of a sales channel than any of the traditional ones are, and they are rapidly growing in importance. The content creation is one of the largest aspects of this work, as the content should be interesting and relevant to the target audience, as well as deeply connected with the hotels daily life and activities.

Many brands and companies today hire the professional, so called community manager (Živković *et al*, 2015), or professional teams for social media management and content management, that are solely in charge of providing a constant stream of content, or simply to publish multimedia information. This can at times become overwhelming, since the basic channels that pretty much all hotels today communicate with guests, are through website, search engines, social media and online travel agencies (OTA). As community managers do their jobs manually, the solution would be in using specialized big data analytic systems.

Information technologies that are implemented in the hotel Square Nine are:

- ◆ Hardware (Figure 3)
- ◆ Software:
    - Fidelio
    - Micros
    - Materials Control
    - Accounting system
- ◆ Network: Free Wife, throughout the hotel, 30 Mbits upload/30 Mbits download
- ◆ Pay TV
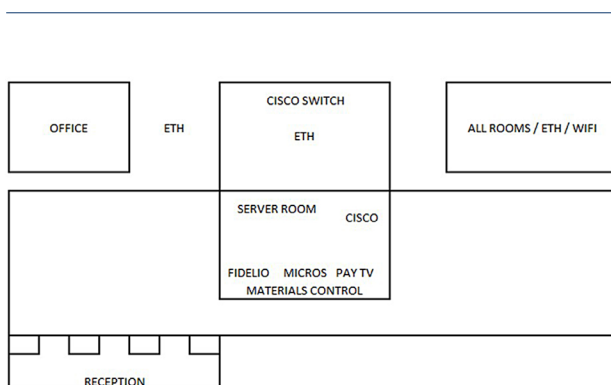
Figure 3. IT distribution within hotel sectors

Internet technologies that are used at Square Nine, are:

- ◆ The hotel web site (www.squarenine.rs)
- ◆ The hotel blog (www.square-nine.rs)
- ◆ The group web site (www.lhw.com)
- ◆ Social media:
    - Facebook (www.facebook.com/squarenine),
    - Instagram (www.instagram.com/square-ninehotel),
    - Twitter (twitter.com/squareninehotel),
    - LinkedIn (www.linkedin.com/company/square-nine),
    - Youtube (channel/UCNwsWH_ivdDlar-P8HEJ0uEg)
- ◆ Google positioning: Google maps, Google +, Google street view
- ◆ Google metrics: Google analitics
- ◆ Survey monkey
- ◆ Dropbox
- ◆ WeTransfer
- ◆ Hotel Mobile App
- ◆ Sales and distribution channels: Booking.com, Expedia, HotelBeds, *etc* .
- ◆ TripAdvisor as a special and unique channel.

The hotel receives constant feedback and information through each of these channels, from its existing guests, potential guests, fans, competition and others. Additional feedback is received through online surveys sent to each gust after departure, and information about guests is collected during their stay, and added to their profiles in the hotel software (in our case Fidelio). Each of the channels provides its own statistic and/or panel for communication, but there is no single panel through which all of these inputs could be connected, reviewed, tracked, or managed. Some current issues are:

- ◆ Fidelio is inflexible, it is very difficult to get certain data or types of reports from it.
- ◆ Fidelio cannot be, or can very hardly be connected and integrated with other software.
- ◆ Each of the technologies used collects its own set of data, but there is no way to connect all of it.
- ◆ Many aspects of operation are done manually, although a better system would be able to do it more efficiently (ordering of supplies, store keeping …)

The main system requirements for the future applications are collecting and connecting guest information from all available sources (internal and external), and offering an easy way to access it, analyze and communicate.

4. CONCLUSION

Considering that one of the key trend in hotel industry today is the new customer segment, so called generation Z (also iGen or Millennials) - the fastest growing segment in the hotel industry - the hotel will need to quickly adapt and prepare tits environment for this generation. By 2025, it is expected that Millennials will represent more than 50% of all travelers. Since technology is essential for this demographic group, hotels should pay special attention to empathy and customer connection through social media using personalized and technology powered hotel processes and services. For those self-sufficient travelers, hotels need to offer mobile check-in, geo-location software, personalized and other services. In this paper, we wanted to analyze the current situation in hotel marketing management, their issues and future information system requirements. The goal was to analyze the current trends in marketing management, and examine the level of their implementation in hotels. For that purpose, the small-sized hotel located in Belgrade was analyzed.

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RESEARCH ON ASSESSMENT CENTERS IN SERBIA

Milivoj Mrdaković,
Jelena Đorđević Boljanović,
Nemanja Stanišić

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

This work represents a condensed version of extensive research conducted as part of the master's thesis work of the lead author. To the best of our knowledge, there is a general lack of research on the subject of assessment centers (ACs) not only in the Republic of Serbia but also in Southeastern and Eastern Europe. Research is being conducted in accordance with the established models and procedures in already publicized papers. We explore where the local AC practice stands compared to the developed economies as well as the developing ones. We also investigate whether there is a specific pattern of "Serbian Assessment Centers" so that we can identify and document the potentially idiosyncratic features of the local AC practice.

Key words:

selection, development, evaluation, promotion, talent management, competence.

1. INTRODUCTION

Assessment centers are a significant tool for assessing the future behavior of the candidate, which could be implemented for three purposes: selection of the unemployed, development of employees and promotion of employees to higher positions. The studies conducted so far have shown that there is no single purpose that is typical for all countries or companies. Despite the existence of a document entitled "Ethical Considerations and Guidelines for Assessment Center Operations"[1], this survey reveals that this document is modestly used in ACs in Serbia.

Also, it is known that some countries such as the United Kingdom, Russia, Germany, Indonesia, Switzerland and South Africa have their own national standards for the implementation of practices in ACs that comply with the international guidelines interpreted within their specific national contexts.

2. SHORT HISTORY OF ASSESSMENT CENTERS IN SERBIA

Assessment centers first arose for military purposes in Germany in WWI and then in the United States during WWII. However, it is not a well-known fact that Serbia, despite being a state with a small population,

Correspondence:

Milivoj Mrdaković

e-mail:

milivoj.mrdakovic.12@singimail.rs

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1 "Ethical Considerations and Guidelines for Assessment Center Operations" is a document that was created under the auspices of the American Psychological Association (APA) with the efforts of the International Task Group.

formed its own aviation and Aerospace Command in 1912. It was the fifteenth country in the world to do so and the fifth country to use aviation in warfare.

Psychological assessment was performed in Serbia for military purposes as well. In 1931, for the first time in Serbia, the army tested the intelligence and mental functions of candidates in order to select the appropriate military pilots.[2] (Стојановић, 2003)

Over time, evolution of psychological assessment took place, and it has been transformed for business purposes. Business professionals reshaped it into a modern form known as assessment centers.

As Serbia is developing and the world is globalizing, the standardization of the practice of psychological pre-dictions for business purposes took place, in particular through the expansion of multinational corporations. At the same time, there are significant variations that are caused primarily by cultural differences.

3. METHODOLOGY

Following several published studies through work of Spychalski, A.C. *et al* (1997), Krause, E.D. *et al* (2003, 2009, 2011, 2012, 2014) and Tasha L.E. *et al* (2009), we conducted the research modelled on previous work on the territory of the Republic of Serbia to examine the state of ACs.

Previous studies have been conducted in countries whose populations are significantly larger than the pop-ulation of Serbia. For example, in "*Assessment center practices in Indonesia: An exploratory study*" Krause E.D. *et al* (2014), Indonesia has a population of 254,5 million (according to the World Bank data for 2014). The USA has 316.5 million people. German-speaking European regions mentioned in Krause E.D. (2003) have a popula-tion of 97,61 million. The smallest researched state with the closest population to Serbia is South Africa, with almost 60 million people. Still, Serbia is much smaller, with population of 7,13 million.

Economically, with the exception of Indonesia and South Africa, these are developed countries, while Serbia is a developing country. The GDPs of these countries are $17,42 trillion for the USA, $5 trillion for German-speaking regions, $350,5 billion for South Africa, and $44 billion for Serbia. Therefore, Serbia could hardly be compared with the other countries.

Our stratified sample was completed randomly with declared professionals who work in human resources management in Serbia through LinkedIn networks, and they were individually invited to participate in the survey.

2   page 219.

We have developed a survey that was generated through Google Forms, and we distributed links via the Internet. We invited 498 human resources professionals, 381 of whom were women and 117 men. 123 individuals completed the survey, but two were rejected because they did not work on the territory of Serbia. Thus, our final sample was **N=121**.

The response rate of females who completed the survey was 97, which is 26% of those invited. The number of male respondents was 24, which is 21% of the number of all invited. The Overall Response Rate without two rejected is 24%, which we consider to be a very high percentage. The survey was conducted twelve days immediately prior to the upcoming holidays (New Year's Eve, 2016 and Orthodox Christmas), which was a pretty bad time for conducting a survey. Luckily, we had a good response.

We can conclude that professionals in human re-sources management showed a high level of collegiality, for which we are very grateful. We attributed such a high response to the fact that we made a personal, rather than machine-generated call to everyone individually.

4. SOME OF THE RESULTS

Number of exercises

Considering that this is a condensed (shortened, light-er) version of the research, we shall present some findings.

After 10 mandatory general questions, we gave an option for those who did not use AC practice in their companies. One of the optional questions was, what is the average number of exercises on assessment centers in your company? Bearing in mind that the answer depended on whether HR professionals used ACs in their practice, the number of those who responded was **N=103**.

Research has shown that the average number of ex-ercises is (in percentages):

	Number of exercises	%
	3 or less	41,58
	4 to 5	51,49
What is the average number of exercises on the AC in your company?	6 to 7	5,94
	8 to 9	0,00
	>9	0,99

Table 1. Average number of exercises on AC

When we regrouped the data obtained, we noticed that 93,07% of organized assessment centers in Serbia have 5 or less exercises, and the remaining 7% (6,93%) have more than 5 exercises.

It was interesting for us to compare and analyze the available data from other surveys.

We compared Serbia vs. Indonesia[3], Serbia vs. South Africa[4] and Serbia vs. USA[5] using Fisher's Exact Test and the Chi-Square Test. All H_0 hypotheses were that the average number of exercises in Serbia did not deviate from the average number of exercises in other (individually paired) countries. Let's look at the following tables.

Number of exercises * Country – Crosstabulation

Number of exercises			Country		Total
			Serbia	Indonesia	
3 or less		Count	42	26	68
		Expected Count	46.4	21.6	68.0
4 to 5		Count	52	16	68
		Expected Count	46.4	21.6	68.0
6 to 7		Count	6	5	11
		Expected Count	7.5	3.5	11.0
10 or more		Count	1	0	1
		Expected Count	.7	.3	1.0
Total		Count	101	47	148
		Expected Count	101.0	47.0	148.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	4.859[a]	3	.182	.175
Likelihood Ratio	5.180	3	.159	.161
Fisher's Exact Test	4.966			.135
N of Valid Cases	148			

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is ,32.

Table 2. Serbia vs. Indonesia (2011)

Number of exercises * Country - Crosstabulation

Number of exercises			Country		Total
			Serbia	South Africa	
3 or less		Count	42	18	60
		Expected Count	42.1	17.9	60.0
4 to 5		Count	52	20	72
		Expected Count	50.5	21.5	72.0
6 to 7		Count	6	5	11
		Expected Count	7.7	3.3	11.0
10 or more		Count	1	0	1
		Expected Count	.7	.3	1.0
Total		Count	101	43	144
		Expected Count	101.0	43.0	144.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	1.853[a]	3	.604	.651
Likelihood Ratio	2.045	3	.563	.651
Fisher's Exact Test	1.960			.623
N of Valid Cases	144			

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is ,30.

Table 3. Serbia vs. South Africa (2014)

Number of exercises * Country - Crosstabulation

Number of exercises			Country		Total
			Serbia	USA	
3 or less		Count	42	7	49
		Expected Count	32.3	16.7	49.0
4 to 5		Count	52	33	85
		Expected Count	56.1	28.9	85.0
6 to 7		Count	6	8	14
		Expected Count	9.2	4.8	14.0
8 to 9		Count	0	4	4
		Expected Count	2.6	1.4	4.0
10 or more		Count	1	0	1
		Expected Count	.7	.3	1.0
Total		Count	101	52	153
		Expected Count	101.0	52.0	153.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	20.993[a]	4	.000	.000
Likelihood Ratio	23.266	4	.000	.000
Fisher's Exact Test	20.795			.000
N of Valid Cases	153			

a. 5 cells (50,0%) have expected count less than 5. The minimum expected count is ,34.

Table 4. Serbia vs. USA (2009)

3   (Diana E. Krause, Neil Anderson, Robert J. Rossberger, Zulaicha Parastuty, 2014), page 390
4   (Diana E. Krause, Robert J. Rossberger, Kim Dowdeswell, Nadene Venter, Tina Joubert, 2011), page 265
5   (Tasha L. Eurich, Diana E. Krause, Konstantin Cigularov, George C. Thornton III, 2009-12), page 390

If we analyze the data and test values in the tables (2,3 and 4), we can conclude that there is no significant difference in the number of exercises between Serbia and Indonesia (2011) and Serbia and South Africa (2014). In fact, the data confirmed the null hypothesis.

We can also see that the **p=0,623** value (in table 3) is greater than **p=0,135** (in table 2), so there is stronger evidence that the similarity between the number of exercises on the AC in Serbia and South Africa is closer.

What differs significantly is the number of exercises in Serbia than in the USA. We have **p=0,000**, so there is strong evidence that an alternative hypothesis is correct: The number of exercises in Serbia and the number of exercises in the USA differ significantly.

However, it should be noted that there is a relatively significant time lag (seven years) between the papers from which we used the mentioned data. The differences in the studies are dispersed through years and are reduced over time, so there is an inverse proportionality. The closer cited facts from already published papers are to the immediate present, the smaller the difference.

Number of assessors

Research has shown that ACs in Serbia usually have one or two evaluators (assessors) (44.66%) (Figure 1).

International Assessment Center Guidelines (IACG)[6] says: "Multiple assessors must be used to observe and evaluate each assessee… When selecting assessors…must strive to have diverse…in terms of demographics (*e.g.*, race, ethnicity, age, sex) and experience (*e.g.*,organizational level, functional work area, managers, psychologists, *etc.*).

The maximum ratio of assessees to assessors depends on the type of exercises used, the behavioral constructs to be evaluated, the roles of the assessors, and the type of data integration…

The ratio of assessees to assessors should be minimized where practicable… to minimize potential bias…"

It is obvious that what IACG says and practices regarding the number of assessors in Serbia are not even similar. Indeed, the "Guidelines" don't mention a clear number of assessors in its description of the requirements to this issue, but it is certainly less than the following recommendations contain.

Also, research has shown that about one-third (32.04%) of Serbian assessment centers have three assessors, and about a quarter (23.30%) more than three.

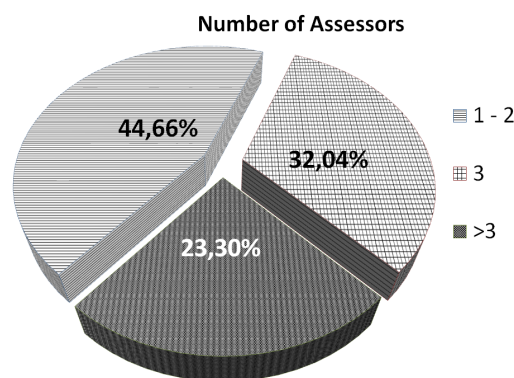6   (International Taskforce on Assessment Center Guidelines, 2015), page 9

Figure 1.

We asked whether there was a connection between the number of observers and the average number of exercises.

Our H_0 (null hypothesis) was: "The average number of exercises is independent of the number of assessors."

We got the strong evidence where p<0.01, confirmed that our alternative hypothesis, H_1—"The average number of exercises is directly dependent on the number of assessors"—was true. Therefore, how to increase the number of assessors of ACs, increases the number of exercises (and vice versa). See Table 5.

How many assessors do you have in AC in your company, on average?		1 до 2	3	>3	Total
3 or less	Count	23	17	2	42
	Expected Count	19.1	13.3	9.6	42.0
4 to 5	Count	20	13	19	52
	Expected Count	23.7	16.5	11.8	52.0
6 to 7	Count	3	2	1	6
	Expected Count	2.7	1.9	1.4	6.0
>9	Count	0	0	1	1
	Expected Count	.5	.3	.2	1.0
Total	Count	46	32	23	101
	Expected Count	46.0	32.0	23.0	101.0

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)	Point Proba-bility
Pearson Chi-Square	16.945[a]	6	.009	.004		
Likelihood Ratio	18.690	6	.005	.003		
Fisher's Exact Test	17.574			.002		
Linear-by-Linear Association	7.120[b]	1	.008	.008	.005	.002
N of Valid Cases	101					

a. 6 cells (50,0%) have expected count less than 5. The minimum expected count is ,23.

b. The standardized statistic is 2,668.

Table 5. Number of exercises * Number of assessors - Crosstabulation

ICT in tourism & hospitality

5. DISCUSSION

Conclusions from this study should be interpreted with certain limitations in mind.

First, the data collected in Serbia (2016) and the data collected in other studies have significant time gaps that could be seen as potential problems. In emerging economies, there is rapid change. There are indications that changes in the development of AC were significant. To quote the study by Diana E. Krause and Diether Gebert, "There are indications that the execution of ACs in the United States may have changed in the meantime because the number of exercises and assessment days have been reduced" (Krause, Diana E., and Diether Gebert, 2003)[7]. We should assume that something similar happened with the surveys whose data was used in this work.

Very important limitation of this study was the "randomness" of the sample of the population that cannot claim to be representative for sure. Not all HR professionals have LinkedIn profiles.

Third, the study was methodologically limited to the quantitative research, and there was no consideration of qualitative analysis of ACs in Serbia. The next qualitative analysis should include the qualified number of HR experts who were not available for the survey at the time.

The fourth possible shortage is objective in its nature, since Serbia is a small country with limited population, especially compared to large countries like the United States, Indonesia, Germany and others. However, we had an excellent response that increased the accuracy and representativeness of the results. Maybe the proposed future research that would include the whole region of Southeast Europe could obtain more representative results.

Finally, it should be emphasized that our intention was to gain insight into the contemporary Serbian practice of ACs, in which it was necessary to have generality since there were no similar studies. In other words, this study tried to make up for the lack of information on AC practices in Serbia in the absence of other studies.

6. CONCLUSION

To the authors' best knowledge, this first study of assessment centers in Serbia and our findings reveal several interesting differences (and similarities) between AC practices in the world according to the available data. In this paper, we may have exposed a small number of very interesting facts about AC practices in Serbia.

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[7]   p. 309

The fact that ACs have their own clearly defined and internationally accepted standards and structure led us to the conclusion that there are cultural and other differences caused by the traditional standards and modalities of psychological evaluation in Serbia compared to "Guidelines."

For the sake of harmonization, it could be necessary to establish the National Congress of Assessment Center Developers and National Guidelines for the Development of AC that could lead and standardize practices of ACs, thus raising the quality criteria, ethical standards and principles.

Future research of ACs in Serbia should also have a qualitative character. Perhaps there could be a regional survey to understand the state of practice of Assessment Centers in this part of Southeast Europe.

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THE IMPACT OF INFORMATION - COMMUNICATION TECHNOLOGIES ON DEVELOPMENT OF RURAL TOURISM IN SOUTHERN AND EASTERN SERBIA

Marko Gašić,
Goran Perić,
Vladan Ivanović

Business School of Applied Studies, Blace, Serbia

Abstract:

Contemporary tourism trends are characterized by the increasing tourist movements towards rural destinations. Tourism in rural areas has become reality, the need and desire of tourists, but also an important activity for development of rural areas. Southern and Eastern Serbia region has great potential for development of rural tourism, but despite this, it is still at an early stage of development. The reason for this situation lies in a number of limiting factors and inadequate valorization of available resources. Therefore, it is necessary to identify the key factors for development and establish the proposed, based on the available resources. One of the limiting factors is the lack of information systems. The subject of this paper is to review the development of rural tourism in the region of Southern and Eastern Serbia, to identify limiting factors and define importance of information - communication technologies in development of rural tourism in the region.

Key words:

rural tourism, ICT, development, limiting factors.

1. INTRODUCTON

In the middle of the last century, a significant change could be observed in tourism offer and tourism demand. Rural areas, which until now have been rather underdeveloped and uninteresting tourism destinations, have reached the center of attention. On the demand side, there was a need for something new, different ways to spend leisure time and the growing interest in the so-called quality products and different experiences, that is, the tourists want all that mass tourism was no longer able to offer them.

Unfavorable working conditions, monotony, noise and dynamics of urban life are just some of the motives that have contributed to the popularization of rural tourism. Surveys conducted on the territory of Europe indicate that about 20% of tourists show interest in this form of tourism, with a growing tendency in the future. Free time activities during the weekends and public holidays are increasingly being used to stay in rural areas, whether it is for the purpose of rest. Overall, the rural tourism is increasingly referred to as a global process, which only 40 years ago was additional developed tourism industry.

Over the last few years, Europe has been the leading provider of rural tourism (Gašić, Ivanović, Komadina 2014, p. 38). The movement "back to nature", which has its roots in the fifties of the last century and refers to the fact that "citizens of different social and educational groups want to spend

Correspondence:

Marko Gašić

e-mail:
gasicmarko@yahoo.com

part of the holiday in the countryside and experience the rural atmosphere and learn about the rural way of life " (Nikolić 1979, p. 17) is growing.

Organized development of rural tourism in the Republic of Serbia started in the seventies of the twentieth century, in the village of Devići, near Ivanjica (Gašić, Perić, Ivanović 2015, p. 73). In the first years of development, the results were impressive, followed by stagnation in the nineties, which completely annulled the positive results. At the beginning of XXI century, a slight increase could be observed in the rural tourist traffic throughout the country. However, a number of limiting factors, then and now disable the faster development of rural tourism, and one of them is certainly inadequate application of telecommunication information technology and misunderstanding of its importance for rural development and rural tourism.

2. DEVELOPMENT OF RURAL TOURISM IN THE REGION OF SOUTHERN AND EASTERN SERBIA

Despite rich in the resource-based, rural tourism in the region of Southern and Eastern Serbia is at an early stage of development. Until recently, the results of the policy in tourism development ignored the inclusion of the continental part of our country in the tourist offer. As a result, over 90% of the total number of overnight stays was registered in the coastal areas (Štetić 2007, p. 233). On the other hand, very significant natural and human resources in the continental part of the Republic were under-used, or not used at all, as was the case with the region of Southern and Eastern Serbia. This field of rural tourism, whose significance has not been sufficiently explored beside all of it possibilities and basides on the experience of many European countries, is virtually limitless in future development.

With the changes that occurred in the second half of the twentieth century at the global level, particularly in the late nineties, rural tourism has become an increasingly important trend. General booming tourist movement in general, and especially to the rural areas from urban centers points to the growing importance of these movements, which if exploited in the right way can bring numerous benefits, both at the community level and at the state level.

Thanks to mainly hilly and mountainous nature of the region, there is a large number of rural areas with favorable conditions for rural tourism development. However, there is a small number of villages which managed to

provide these services. Some of them are shown in the following table.

District	Villages in which has developed rural tourism
Podunavlje	Jugovo, Aleksandrovac, Moravski konaci
Braničevo	Aljudovo, Salakovac, Kaona, Ždrelo, Malo Laole
Bor	Gornjane, Metovnica, Zlot, Džanovo polje, Šarbanovac, Luka, Bučje, Crnojka, Rudna Glava, Rajac, Rogljevo, Plavna
Zaječar	Crni Vrh, Balta Berilovac, Kalna, Vrtovac, Inovo, Jakovac, Jakovac, Mezdreja, Mali Izvor, Ilino, Rgošte, Ravna, Potrkanje, Gradište, Lužinac, Vrmdža, Trubarevac, Jošanica, Žuškovac
Nišava	Pirkovac, Niševac, Beloinje, Dubrava, Donji Dušnik, Semče, Gornej Vlase, Gornji Barbeš
Jablanica	Dadince, Magaš, Ivanje, Dobra Voda, Gornji Brestovac, Borince, Sijarinska spa
Pirot	Dojkinci, Rsovci, Jelovica, Slavinja, Brlog, Osmakovo, Vojnegovac, Topli Do, Gradašnica, Visočka Ržana, Temska, Kamenica, Poganovo, Donji Krivodol, Senokos
Toplica	Bublica, Togačevče, Cekavica, Prekopčelica, Štulac, Svinjarica, Beli kamen, Lukovska spa, Prolom spa, Kastrat
Pčinja	Poljanica, Kriva Feja, Duga Luka, Zagužanje, Jablanica

Table 1. Villages in the region of Southern and Eastern Serbia with developed rural tourism
Source: own research

Data on accommodation in rural tourism in households in the region of Southern and Eastern Serbia have not been covered by the official statistics. Available resources include portal Rural Tourism (www.selo.rs) and local tourism organizations (Bogdanov, Zečevic, 2011, p. 37). Types of properties in rural tourism, according to the data from Rural Tourism Association of Serbia, and relations to the region of Southern and Eastern Serbia, are shown in the following table.

Municipality	Number of accommodation facilities	Type of accommodation	Number of beds	Activities
Žagubica	1	Ethno village	18	Traditional food, visiting cultural - historical monuments
Bor	1	Beds	6	Cycling, recreation, fishing, walking, hiking, swimming
Knjaževac	1	Rural household	10	Resting in the nature, hiking, fishing, biking, hunting
Dimitrovgrad	1	Rural household	8	Ride bikes, walk in nature, traditional food
Bela Palanka	1	Guest house	-	Hiking, swimming, visiting religious sites
Sokobanja	1	Apartments	20	Hiking, swimming, walking, cycling
	1	Beds	4	Swimming, outdoor activities, visiting cultural - historical monuments
Pirot	1	Rural household	5	Hiking, bathing in thermal waters, hiking, biking, visiting historic buildings
	1	Guest house	6	Skiing, picking herbs, hiking, walking, biking, mushroom collecting

Table 2. Accommodation capacity of rural tourism in the region

Source: selo.rs

Based on the Table 2, it is possible to conclude that rural tourism is developed in a few villages in the region. However, due to insufficient application of modern information and communication technologies as well as inadequate level of education of the owners of rural tourist households, many of them have presented an offer within the site. Households engaged in rural tourism are far greater but are not engaged in this activity at all,and without organization or network about them, there are no precise data.

On the other hand, organized statistical monitoring in this segment of tourism is still at initial phase, but it can still be a reference. A large number of states, including the Republic of Serbia, do not collect statistics linked with rural tourism observations, especially in relation to other forms of tourism. However, the current development of rural tourism in the Republic of Serbia can be analyzed on the basis of data published by the Republic Statistical Office and related to tourist traffic viewed from the aspect of the realized number of overnights (Radović 2013, p.

120). The average percentage of overnight stays in rural tourism is 21% of the total number of overnight stays at the global level as well as at the country level (see Table. 3).

Year	Realized number of overnight stays in all tourist areas of the region	Realized number of overnight stays in rural areas of the region
2004	1447790	304036
2005	1379610	289718
2006	1302608	273548
2007	1472707	309268
2008	1541735	323764
2009	1346368	282737
2010	1314707	276088
2011	1350476	283600
2012	1315434	276241
2013	1106177	232297
2014	995948	209149

Table 3. Tourist traffic - the number of realized overnight stays in rural tourism in the region (2004-2014)

Source: Calculation based on the data of the Statistical Office of the Republic of Serbia

Given that the World Tourism Organization as well as the Organization for Economic Co-operation and Development failed to take appropriate measures, there are several constraints involved when it comes to providing accurate and logical data in connection with rural tourism and recreation (Petrić 2006, p. 7): First, the area where rural tourism is developing is difficult to define because different countries take into account different criteria; Secondly, all tourist activities in rural areas do not have to be strictly rural, but in its content can be urban, or only take place in rural areas; Thirdly, different regions develop different forms of rural tourism, and is therefore difficult to find common characteristics for all countries; Fourthly, rural areas have engulfed the complex change processes arising as a result of changes in the global market, particularly in the area of contemporary information and communication technologies, which are changing market conditions and demand for traditional products.

3. LIMITING FACTORS IN DEVELOPMENT OF RURAL TOURISM IN SOUTHERN AND EASTERN SERBIA

Previous efforts to develop rural tourism were not satisfactory. Resources for the development of rural tourism in the region of Southern and Eastern Serbia are related primarily to the fact that over 90% of the territory of the

region consists of rural areas, express geographically diversified in the form of hilly - mountainous areas. Around 70% of the total population lives in rural areas and multi-ethnic structure of the population which, which clearly indicates unexplored potential.

Unsatisfactory level of development of rural tourism in the region is the result of a number of limiting factors. Some of them are: unfavorable demographic trends, the lack of financial resources, inadequate rural infrastructure, lack of cooperation between different levels of government, lack of interest and motivation of the rural population to engage in this form of tourism, insufficient education and others. The lack of application of modern information and communication technologies is one of the factors that can also affect the development of rural tourism and that can also be seen as a limiting factor.

The causes of this problem must be found in, above all, the indicator of computer literacy. On the basis of that, it is possible to give appropriate recommendations for the next period. See Table 4.

Categories		Republic of Serbia	Southern and Eastern Serbia Region
	total	6161584	1347323
	man	2971868	661251
	woman	3189716	686072
Computer literate persons	*total*	2108144	362832
	man	1062125	191272
	woman	1046019	171560
Persons who are partially familiar with the work on the computer	*total*	910586	193506
	man	463780	101374
	woman	446806	92132
Computer illiterate persons	*total*	3142854	790985
	man	1445963	368605
	woman	1696891	422380

Table 4. Computer literacy in the region
Source: Statistical Office of the Republic of Serbia

According to this indicator, Serbia is below the EU average, but more computer-literate than some of its members, such as Romania and Bulgaria. At the regional level, the indicator is below the national average while the biggest problem of computer literacy is expressed in Jablanica and Zaječar district.

If we analyze the entire structure, it is possible to observe significantly greater participation of women in the group of computer-illiterate persons or group of persons partially familiar with the work on the computer. The causes of this phenomenon should be found in the position of women in the countryside and centuries of domination of the male population in most jobs. Nevertheless, this situation is gradually improving if we perceive the figures of male and female participation in previous census years.

Overall, regardless of the fact that the situation in the field of application of modern information and communication technology in rural tourism is gradually improving, it is still viewed as unsatisfactory. It is evident that the possibilities offered by modern technology are not sufficiently explored in rural areas in the Southern and Eastern part of Serbia, and that this still does not meet the appropriate conditions.

4. IMPORTANCE OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN DEVELOPMENT OF RURAL TOURISM

In order to achieve successful development of rural tourism in the region, it is necessary to dispose not only of attractive natural and human resources, capacity and quality products, but also efficient organization, adequate education and well-designed marketing. Owing to the changing lifestyles, economic conditions and other characteristics of tourists, tourist market is shifting from not so critical mood conventional tourists who were easily manipulated to mature, critical and emancipated, so-called new tourists. New needs, new interests and new knowledge about the destination of rural tourists carry with them; require a different approach to marketing in rural tourism, as it was the case with other forms of tourism (Stojanović 2011, pp. 194-195).

The approach of planning for tourism development in rural areas of the region, with particular importance at market research and the use of marketing instruments, must include the Internet because of its advantages over other instruments. Numerous studies have confirmed that the Internet as a global network with its various services is increasingly used in the promotion of all forms of tourism, including rural tourism. Thus, the population located in rural areas of the region has the opportunity to access the Internet and social networks and create their own content and publish it worldwide in order to attract potential tourists.

The importance of information technology and the Internet is evident and is of strategic importance in the development of rural areas. New information technologies offer unprecedented possibilities for initiatives in rural tourism, allow visitors quick and easy access to information, the ability to offer online reservations and other activities that are related to their departure to your destination. The importance of the Internet promotion is that in this way information is made widely available to potential users, who can more easily plan the journey (Todorović, Štetić 2009, p. 109).

Social networks encourage development of rural and less developed regions networks, households, local governments, tourist organizations and businesses that are directly or indirectly reliant on tourism. A number of social networks can be used in development of rural tourism and to achieve competitive advantages in both domestic and international markets. Social networks such as Facebook, Twitter, YouTube and Google Maps can be of great importance in tourism planning (Zrilić 2012, p. 346).

The importance and role of the Internet in general and contemporary technology in the development of rural tourism is priceless. The survey conducted by the Internet Advertising Bureau, with respect to the effectiveness of the promotion on the Internet, revealed the following results: (Čomić, Kosar, 2011, p. 27):

- The level of acceptance of the Internet as a means of advertising is much higher compared to traditional media
- Advertising on the Internet dramatically increases the awareness of the product after just one viewing site
- Advertising on the Internet significantly increases the awareness of the brand or product promoted
- Significant increase in communication power of a particular brand if it is promoted via the Internet
- Advertising on the Internet has the potential to increase sales
- Advertising on the Internet is more likely to be noticed than advertising on television
- Internet and other electronic information technology can influence the search of tourist information as well as the travel decision-making and choice of destinations.

Based on the above-stated, modern ICT, the Internet and social networks can be characterized as a necessity in modern business.

5. CONCLUSION

Changes that occur globally positively affect the development of selective forms of tourism, as tourism is based on the use of different natural and social resources. Attention must be paid to certain segments of the system, especially the development of tourism in rural areas.

Rural tourism has been expanding in recent years; due to the growing needs of urban population for recreation in a different area, under rural setting. In addition, rural demand for peace, rest and recreation is a growing trend at the regional, national, European and international level. In Serbia, this form of tourism is still at its initial stage.

Southern and Eastern Serbia owns attractive natural and cultural tourist motifs that have not yet been adequately socio - economic valorized. The reasons should be sought in a number of limiting factors, among which certainly should be highlighted the lack of knowledge and application of modern information and communication technologies and the benefits they provide, especially in the promotion of tourist offer of rural households.

Importance of information technology and the Internet are evident, and thus strategically important in development of rural tourism. One of the priority tasks at the regional level will be organizing a number of training courses on which the owners of rural tourist households are informed to the benefits of modern technology and the importance of promotion of their offers on the Internet. The Internet is the best and fastest way (channel) for transmitting and exchanging information.

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THE IMPACT OF ICT ON TOURISM BUSINESS-IMPROVING EFFICIENCY, PRODUCTIVITY AND BUSINESS PERFORMANCE

Predrag Vukadinović[1],
Goranka Knežević[1],
Aleksandar Damnjanović[2]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2] Higher School of Academic Studies "Dositej",
Belgrade, Serbia

Abstract:

Tourism is one of the most complex industries, which exerts considerable impact on other industries. Many abandon the thesis that tourism is a result of economic development, but increasingly accept the claim that tourism is a factor of economic development. Information and communication technologies (ICT) have been confirmed, as they increase efficiency, productivity and improve overall business performances. Numerous authors have examined the relationship between ICT application and business tourism development, but also with the aim to prove the application of various models from different perspectives. This paper aims to present some of the aspects of the connection between the application and development of ICT and improvement factors in tourism business.

Key words:

ICT, tourism, business performance, efficiency, productivity.

1. INTRODUCTION

The emergence and development of information and telecommunication technologies (ICT) has a considerable impact on economy in general, on a global level, but also on tourism as an economy activity. The impact of ICT has been widely explored in numerous works. Special emphasis is places on theoretical works and explorations dealing with the impact of ICT on business performances, productivity and efficiency of tourism in general and travel agencies. The result of the emergence and development of ICT in tourism means emergence of e-tourism, based on application of ICT, with strong influence on development and changes within operations of this activity. Accordingly, various web tools and applications as well as new website channels for distribution and communication have been developed. The progress and improvement of business performances of tourism companies is associated with ICT development. This paper presents some of the theoretical attitudes related to the emergence and impact of ICT on operations of tourist industry and tourist companies and their business performances.

Besides theoretical positions, certain models of empirical explorations dealing with different problems are developed. Model RE-BP (RE: relationships, enhancement due to ICT, BP: business performance improvements due to ICT) has been developed based on the analysis of two business segments – advancement of relationship between companies within

Correspondence:

Predrag Vukadinović

e-mail:

pvukadinovic@singidunum.ac.rs

distributive channels, under the influence of ICT, and improvement of business performances of the companies under the influence of ICT.

Porter`s model, implemented in tourist industry, points out the need of assessment of changes in competitive position of an actor at the market, taking into account that market changes are happening almost every day, and that they arise under the influence of developed information systems.

Balanced Scorecard (BSC) model is made in order to find an answer related to the measurement of efficacy of different applications uses, so as to define the type of applicable ICT. The necessity of using this model stems from the need to perform the assessment of business results and efficacy, as well as for the more effective strategic determination.

Fuzzy Risk Analysis (FRA) represents a methodological model which basically aims to the assessment of risk for the investment in e-tourism, respecting all basic risk factors that have great impact on the investment determination.

Certain empirical surveys deal with the relationship between acceptance and implementation of ICT and business performances of tourist enterprises and hotels. These surveys aim at pointing out the possible impact of ICT on improvement of hotels` business performances.

Certain differences are notable within positions about the efficacy of implementation of some models that analyse the relationship between investment in ICT and increase of productivity. Thus, on the basis of new methodological postulates, some other models are formulated that deal with this issue. One of those models is Data Envelopment Analysis (DEA), based on nonparametric technique.

2. THEORETICAL-EMPIRICAL ASPECT

ICT play a significant role related to basic changes in tourism, *i.e.* in global transformation of tourist industry. Development of hardware, including various advancements of possibilities for data processing, gives opportunity for solution of many complex issues with computers. This characteristic (Buhalis and O'Connor, 2005) allows organisations to centralize ICT in organizational units, to be able to control the overall organization. At the same time, organisations may leave certain non-core functions to the specialized enterprises that maintain data bases, applications or guide the overall processes. The use of such ICT system leads to improvement of possibilities and increase of flexibility of data processing, which finally

allows organization to use its sources in a more profitable and more effective way.

The emergence and implementation of ICT strongly influence basic changes in e-tourism. These changes, arising under the influence of ICT, are oriented to several basic goals: advancement of business activities-processes, increase of profitability, establishment of new business relationships, as well as maintenance of the existing ones. ICT have significant implications within tourism and e-tourism, which results in digitalization of all processes and value chains in tourism, travelling and catering. In that respect, tactically observing things, e-tourism gives possibility to organizations to manage their operations-business processes and to undertake e-trade, eliminating thus intermediaries and boosting their own brand. Strategically, e-tourism makes basic changes within business processes, entire value chain, as well as better strategic relationships with all stakeholders. E-tourism influences competitiveness of organisation in the way that it uses intranet for reorganisation of internal processes, internet for development and effective management of different transactions with confidential partners and internet for interaction with all stakeholders (Buhalis, 2003).

The future of e-tourism is projected with the emergence of ICT and new possibilities they bring. New trends appear at the market, which require new projections of e-tourism, along with structural changes of this industry. Emergence of new possibilities is not the only side of future projections. New possibilities and new chances bring new threats at the markets (Egger and Buhalis, 2008). Changes arising from ICT are not only of technical character. Some of them go deep even into new concepts of management and organisation of tourist industry as well as into the economic entities that make this industry. The structure and activities of management, as well as organisations of tourist economical entities cannot be the same as before the emergence and implementation of ICT. It is necessary to connect this change (Egger and Buhalis, 2008) to the new management innovation, which must be the result of successful implementation of ICT. Innovative management is supposed to constantly deal with the analyses of new development and adoption of new technological solutions, in order to – as these authors point out – increase organizational competitiveness. Also, ICT bring overall transparency at the market, while encouraging consumers to identify, adapt and purchase tourist products.

As the authors state (Egger and Buhalis, 2008), the analysed case studies point out several key trends, visible at the market, with the use of ICT for various purposes.

However, the most important and obvious trends are related to: getting close and interacting dynamically with the customer, managing the extended business value chain and adopting technological innovations as a source of competitive advantage. Each of these trends has specific differentiating features. Emphasizing specificities and features of the observed trends (Egger and Buhalis, 2008) point out that many tourist organisations develop information tools, in order to make direct contact with buyers, eliminating thus intermediaries, and tending to enhance personal brand and win loyalty of the buyers. The authors, furthermore, state, that many case studies, including British Airways, Intercontinental Hotels and Hotel Sallerhof, showed interaction of two related goals: tourist organisations aim to reduce the dependency on intermediaries, through development of personal websites and through loyalty of buyers-consumers, encouraging them to believe that the website is a safe channel for distribution and communication. Costs management aims at using ICT for the decrease of administration and production costs, through integration of internal data bases and processes. Efficacy within the costs decrease is shown in several studies, such as: Enterprise, Intercontinental hotel group and Omena hotels. Technological innovations are practically endless, since few innovations are shown at the market every day. Tourist organisations, therefore, must constantly follow innovative changes, in order to improve their efficacy, capability for direct interaction with the consumers and to increase profitability. Several cases studies record emerging innovations as a significant factor of competitive advantage: Tripvise, Check effect and Finnair (Egger and Buhalis, 2008).

Impact of ICT expansion on tourist industry is visible in creation of stronger competitive environment, whereby these technologies become inevitable factor of development of tourist business and change of business performances of tourist enterprises. In the context of development of business performances, an important position takes development and advancement of performances of tourist distributive channels. However, this field is still not enough explored, although tourist enterprises develop very complex networks of mutual relations, in order to change and improve these relations in accordance with market requirements. It is not clear how ICT influence business performances of tourist enterprises. As (Berné et al., 2015) point out, up to now there is no valid model in literature dealing with tourism, which would explain this relation. Also, besides the fact that there is uneven effect of influence of ICT on different types of tourist enterprises inside distributive channels of tourist services,

there are significant gaps in the published surveys. The mentioned authors state that the knowledge about ICT impact on the relationships of enterprises in tourist distributive system and the way these technologies lead to higher or lower levels of business performances are not sufficient, and that new surveys are necessary in order to be able to answer this question. Most of the literature on tourism does not give sufficient valid empirical analyses, and there is no specific formal, reliable framework of the survey. Therefore (Berné et al., 2015), in order to find empirical proofs about the variety of the ways in which relations inside distributive channels and ICT influence the improvement of business performances, it is necessary to include surveys outside the tourism sector. The authors develop RE-BP model, based on the presentation and analysis of two basic elements, shown through the improvement of relationships under the influence of ICT, and improvement of business performances of enterprises under the influence of ICT. Relationships within distributive channels are supposed to be connected to the improvements of two main business segments: market and financial. The first element of the model (RE element) is divided into three segments, as follows: R1-channel relationships with virtual intermediaries, RE2-channel relationships with virtual intermediaries i RE-3: industry relationships. Relevant variable for the first two elements (RE1 and RE2) is intensity, and for the third (RE3) it is number. Business performances are presented with two elements: BP1-market performance and BP2-financial performance. According to empirical surveys based on the presented model, and respecting influence of variables (intensity and number of contacts-relationships within distributive tourist channels) authors conclude that surveys confirm relationship between the increasing use of ICT among intermediaries of the tourism sector, and business performance. Moreover, this relation arises through the increase of the intensity and number of mutual relations of the actors of distributive channels.

Literature as well as theory, for more decades back, have been dominated by the position that tourism sector presents one of the most important sectors for development, even in the developed economies. It has also been emphasized that tourism includes many characteristics of information society, such as globalisation, mobility and abundance of information. Tourist industry is among the first ones to apply information systems (IS) and computer applications, such as: Computer Reservation Systems (CRS) or Global Distribution Systems (GDS). These computer applications were practically the first global, international organisational information systems.

ITC are probably the strongest drivers of change within tourist industry (Werthner and Klein, 1999). Computer Reservation Systems have been developed in air companies, in order to overcome the problem of the increasing number of travellers and to make the relationship between logistics and operational problems more efficient. This application was the first world information application, implemented in the number of companies. At the same time, similar applications were implemented only within the financial sector (Werthner and Klein, 1999).

With the emergence of the Internet, significant changes occured within tourist industry. It is emphasized (Buhalis and Zoge, 2007) that the emergence of the Internet has changed the structure of tourist industry as well as the best operational and strategic practice. Stated authors, using Porter`s model, analyse the impact of Internet on five Porter`s forces and on competitive position of all key actors of the market, as well as the form of tourist industry in such context. The analysis shows the emergence of the Internet intensified rivalry, because it allowed decrease of barriers needed for the entrance at the market. This led to the increase of competitors within the supply, because new competitors at the market had the same conditions as the existing ones, and thus were able to occupy the greatest positions at the market. In the conducted survey, the most emphasized causes that led to the change of factor of impact on competitiveness are transparency of the offering conditions, accessibility of products and prices. Majority of the answers defend the position that the increasing intensity of competitiveness leads to the more obvious price competitiveness, which increases negotiating power of buyers, while, at the same time, decreases negotiating power of suppliers. Also, the majority of the respondents agree that internet led to the more expressed appearance of homogeneous and non-differentiating products, where price competitiveness is predominant, while offer is characterised by similar products. Negotiating power of suppliers is increasing under the influence of internet, taking into account that suppliers have access to the more cost-effective distributive platforms, and that they are in a position to have transparent and direct interaction with buyers, which allows them reduction of costs and better orientation to the prices. In such a way are created conditions where buyers can easier choose the offered alternative. Internet also allows implementation of wide distributive possibilities, which decrease dependency on intermediaries, decrease costs and increase profits. In this way, conditions for better competitive position of the suppliers are made. Important factor of impact on the negotiating power of the suppliers is also possibility

for cooperation, significantly improved through internet. Survey shows that this fact is especially emphasized by hoteliers, who point out that certain internet tools can be used for the grouping of similar or complementary products. This approach leads to the improvement of their negotiating power, since on the basis of created conditions, they can integrate and form unions. It helps suppliers to achieve maximum of efficacy, performance and income, while at the same time avoiding exclusively price competitiveness. As for the negotiating power of buyers, positions of hoteliers of air transporters on one side, and intermediaries on the other side, are different. Hoteliers and air transporters point out that negotiating power of buyers is increasing, while intermediaries state that the power is decreasing. In favour of this statement, it is said that the increase of transparency improved negotiating power of buyers, because transparency increased price competitiveness, decreased barriers for entrance into market and improved variety of offer at the market. Result of the development of the stated conditions is the decrease of loyalty of buyers to certain suppliers, and possibility of easy switch to the supplier who fulfils their requirements, which reduces negotiating power of suppliers, while at the same time negotiating power of buyers is increased. As for danger from substitution, contradictory thoughts are also expressed. Intermediaries emphasize that internet leads to the increased danger from substitution, considering that buyers have possibility of contrasting non travel offerings, and so possibility for preorientation to different products. However, hoteliers and air transporters do not agree that internet leads to the increase of danger from substitution, but, on the contrary, it protects their products against substitution. Reduction of barriers for entrance into the market is the position that everyone supports. Factors of influence have market features, on the basis of internet influence, but very often Government`s policy reduces these barriers for entrance into market, since companies dealing with online-business have tax allowances.

With emergence of ICT different applications are developed, aiming to increase e-tourist business activities. These applications are important because their implementation increases competitive ability of e-tourist business. For each company it is of great importance to define which type of ICT it will use, in order to provide better efficiency and competitiveness. One of the methods and approaches for the measurement of efficiency of use of different applications that may help with identification of certain ICT, with making appropriate business decisions and measurement of business performances of an enterprise is Balanced Scorecard (BSC) model.

According to (Qin *et al.*, 2013) it seems obvious that e-tourism is in the process of evolution, launched by the improvement of ICT, which gives possibility to search for the data and knowledge base, to choose most suitable Web tool technological solutions and to establish accompanying infrastructure. It is at the same time a challenge for future improvements in the business of e-tourism. Authors also emphasize suitability of BSC method in assessment of business results and in more efficient strategic decision-making.

In the case study that the authors analysed, four tourist organisations are selected, whose business performances are measured with implementation of BSC, whereby selected companies represent four different tourism fields, manifestations, attractions, hotels and museums. In methodological context, each case study comprised three parts: business background analysis, information technology application and BSC measurement. Authors conclude their survey with clear statement that tourism as service activity is information intensive activity. This conclusion is based on the fact of existence of great number of individualized interactions with clients, which opens a significant space for implementation of ICT. Number of information in possession of this industry makes basis for analysis and identification of growing trends, which also influences development of innovations. This model, however, is not without defects, *i.e.*, visible defects are close to the statement that BSC is not a suitable model when it comes to the reaction or matrix setting, and also to the assessment of competitiveness.

E-tourism, as part of electronic trade, creates new possibilities for the increase of demand for tourist products and services, and conditions for more efficient management within the tourism sector. Result of application of ICT in tourism is reduction of variable costs, saving of time and increase of self-confidence. Starting with given positions and necessity for constant investment into ICT, in terms of development of e-tourism, authors (Jowkar and Samizadeh, 2011) propose system of support to the decision-making, which, for its basis, has risk analysis, connected to the investments in e-tourism. This analysis - Fuzzy Risk Analysis (FRA) – identifies risks in certain situation and certain region. System of support to decision-making takes into account the most influential risk factors in the context of making investment decisions, it calculates risk factors as recommendation what kind of investment decision should be made. Priority developmental activities of e-tourism are investments, whereby the process of investment decision-making is complex and faced with number of problems. Authors

start with a situation that a certain local tourist organisation must decide whether to invest or not, and where to invest, in order to increase the income. One of the main questions is risk analysis within the proposed investment in e-tourism. In the designing phase of the process, the first task of the analyst of the investment risk is to identify the factors that primarily contribute to the risk for the investor in relation to the investment in e-tourist objects. Authors of this model identify four main factors, with elements of structure for each of them as the starting parameters for analysis: available investment amount (governmental, private sector, foreign sector), human skill (educational level, employment level), e-tourism related infrastructure (ICT, tourism, business) and stability (political, human, environmental). In undeveloped countries, main investors in tourism are: Government, private sector and foreign sector. According to survey of the mentioned authors, distribution of participation into investments in tourism is as follows: 50% Government (GI), private sector (PI) 40%, while foreign sector (FI) is in the third place, with participation of 10%. Also, it is considered that Government and private sector will invest 10% each, out of their total investment amount, while foreign sector will invest 5% out of the total investment amount. The following formula is derived on the basis of coefficient from all three investing sectors, in relation to the percentage of total investment available for implementation in e-tourism.

Formula for the first, investment amount factor is:

$$\text{INVESTMENT AMOUNT} = \text{PERCENTAGE OF } GI*5 + \text{PERCENTAGE OF } PI*4 + \text{PERCENTAGE OF } FI*2$$

This formula presents normalized investment amount for e-tourism, with scale from 0 to 1, where 0 means that there are no available investments, and 1 indicates high level of available investments.

Factor human skill is seen by the authors from the position of influence of education and employment rate, whereby these rates are observed in relation to the total population. In the derived formula, 70% of the weight is given to education, and 30% to employment. It is supposed that 50% of people in the examining region are educated, and 30% of the total population is employed. Formula is made on the basis of weighting factor given for both sectors of influence on human skill, in relation to the total population. Coefficient 1.4 with education rate is made by division of education (70%) and percentage of education level (50%), while coefficient 1 with the employment rate is made by division of the percentage

of employment (30%) and percentage of employment in the region (30%).

On the basis of stated postulates, formula for human skill is:

$$\text{HUMAN SKILL} = \text{EDUCATION RATE}^{*}1.4 + \text{EMPLOYMENT RATE}^{*}1$$

Formula for the third risk factor, infrastructure, is made out of the formulas for three sectors: tourism infrastructure, ICT infrastructure and business infrastructure:

- formula for tourism infrastructure is:

$$\text{TOURISM INFRASTRUCTURE} = \text{PERCENTAGE OF TOURIST ARRIVAL IN THE TOURIST SITE}^{*} \text{ NUMBER OF TOURIST SITE} + \text{PERCENTAGE OF TOURIST ARRIVAL USE STAR HOTELS}^{*}\text{NUMBER OF STAR HOTELS} + \text{PERCENTAGE OF TOURIST ARRIVAL USE TOUR AND TRAVEL AGENTS}^{*}\text{NUMBER OF TOUR AND TRAVEL AGENTS}$$

- formula for ICT infrastructure is:

$$\text{ICT INFRASTRUCTURE} = 2^{*} \text{ NUMBER OF TELEPHONE LINE DISTRIBUTED FOR OPERATION} + \text{NUMBER OF COMPUTERS AVAILABLE IN THE REGION}^{*}10 + \text{NUMBER OF INTERNET CAFE}^{*}500 \,/\text{TOTAL POPULATION OF THE REGION}$$

In this formula authors start with the premise that one phone is available for 2 persons, one computer is available for 10 persons and one internet cafe for 500 persons.

- formula for business infrastructure is:

$$\text{BUSINESS INFRASTRUCTURE} = \text{PERCENTAGE OF BUSINESS USE IT IN THEIR BUSINESS}$$

Derivative formula for infrastructure is made out of three formulas, within different sectors (tourism infrastructure, ICT infrastructure and business infrastructure), and it is:

$$\text{INFRASTRUCTURE} = \text{VALUE OBTAINED FROM ICT}^{*}0.267 + \text{VALUE OBTAINED FROM TOURISM}^{*}0.0067 + \text{PERCENTAGE OF BUSINESS USE ICT IN THEIR BUSINESS}^{*}1.5$$

The weighting coefficient 0.267, 0.0067 and 1.5 are determined on the basis of weight given for ICT (0.4) divided by the value obtained for ICT infrastructure (1.4), tourism (0.3) divided by the value obtained for tourism (45) and business (0.3) divided by the value obtained for

business (0.2) in their business respectively (Jowkar and Samizadeh, 2011, p. 73).

The fourth factor, stability, authors observe through the effect of three risks that have influence on stability, aiming at destroying stability, and thus we talk about instability and level of instability, under the influence of three risks that are able to destroy stability, *i.e.*, cause instability: political instability (PI), human resource instability (HRI) and environmental instability (EI). Political instability, in premises of the authors, participates with 50% of influence on the increase of risk, human resources 30% and environmental 20%. Political situation and environment play an important role in the future of a nation, and thus it is given to the political instability 50% of the influence, while for human resources and environment it is 25% each.

From the stated premises the following formula is derived:

$$\text{INSTABILITY} = \text{PERCENTAGE OF PI}^{*}1 + \text{PERCENTAGE OF HRI-}1.2 + \text{PERCENTAGE OF EI}^{*}0.8$$

1, 1.2 and 0.8 are the weights given for political instability, human resource instability and environmental instability divided by the contribution to enhance instability respectively (Jowkar and Samizadeh, 2011, p. 73).

Relation between adoption and implementation of ICT and business hotel performances is subject of analysis that aims at pointing out possible impact of ICT on improvement of business hotel performances. Issue of impact of ICT on improvement of business hotel performances is important because answer to this issue greatly defines future of investment in ICT, as the factor of impact on hotel business. It is well known that ICT have positive impact on hotel business as well as on tourism industry in general. Some of the first international IT applications are developed within tourism industry.

According to (Sirirak *et al.*, 2011), impact of adoption of ICT on business can be observed through relationship between ICT and operational productivity. This relation is explained in the following way: observing adoption of ICT in certain operational fields, then availability and intensity of ICT use in room division (RD), and general ICT integration, a significantly positive relation with operational productivity is visible. Choice of check in/ check out system in RD can reduce paper costs as well as number of employees. Importance of integration of ICT is seen through possibility of giving information in real time about resources of the hotel material, material costs, availability of hotel rooms *etc*. These information

are useful for supply managers, in order to reduce business expenses with buying material at the lowest prices and for optimally needed amount. More intensive use of ICT leads to the increase of operational productivity, because hoteliers, with using room status and housekeeping system, can check and more effectively prepare rooms for buyers. Result of this way of operation is increase in capability of staff to manage more rooms with the same number of employees, which, at the same time, leads to the better operational productivity. Authors emphasize that the study analyses impact of adoption of ICT on hotel performances from the perspective of operational business, but also from the perspective of the buyer. Observing impact of ICT from both perspectives, it may be concluded that adoption of ICT has positive impact on operational productivity, while intensity of ICT use has positive impact on buyers` satisfaction. Both factors, operational productivity and buyers` satisfaction should be observed together by hotel management, because hotels, in general, do not observe only operational efficiency, but also creation of long-term relationships with buyers, and credibility of the hotel. In general, authors (Sirirak *et al.*, 2011) conclude that adoption of ICT has positive impact on improvement of business performances of the hotel, but still, specificities of the researched location should be taken into account, as well as the fact that the survey is based on three stars hotels.

With regard to the position that increase of investment in ICT is in relation to the increase of productivity, there is no consensus. Different opinions are expressed by some authors (Sigala *et al.*, 2004), who state that, in spite of the increase of investments in ICT in tourism industry, empirical studies do not persuasively show relation between increase of investments in ICT and increase of productivity. Observed methodological defects in previous studies and applied methodologies require new methodological solutions within assessment of productivity. Framework for the measurement of productivity of ICT investments should be based on Data Envelopment Analysis (DEA). Results of this analysis are supposed to give so-called ICT productivity paradox, *i.e.* theoretical and practical basis for exploitation and management of ICT possibilities. Methodology of this analysis is based on nonparametric technique, whose importance is ever growing in academic as well as in management circles. Study comprises three stars hotels in the UK.

Authors of the study (Sigala *et al.*, 2004) emphasize that the results of the survey of the impact of productivity show that this impact becomes obvious only after analysis of exploitation of the network/integration, infor-

mational and transformational capabilities. Optimisation of business values requires more of strategic approach in implementation and management of ICT. Especially three capabilities (information, systems integration and architecture) must be adapted and managed in accordance with business strategy and business operations. Without neglecting the results, this study, based on DEA methodology, has certain limitations, observed in requirement for more precise incoming indicators. The study used data about the permanently and temporarily employed, though number of the permanently employed could represent incoming indicator. Authors (Sigala *et al.*, 2004) emphasize that future studies, based on different statistical analyses, should explore productivity paradox and compare given results. Future studies should try to develop better indicators for qualitative dimensions (eg. satisfaction of buyers and skill of the employees); DEA should also be used to examine potential effects. This suggestion is based on the fact that DEA can deal with qualitative indicators, because it gives number of possibilities for redefinition of service productivity and solution for some problems within the measurement of this productivity.

3. CONCLUSION

Emergence and development of ICT led to the revolution within development and way of operation in tourist industry. Impact of ICT on business and improvement of business performances of tourism and touristic enterprises is observed as highly intensive. Changes are seen through emergence of e-tourism, as a new and advanced touristic activity. Essential business changes are introduced also into business processes, entire value chain and strategic relations with all stakeholders. Development and implementation of ICT allow tourism industry to be one of the first activities to introduce international information systems CRS and GDS that led to the more efficient business, better direct interaction between tourist organizations and buyers, along with the reduction of costs and increase of productivity. Future projection of e-tourism is in close relationship with the development of ICT and possibilities available to the users of ICT. ICT changes, however, go deep into management changes, creating new managing concepts, and emphasizing new requirements for management innovativeness.

Empirical researches, based on certain models and methodologies, have different character, efficiency and scope. There is no consensus about certain models and given results. One of the main issues that empirical

researches deal with is impact of ICT on improvement of business performances. Some researchers emphasize that it is still not clear how ICT influence business performances of tourism enterprises.

One of the models, developed on this thesis, is RE-BP model, which broadens the field of research to the improvement of total relationships among tourism enterprises in distributive channels, under the influence of ICT, and to the improvement of business performances of the enterprises, under the influence of ICT. This model, with spreading out of the limited circle of influence of ICT on the improvement of business performances, allows conclusion that the researches confirmed relationship between more intensive use of ICT and improvement of business performances.

Porter's model showed that it is not possible to talk about the increase of only one`s side negotiating power: buyers or suppliers. Studies on the basis of this model showed that competitiveness as well as negotiating power of the supplier increase, since application of ICT allows more effective costs management, and thus there is no reason to be oriented exclusively to price competitiveness. Negotiating power of buyers increases among stronger competitiveness of suppliers, and competitiveness boosts since the development of ICT erases barriers for entrance of the new suppliers into the market. In this situation, negotiating power of the suppliers decreases.

Development of BSC model followed the development of ICT and new applications. Implementation of new applications aims at increasing business efficiency and business performances of tourist enterprises. Study which dealt with the problem of measurement of business performances with application of BSC model, offers conclusion that tourism presents information intensive activity, and so relation between impact of ICT and improvement of business performances of tourism enterprises is obvious, and business performances are measurable with implementation of this model.

Fuzzy Risk Analysis is a developed model, which comprises risk analysis in relation to the future investments in e-tourism. Role of the analyst in the first phase of making investment decision is to detect certain investment risks for the investor, related to the investment in e-objects. This analysis is based on four basic elements, out of which derivative formulas are made, for each element separately and on the basis of internal structure. Basic elements of this model are: available investment amount (governmental, private sector, foreign sector), human skill (educational level, employment level), e-tourism related infrastructure (ICT, tourism, business) and stability (political, human, environmental). Each of these elements has its own inter-

nal structure, and formula is made for each segment of the structure. This complex model widely encompasses elements and factors of the investment risk, which makes it complicated but, at the same time comprehensive, and, on the basis of precise analysis, also in a certain degree precise and objective.

Issue of impact of ICT on operational productivity is one of the more important issues, and it is subject of empirical researches. Certain researches emphasize visible positive relation between development of ICT and increase of productivity, proving this thesis by pointing out the use of different ICT systems, which finally leads to better management of the existing capacities, with lesser number of employees.

There is no consensus in relation to this thesis, and even models dealing with relation between wider implementation of ICT and increase of productivity are questionable. Objections to these models are that they do not use adequate incoming indicators, especially at a qualitative level. This defect, to a certain degree, is corrected by DEA model, which insists on nonparametric technique, and which is more and more acceptable model within academic as well as within management circles.

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THE INFLUENCE OF VIRTUAL TOURS ON ROMANIAN TOURISM

Cipriana Sava

Christian University "D. Cantemir"
Bucharest,
Faculty of Tourism and Commercial
Management Timişoara
Bucharest, Romania

Abstract:

The aspects of everyday life also influence the choice of destinations for spending free time. It is well known that motivation has a major role, since it is personal, subjective and directly under the influence of endogenous and exogenous impulses. Technology has invaded our lives and can help us choose the appropriate holiday destination.

Virtual tours give a new perspective to those willing to experience a tourist destination, as they are available 24/7, free of charge and easily accessible. Promoting Romanian tourism through modern instruments in the online environment can become an advantage. Numerous tourist resources and locations presented in this way can raise the users' interest, thus urging them to visit such places.

Key words:

tourism, online environment, virtual tours, website, promotion.

1. INTRODUCTION

The ongoing development of society has given rise to other needs, from natural psychological needs related to the need of water, food, air, clothing, over social needs that can translate by the need of belonging to a social group, networking and joint action with other individuals, and then to the rational, spiritual - psychological needs related to education and higher rational professional thinking.

According to the American psychologist Abraham Maslow, needs could be classified into: physiological, safety, love and belonging, esteem and respect, as well as self-achievement.

Currently, the majority of the population wants to occasionally break away from everyday problems and spend leisure time outside their residences.

The main motivations in choosing tourist destinations are linked to a range of needs, namely relaxation and rest ("charging batteries"), knowledge, keeping health or its restoration, integration into a group and comfort, practising sports, entertainment and leisure.

Currently, there is a growing interest in maintaining and beautifying the body, as well as intellectual stimulation (widening the intellectual horizon). It can be said that man travels to feel special.

Correspondence:

Cipriana Sava

e-mail:

cipriana.sava@gmail.com

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Given the reasons presented, the trip can be seen as:

- an initiation;
- an expedition;
- a pilgrimage;
- an access to new places;
- a way of life.

The decision to choose a destination for leisure is influenced by a number of personal impulses or recommendations from close friends and acquaintances.

Increasingly advanced technology also contributes to the choice of the holiday destination.

2. THE VIRTUAL TOUR

A tour means a short walk on a chosen route, and virtual refers to something that is only a possibility, not a fact.

The term "virtual tour" was first used in June 1994 to refer to the presentation of the Dudley Castle museum in England. Two specialists, Colin Johnson (Image Interactive) and Peter Bolad (Dudley Metropolitan Borough) made a 3D reconstruction of the castle, offering visitors a unique "virtual walk" experience. The system conceived in 1994 worked until 2005, but since technology has significantly evolved, today the virtual tour has new meanings.

The virtual tour is based on modern technology to interactively present a location. It is made up of interconnected panoramic images, among which, by means of connections, the transaction can be achieved.

A panoramic image is a photo that can be seen in any direction; it is the basic element of the 360° virtual tour. A virtual tour consists of at least two spherical panoramic photos.

Briefly, a virtual tour may contain the sketch of the location (floorplan), with rooms and places where panoramas were photographed to facilitate the formation of an objective opinion about the tourist attraction, building, hotel, accommodation facility or food service facility. If the presentation of a geographic area is wanted, virtual tours may contain maps like Google Maps or Yahoo Maps, satellite images, panoramas being geo-located by GPS.

For information to be complete, text and photos can be integrated, placed within the panoramas and associated with them or with certain areas of interest, and displayed through sensitive areas.

Last but not least, it is necessary for a virtual tour to have a friendly navigation interface.

Watching virtual tours is performed using Quick-Time, Java, Shockwave Flash and OpenGL plugins. Currently Flash 10 is the best option because over 98% of users have Flash installed on their PCs, and no other plugins are necessary. Using Flash allows us to provide interactive solutions for the 360º virtual tour, and the possibility to show full screen panoramas and virtual tours.

These virtual tours can be viewed on any computer and smartphones.

Their presentation can be integrated in the official website presentation of the location, can be posted on social networking sites, distributed on CD, DVD, flash card, etc., or optimized for printing.

The applicability of virtual tours in tourism refers to the presentation of:

- tourist attractions (buildings, castles, fortresses, museums, memorial houses, churches, monasteries, caves, salt mines, etc.);
- accommodation facilities;
- food services facilities;
- leisure spaces;
- exhibitions;
- treatment centres and spas;
- tourist resorts.

There are multiple benefits of using a virtual tour, namely:

- it is available 24 hours a day, 365 days a year from anywhere in the world;
- it presents reality 100%, offers full transparency;
- highlights the strengths of the location / sight;
- gives confidence in the quality and accuracy of provided services;
- the degree of interactivity and accessibility can impress any client;
- it gives the opportunity to explore an area at your own pace, without constraints;
- it presents an increased portability;
- it offers a big advantage over the competition;
- it is the most modern and effective method of promoting a place or a business;
- costs are low compared to other promotion methods;
- the investment for a virtual tour is very low, while the benefits are maximized.

It was found that a virtual tour of a tourist attraction increases the number of visitors, the same goes for the virtual tours of some accommodation facilities where the number of online bookings and occupancy has signifi-

cantly increased. If users are presented a virtual tour, the probability that they make an online booking is twice as high. Users aged between 18 and 34 years are by 130% more inclined to make a reservation after seeing such a tour.

3. VIRTUAL TOURS IN ROMANIAN TOURISM

Romania is one of the countries bordering the Black Sea, located on the north-western shore, in the south-east of Central Europe. Its total area is 238 391 km² plus 23700 km² from the Black Sea platform.

Due to its geographical position, relief and climate, hydrographic network, history, and cultural values, various forms of tourism like coastal tourism, mountain, countryside, spa, transit, business, cultural, scientific, religious tourism, agro tourism, ecotourism can be practiced on the territory of the country.

In order to analyse the evolution of the number of tourists and their preferences, some categories of tourist destinations were marked off, namely:

- resorts;
- coastal resorts;
- mountain resorts;
- the Danube Delta;
- the capital city and the county capitals;
- other destinations

The evolution of the number of tourist arrivals in Romania in recent years has been increasing, oscillating only between the selected destinations (Table 1)

Tourist destina-tion	Year 2010	Year 2011	Year 2012	Year 2013	Year 2014
Resorts	568257	689195	696180	678536	655565
Coastal resorts	702566	735881	804198	728748	747103
Mountain resorts	814973	962415	1121238	1241133	1291013
The Danube Delta	68414	81567	88021	80885	65604
Bucharest and the county capitals	3011688	3541409	3816873	3983497	4308117
Other localities and tourist trails	906859	1021139	1159979	1230354	1398507
TOTAL	6072757	7031606	7686489	7943153	8465909

Table 1. Evolution of the number of tourist arrivals according to tourist destinations - No. of tourists

Source: TUR 104C Tempo Online time series, www.insse.ro

It could be noted that the number of tourists has increased annually at resorts in the mountain area (new resorts have opened and existing facilities have been modernized), the capital city and the county capitals (promoting city break, organizing various events), and at other localities and tourist routes.

The tourists registered in 2014 in the capital city, in Sibiu (European Capital of Culture in 2007) and Bran (Bran Castle - Dracula myth) preferred September, October and August (Table 2)

Month	Bucharest	Sibiu	Bran
January	80834	15075	4059
February	95114	16445	4714
March	120721	15793	4088
April	111122	18626	4527
May	142027	26343	4257
June	141962	26240	6215
July	125197	24790	7259
August	131688	31860	9367
September	157382	26058	6191
October	157606	21112	5805
November	137846	19309	5255
December	108723	17160	5129
Total	1510222	258811	66866

Table 2. Distribution of tourists by months in 2014. - No. of tourists

Source: TUR 104H Tempo Online-statistical series, www.insse.ro

Business, cultural and scientific tourism is present in Bucharest, while Sibiu and Bran are well known for leisure, recreation, cultural, historical and event tourism.

An issue that the Romanian tourism is still facing is the small share of foreign tourist arrivals (Table 3).

Attracting a larger number of tourists, especially foreigners, can also be achieved through a more sustained promotion in the online environment.

In Romania, 10.3 million people use the Internet (Romanian Audit Bureau Transmedia - BRAT), that is 68% of the population aged between 16 and 64 use the internet, while worldwide there are over three billion people using the Internet (International Telecommunication Union - ITU), therefore the possibility of people knowing the Romanian tourism offer is extremely high.

Indicator	2010	2011	2012	2013	2014
Romanian tourists (no. of persons)	4726414	5514907	6030053	6225798	6551339
Foreign tourists (no. of persons)	1346343	1516699	1656436	1717355	1914570
Share of foreign tourists (%)	22,17	21,60	21,55	21,62	22,61

Table 3. Evolution of foreing tourist arrivals in Romania

Source: TUR 104C Tempo Online time series,
www.insse.ro, processed data

Virtual tours are currently the most modern technology used for the presentation of a location.

There are numerous tourist attractions, accommodation and food services and facilities in Romania that have their presentation via virtual tours, some of which are summarized in Table 4.

Virtual tours have increased people's interest in the tourist attraction, accommodation or food service facility presented. Such tours can be found in Bucharest, Sibiu, Bran and we can say that the number of tourists registered per year and per month shows the growing interest of tourists.

Making more quality virtual tours has a positive bearing on tourist traffic in Romania.

4. CONCLUSIONS

Interactive virtual tours are currently the most innovative technology used for presenting tourist destinations and it allows for effective marketing strategies.

If a virtual tour is well done, it can make any user feel present in the visited space. Watching a virtual tour is extremely easy, the user being able to control his movement within the area, zoom in and out, and being able to focus on the areas that draw his attention.

More and more websites display virtual tours that seek to convince users to buy tourism services. In the case of accommodation facilities, in general, a significant increase could be observed in online bookings.

Romanian tourism can be positively influenced by the existence of these virtual tours accessible to an extremely high number of people, both in the country and worldwide.

Tourist attraction	Location	Link
CurteaVeche Museum	Bucharest	http://360.inp.org.ro
Romanian Atheneum	Bucharest	http://gratuitor.ro/tur-virtual-al-ateneului-roman/
Aviation Museum	Bucharest	http://www.360trip.ro/muzeulaviatiei
Bran Castle	Bran, Braşov County	http://www.castelulbran.ro/
Black Church	Braşov	http://turism.brasovcity.ro/index.php/tururi/detail/12
History Museum	Sighişoara, Mureș County	http://sighisoara360.ro/sighisoara/muzeuldeistorie
Brukenthal Museum	Sibiu	http://www.sibiul.ro/sibiu-virtual-tour/sibiu-virtual-tour-68.html
Astra Museum	Sibiu	http://muzeulastra.ro/vizitare/vizita-virtuala.html
Peleş Castle interior-exterior	Sinaia, Prahova County	https://www.youtube.com/watch?v=CqhAUZHBvps
Sarmizegetusa Archaeology Museum	Sarmizegetusa, Hunedoara County	http://muzeu.geomatic.ro/sectii/sarmis/sarmi_virtual/ro/2/2_amfiteatru.htm
Corvinilor Castle	Hunedoara	https://www.city3d.ro/castelul-huniazilor-hunedoara-city3d
Turda Salt mine	Turda, Cluj County	http://www.qbox.ro/salina-turda/tur-virtual-1974.html
Hotel Aro Palace	Braşov	http://www.aro-palace.ro/tururi-virtuale/hotel-brasov-aro-palace.html
Siago Pension	Cluj-Napoca	http://www.pensiuneasiago.ro/tur-virtual.php
Caru cu Bere Restaurant	Bucharest	http://www.vederepanoramica.ro/tur-virtual-caru-cu-bere
Transfăgărașan	Făgăraş Mountains, Southern Carpathians	http://www.360cities.net/image/transfagaran-virtual-tour-360-romania-fagaras

Table 4. Virtual tours for tourism promotion – examples

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ICT in tourism & hospitality

A ROLE OF SOCIAL NETWORKS IN CREATING A MARKETING CONCEPT OF HOTEL COMPANIES

Filip Đoković,
Ivana Damnjanović,
Vladimir Džamić

Singidunum University,
Faculty of business in Valjevo,
Valjevo, Serbia

Abstract:

The last decade has witnessed turbulent changes in hotel industry marketing. Key reasons arise from high elasticity of demand and the volume of information about the destination and accommodation available to potential guests. Hotels need repositioning in the market and one possible path requires radical alteration of marketing concept in terms of adapting to new methods of communication with guests. In addition to website as the main communication channel within the framework of information and communication technologies, social networks are becoming increasingly present. Numerous social networks are characterized by a specific way of communication. Therefore, a role of marketing in hotel sector is being well acquainted with diversified and abundant functions of various social networks and characteristics of their users.

Key words:

marketing, social networks, hotel industry.

INTRODUCTION

The environment in which hotel companies operate is very turbulent due to many changes that permeate every business sector. Any change is characterized by speed and scope of impact. Information technologies have contributed to the acceleration of change which cannot be seen in its entirety, and to the fact that it is actually up to the hotel management to shape the policies and strategies in order to create a flexible organization.

The changes are characterised by uncertainty and in some ways can be perceived as a "strike" on the current operations and results in general. Therefore, the creation of flexible organizations is essential so the changes in modern hospitality market trends could be implemented in the relevant business operations.

Relations between hotel and market, taking into account the nature of the change, have become more complex for a number of reasons. Firstly, marketing concept changes radically depending on information technology. The focus has evolved from a product to the consumer/ customer, or the requirements and the ways in which guests express their demands have changed and are changing. Secondly, communication channels are becoming more numerous and each new communication channel requires a specific mode of communication. Thirdly, segmentation of target group gets new frames due to the development of information and communication technologies. There are new segments and target groups that must be duly recognized by decision-makers in hotels.

Correspondence:

Filip Đoković

e-mail:

fdjokovic@singidunum.ac.rs

2. MARKETING CONCEPT OF HOTEL COMPANIES

Marketing concept of hotel and other businesses indicates a market-oriented thinking (Djokovic, F., 2013). The key question is how to determine the manner in which to market a hotel product? Acceleration of the flow of information, taking into account its quality, scope and potential impact, has led to an essential systematic approach in creation of marketing concept.

The aim of any hotel company is making profit, which is a result of meeting its guests' needs. Hotel as a bearer of product consists of parts that have to be complementary: location, hotel facilities, service range, price and brand. Only realistic assessment of accommodation, IT and human resources can provide the basis for creating marketing concept.

In order to make the long term results, marketing concept must have a strategic nature. This means that hotel management is committed to determining target groups and adapting to their needs in a systematic manner by careful monitoring and predicting changes in their behaviour (Grgona, J., Supić, A., 2007).

Formulation of marketing concept must have the purpose of considering all processes and phenomena in hotel operations. Strategic framework of marketing concept requires excellent knowledge of value chain.

Profit as a strategic direction is a result of the primary and supporting activities in the hotel. Primary activities relate to all phases in which the customer is in focus (phase prior to arrival, the phase when the customer resides and the phase in which the guests have left the hotel).

Supporting activities are activities that are not strictly related to the service but create the setting for quality service delivery. These are the sectors of finance, procurement, human resources and others. Excellent knowledge of primary and supporting activities represents the basis for creating marketing concept the purpose of which is meeting hotel's strategic and operational objectives.

Modern trends in tourism and corresponding hotel market, impose different views on the market itself and ways of communication. Information technologies have created an environment in which approaches to the market are radically changing. Since the impact of information and communication technology is dominant, so-called e-marketing can be discussed.

Defining e-marketing in the hotel industry is diverse, mainly due to the various aspects of perception. Some authors believe that the Internet is at the core of e-marketing, assuming certain applications and information and communication technologies solutions. There is a perception that e-marketing is oriented exclusively to sales and promotional activities via the Internet. There is also the opinion that e-marketing includes Internet marketing and therefore has a wider scope as it involves a number of communication technologies (Knežević, M., 2016).

Social networks fall within the domain of e-marketing and increasingly influence the creation of hotel marketing concept. The essence of social networks is to attract potential guests to stay at hotel and to surpass their expectations to become part of the loyalty program. In last decade, the number of social networks has grown rapidly, so it is important to take into account the specific characteristics of each of them.

3. ROLE OF SOCIAL NETWORKS IN HOTELS OPERATIONS

Social networks are a part of social media. In certain cases, these terms are synonymous. Being active on a social network means having a profile that contains specific information about the user. It is noteworthy, particularly from corporate perspective, that social network user (*e.g.* hotel) can fully coordinate activities related to the content on social networks. Each content is also possible to be commented on by a variety of content (Štavljanin, V., Filipovic, V., Kostić Stanković, M., 2011).

When planning a trip, regardless of whether they travel for recreation and leisure or business, tourists find information about destination on the Internet. This also applies to the accommodation. The Internet as a source of information for potential guests is essential because it provides an opportunity for diversity of content which allows examination of destination, accommodation and associated facilities from multiple perspectives. Social networks in this case represent virtual frames in which information according to specific requirements can be found. The reason is that a growing number of potential tourists are active on social networks.

The virtual frames or so-called profiles on social networks represent a huge potential given the diversity of content. The biggest hotel chains such as IGH and Marriot have recognized the importance of social networks. They have realised that their use contributes to a better understanding of target groups, strengthening the brand and ultimately achieving higher profits. In addition to the hotel, the importance of social networks has also been recognized by tour operators and travel agencies, airlines, tourism organizations and other enterprises in the field of tourism.

Certainly the most important aspect is that social networks are recognized as one of the key means of communication with the market, although, it carries certain risks (Loncaric, D., Melissa, N., 2015). It is necessary to

manage social networks adequately in order to achieve marketing objectives (Iacianci, C., 2015). The point is that social networks are means of communication, not an end. The focus on social networks as a communication tool implies excellent knowledge of general and specific characteristics of each social network in order to avoid undesirable effects (dissatisfaction, lower capacity utilization, different message due maintenance of certain events, *etc.*).

One of the key benefits of social networks is that on the basis of excellent knowledge of a particular network target group can be efficiently defined. Based on search criteria, each segment is easily determined and thus a communication plan made. Each activity within marketing concept, especially old, requires certain costs (Unković, S., Zecevic, B., 2011). The Internet as a virtual space framed in a social network initiates significantly lower costs in the marketing budget.

Finally, the use of social networks includes control mechanisms. This means that activities undertaken on social networks can be controlled through specific tools, *e.g.*, via Google analytics information on how much specific content is visited, how much time potential guests spend on them, the extent to which content is explored and the like can be reached.

During the formation of the first social networks, users exploited them primarily for private purposes. However, the corporatisation of social networks has become an imperative in the last decade. Use of profiles for private purposes (maintaining contact with friends, family, *etc.*) is significantly different from corporate (brand improvement, increasing loyalty, *etc.*).

A new hotel marketing concept involves two-way communication. This means that the initiation of any content by hotel is under the scrutiny of the virtual public (potential guests, competition, *etc.*). For each content reactions can be expected (comments, suggestions, proposals, *etc.*).

4. BASIC FEATURES OF SOCIAL NETWORKS USED IN HOTEL BUSINESS

The process of transition from private to business purpose of social networks was fast and it was an immense change which resulted in review of the previous marketing activities. In hotel industry it has caused so-called domino effect, in the sense that the initiators were big corporate hotel chains. Then it spilled over to other corporate and voluntary hotel chains and independent hotels.

The most significant social networks used in hotel business today are:

- Facebook;
- Instagram;
- Twitter;
- Pinterest;
- Foursquare;
- Tripadvisor;
- Google plus;
- Linkedin.

Each social network has its own characteristics which affect the diversification of users. Each specificity points to creation and delivery of content sent as well as control of effects of the activities undertaken. What is true for one social network is often unacceptable to the other and may cause undesired effects.

Use of profiles or accounts on social networks in hospitality requires the involvement of qualified human resources. Bearing in mind the fact that these jobs are novel in the last decade, willingness and understanding of management to perceive the importance of the use of social networks and employment of professional people need to be emphasized.

social network	Features	
	Content	Specificity
Facebook	Text, photos, audio and video recordings	Dominant entertainment facilities
Instagram	Photos, audio and short video clips	Content is only sent to the mobile phone, tablet, hashtags
Twitter	Text, photography	Limitations of characters, a focus on information, hashtags
Pinterest	Photos and pictures	Focus on visuals
Foursquare	Displaying locations	The focus on the location and characteristics of the site, for example. the hotel and its facilities
Google plus	The possibility of more extensive texts, photographs, recordings	Circles by interests
Tripdvisor	Text, photography	Rating and commenting hotel - Review
Linkedin	Information on the business career of individuals and enterprises - timeline of career, tables, charts, biographies, photos	Business purpose

Table 1. Features of social networks

The table shows the main characteristics of social networks that are commonly used in the hotel industry. It should be noted that the presence on most social networks is effective only if the hotel is familiar with their users. Also, the activities on social networks must be in line with hotel strategic orientation to promote the brand and increase market share.

The control functions of social networks indicate the need for constant evaluation of the undertaken business activities. Therefore, it is important that social networks are an integral part of the objectives, plans, policies and procedures of hotel operations.

Social networks should be key in the process of potential travellers' search and decision-making to stay at a particular hotel. Website as hotel's important presentation continues to be a glorious picture of the hotel, which is very often not in line with the actual situation. Therefore, the role of social networks is to compensate for deficiencies of the site.

In the chain of decision-making on the selection of accommodation, social networks precede the Internet distribution systems. Internet distribution systems as technology enable users to obtain information and organize their trips entirely. The role of social networks influences the final choice of the mode of transport and accommodation facility.

Connection between the Internet distribution systems and social networks is important in order to maximize the accommodation utilization in short term and thus achieve financial targets.

The essence of the use of social networks is additional information on destinations, accommodations and other amenities. Apart from additional information, it is important to note that through social networks information found on the official websites of the hotel and tour operators can be confirmed or proved. Depending on the social network, information confirmation and additional information can be sublimated through a variety of content such as video clips, short messages (eg. Tweets), photos *etc*. Acknowledging reviews (Tripadvisor), a potential customer can change the original decision on booking a stay at a hotel.

A special, though no less important segment, is the guest stay in the hotel. Surpassed expectations can initiate guest's expression of satisfaction with a timely photograph or image on a social network (*e.g.* Instagram). Also, dissatisfaction with service may result in display of revolt through certain content (photos, comments, *etc.*). Any deviation, enthusiasm or anger can be expressed on social networks.

Simultaneous provision and consumption of services means that the quality of service or overall experience at the hotel is assessed at the moment. Therefore, any delay in finding solutions to problems can adversely affect immediately after the provision of services.

Customer loyalty is also built after he/she leaves the hotel. This is particularly important for tourists who stayed at a hotel for the purpose of recreation and rest. The phase of guest adaptation to ordinary activities lasts for a certain period of time during which the impressions of the stay at the hotel are sorted according to their level of satisfaction. This means that after staying at a hotel, guest transfers the experience of the trip, including the hotel stay, through photos, videos and other content.

The tasks of marketing and sales staff need to be diverse and interrelated and include the following:

- Setting objectives for hotel e-marketing;
- Creating unique content appropriate for a particular social network (*e.g.* indigenous hashtag);
- Control and monitoring of broadcast content and comparison with the defined operational and strategic goals;
- Continuous coordination with other sectors, so that employees in marketing and sales are timely informed;
- Conformity of the hotel content across social networks;
- The introduction of innovations in the presentation of certain content;
- Reports to management about the effects of the use of social networks and other information that may be relevant to the decision-making.

Stages of informing potential guests during the stay in the hotel, transportation phase and the phase after leaving the hotel are supported by numerous activities on social networks. It is, therefore, important that employees in marketing and sales closely monitor and act in accordance with business policies (*e.g.* especially in the case of lower hotel occupancy).

5. CONCLUSION

The marketing concept represents the basis for creating the marketing mix, marketing strategies and strategic objectives. Social networks in these settings play an important role as a mediator and controller of numerous activities and relationships between the hotel and the market.

There is no doubt that the presence of hotels on social networks is inevitable, and that information and commu-

nication technologies have contributed to reassessment of marketing concepts up to the moment. The objectives of hotel company operations have not changed. However, marketing channels which also have a role in achieving these goals have altered. Achieving profits, improving brand as well as permanent control of operations now have an additional component which valorises achieved results more quickly, efficiently and effectively.

Through the presence on social networks, hotel meets its guests further and discovers its potential target groups. In the long term, time is more effectively managed and management obtains information that may affect the creation of marketing concepts more quickly.

Orientation towards e-marketing requires employees with professional knowledge, skills and abilities which will bring a hotel closer to its market. In addition to hotel staff, the tendency is to outsource the activities within e-marketing and submit them to specialized marketing agencies that have experience in so-called "digital".

Good knowledge of social networks entails analyzing each one so a decision which social network to use as a communication channel can be made. Taking into account the specificity of each social network, the decision on the use of certain but not all can have enormous significance for the promotion of the brand, increasing capacity utilization and loyalty of the guests.

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ICT IN TOURISM & HOSPITALITY

THE IMPORTANCE OF THE INTERNET IN DEVELOPMENT OF RURAL TOURISM IN SERBIA

Aleksandra Gagić,

Mirjana Dubičanin,

Nada Maenza

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The Internet presents one of the most important media in data transferring and its use is constantly growing. Almost 40% of the Serbian population uses the Internet and more than 3 million inhabitants have active profiles on Facebook. Serbia has been registered on the Internet since 1996. According to numerous research, tourism, just like a Serbian tourist offer, is part of that service category whose presentation, distribution and purchase are greatly carried out on the Internet. At the early beginning of the rural tourism development, a limited number of households were involved in this type of tourism and later it has grown massively due to the Internet and tourism associations advancement. During 2014, Serbia made 2200 overnight stays showing its position in the first phase of the rural tourism development. The National Tourism Organisation of Serbia has included this type of tourism, which has been neglected for over the past fifty years, giving it priority in its programme. Due to the website www.selo.rs, National Association of Rural Tourism of Serbia has become an active representative in the European Federation of Rural Tourism Development. Today, many social networks have great importance in promoting tourism services.

Key words:

rural tourism, the Iinternet, social networks, websites.

1. INTRODUCTION

Today, the Internet is a very important media in transferring data that is in continuous expansion. It has no limits in using time, topics, frame and effects. Its additional value is pretty great: it offers direct approach to information and documents. According to some research in Serbia, there are about 1,5 million people connected to the Internet [7]. The market is huge if we take into account that there are around a million Serbian people currently living abroad that look for the information on the Serbian web sites. Over the past ten years, Internet promotion has triggered numerous positive changes in rural tourism of Serbia.

The role of the Internet

The target group are young, educated, business people as well as children. Some of the preferences of the Internet is that it is never closed and it is available to the users all around the world, every day of the

Correspondence:

Mirjana Dubičanin

e-mail:

mdubicanin@singidunum.ac.rs

week. It covers the whole world and it can also transfer the color photos [3]. The Internet has brought transparency to many organizations. Without transparency the organizations loose their credibility, that influences their image which is also very important. It is estimated that there are currently around three billion Internet users worldwide [6].

When we are talking about the usage of social media, it is necessary to know all the possibilities they offer, to follow the trends, to have continuous interaction and to create proper image on the Internet according to the collected information. The presence of the organization on the Internet implies first of all the creation of the web site. Tourism web site should not be a brochure or a flayer posted by the organization on the Internet to inform future tourists about the destination and prices of travel arrangements. The site should offer complete presentation of the destination, give relevant information and reply to every single tourists' question about the destination, its offer and content. The site should be creative and well imagined. It can contain some records, reports and experiences of tourists who have already visited the destination. That material is very useful to the media. The pictures give us very interesting information, especially if it is about the attractive destinations and Serbia has plenty of such. The Internet is not used only to give us tourism information but also for selling the travel arrangements. According to numerous research, tourism and trips are the main categories of products/services being bought on the Internet. Prospective tourists can refer to Internet tools to obtain all necessary information about the tourism product and all the elements regarding the trips: price, currency exchange, area attractions. The consumers can make trip reservation and credit card payment too. The role of travel agencies has decreased recently as the travel arrangements are directly bought on the Internet. Every serious organization in tourism sector has its presentation on the Internet.

Tourism forums have a considerable importance in establishing interactive communications, as they offer the possibility of general discussion on trips, destinations and experiences. Through distribution of different content regarding the proper trip adventures and reading of someone else's experiences, the visitors of forum discover important information that can help them make future decision. Website of numerous travel agencies or online reservation systems imply forums and photo galleries that the visitors put on in order to promote certain destinations or travel arrangements.

Today in tourism services marketing many social networks are extremely important. Some of them are perfect to share information about the rural tourism offer. Facebook is a very important communication mean. If we want to open a profile on the network promoting the destination, we have to act strategically. The best option is fan page opening that shows us the number of fans who visit or leave the page, like following their activities too. Globally, Facebook is the largest social network and almost everyone uses it. It is an extremely strong marketing strategy, so it is often used in promotion. Tweeter belongs to the group of micro blogs where the length of the message is limited to 140 characters. Towards those short messages we place some idea, news, thoughts. We can also share the photos, links or can call someone to certain event. Tweeter provides open communication where we can hear everyone's suggestion or reaction, as there is no friend request. It is suitable for rapid information sharing where the users do not expect strict and official communication. It is especially characteristic note to tourism as it is the industry based on vacation, fun and leisure time. Instagram is a social network dedicated to photos sharing and can be used on smart transferable devices, mobile phones, tablet computers and so on. From the marketing point of view, it can also be an excellent mean for making good communication with the guests as for the image creation of the households. Pinterest is a social network based on visual content – photos and pictures. It is well known that the man is a visual being, that we pay much more attention to the photos than to texts or information. As it is based on the photos, the tourist use it for the photos research of the destinations they would like to visit. In this way, they decide where to go and where to stay. Foursquare is a location social network. The tourist can see the places they want to go, find the information about the accommodation, restaurants, attractions, events, interesting locations, hidden places and to get some advice from other users. Such kind of advice is very important to the tourist as they present real, personal experiences of the people that have already visited those places, which is much more objective than any other paid commercial. Tourists can share their locations even on other social networks, so they can get advice about the location even from the friends on Facebook. The tourists can announce their friends on other social networks that they currently are in certain rural household, so the others will find out on that way about that place and those who are not far away from that place can also join them. Thus, one household can get more guests in that period thanks to the Foursquare [2].

2. THE IMPORTANCE OF THE INTERNET IN TOURISM OF SERBIA

As the time goes by, the number of web sites presenting the tourism and hospitality offer of Serbia on the Internet is increasing. Our country was connected on the Internet in 1996. When we are talking about the tourism of Serbia, significant level of implementation of information technology is an important aspect of its development: hotel business, travel agencies and tour operators and all other tourism economy entities; tourism products and services distribution; tourism presentation of Serbia and in the way of tourism services purchase. During the rapid development of the Internet in developed countries, Serbia had been suffering bad economic and political situation, that caused the problems in information communication technologies adaption. Today, we also have Internet presentation of the tourism destination no matter if they present the whole country, region or particular places and locations. The National Tourism Organization of Serbia, www.serbia-tourism.com, has the greatest importance in this presentation, like the regional and municipal tourism organization (Tourism Organization of Vojvodina, www.vojvodina-tourism.com). The Web portals present the tourist potential of Serbia, attract Serbian and foreign tourists and offer all useful information. The most famous Web portals of Serbia are: visitserbia.org and serbiatouristguide.com. The purchase of tourism services on the Internet is not at the adequate level, but the data is encouraging. Therefore, we can expect that the number of people purchasing tourism services over the Internet will continue to increase [4].

Rural tourism development in Serbia

Rural tourism in Serbia, like an organization activity, started its development more than twenty five years ago. The only beginning of rural tourism development refers to the spontaneous movement of tourist, who wanted to escape from cities and polluted areas at least for a while and spend some time in the nature. At the beginning, only few householders were engaged in such kind of tourism. As the time went by, motivated by the tourism organizations, the rural tourism got massive character. For the purpose of rural tourism development, tourism associations had were founded, especially in the hill – mountain areas (Devići, Brankovina, Studenica), Municipal Tourism Associations (Kosjerić, Ivanjica, Knić).

Even the agricultural organizations and tourism - hospitality industry were engaged in this activity. According to the Tourism Association Archive information, in the end of eighties of the last century, 50 villages were engaged in tourism. They had around 3.000 beds in 800 households, distributed in almost 70 municipalities, generating annually about 10 billion dinars of accommodation incomes and contributing approximately 5 billion RSD more direct incomes for the tourism sector. Furthermore, these incomes do not take into account visitors that do not stay at least for one night or stay with friends or relatives, although they also spend money on tourism services, therefore generate additional income for the rural areas [7].

It is expected that rural tourism will have achieved the following results by 2020:

- increase overnights from 2.7 million to 7.4 million;
- increase day visitors: domestic, regional and international;
- increase occupancy rates in rural accommodation to 30%;
- increase the number of beds in line with expected occupancy rates;
- close gaps in the rural tourism value chain and increase the multiplier effect of tourism from 1 to 1.6; and
- increase direct contribution of rural tourism to the economy from 100 million € to 439 million € [1].

According to the data of the Serbian Tourism Organization, the householders living in the municipalities of Kosjerić, Valjevo, Ljig, Čačak, Požega, Knić, Lučani, Mionica, Užice, Sokobanja, Čajetina, Prijepolje, Brus, Šabac, Kraljevo, Ivanjica, Rača Kragujevačka and Gornji Milanovac are engaged in professionally organized tourism. The rural tourism in Serbia should give its contribution to the rural environment protection and cultural heritage protection, but also to motivate local inhabitants economically to stay in the villages and continue their lives there. There has been recently certain increase of the general services in the households. Guests and the householders usually stay in different houses or in separate parts of the houses, adopted for tourists accommodation. The rooms more often have separate bathrooms and some of them also offer whirlpools, Internet and cable TV. Tourism resources diversity and rich cultural heritage are accompanied by extreme hospitality of the local inhabitants that in accordance with tradition accept every tourist as a friend and make him feel comfortable offering him rich traditional cuisine based on

healthy food. Great number of villages is close to precious cultural historic monuments with characteristics of certain areas. There are also more and more tourism manifestations taking place in those villages. Staying in the nature offers to the tourists possibilities to walk, to recreate themselves, do sports, have organized picnics, walk to the caves, spring of water, waterfalls. They also can go hunting, fishing, riding horses, hiking, can collect healing herbs and do other funny activities in the nature. Tourists can also do some agricultural work with their householders. The rural tourism income could be even higher if we had better use of the current potential and if we had more aggressive commercial campaign. It is also an excellent opportunity for the inhabitants to get the job, for the young people to stay in the villages and the villages to get revitalized. Spending holidays at rural destinations in the nature is becoming increasingly popular among both foreign and Serbia tourists. According to the number of rural tourists before the WWII, Serbia was ranked second, right after the Chez Republic, while today it attempts to reach other European countries that are enagaged in rural tourism.

Today, over 950 households in Serbia are engaged in rural tourism, having around 5.500 beds, in 67 municipalities. More than 200 households can offer accommodation to the most demanding tourists that had travelled all over the world. Nowadays, according to the number of overnight stays, Serbia is practically at the beginning of its rural tourism development. The new Tourism Law, for the first time, determines the term "rural tourism households" and define formally offering of rural tourism services to the organized tourism groups. Other positive side of the state policy towards this type of tourism are future loans for the rural tourism development – Tourism Development Funds and categorization of facilities. This type of tourism, being neglected unfairly in recent 50 years, has become the priority of the Tourism Organisation of Serbia [11].

The Internet and rural tourism

Nowadays, the main characteristics of tourism have changed. We cannot talk anymore about the tourist with unified needs, as a part of the massive demand, having the same interest as the tourist in the last century. Today, they have great experience, knowing exactly what they want and what they can expect for the price they pay. They don`t have much free time, they want to take rest, to see lot of new things during the short stay in the village. They want to feel the atmosphere, learn new things, try traditional food. Thanks to the Internet, they

have huge choice and possibility to get the right thing. Because of that, rural tourism households, besides they should know how to satisfy all the needs and expectations of the modern tourist, how to make them content and keep them in the village, they must have their own place on the global network. If we type on the Google the key words "rural tourism of Serbia" in Serbian, we get the result of 117.000 links. If we type the same words in English, we have around 180.000 links and if we type "village tourism Serbia" we get 649.000 links. Navigating the Internet the consumer chooses when and which information he/she wants. He is not only a passive receiver of the massage, someone who wants to have commercial put in advance. The great number of modern tourists start theur trip to the village on the Internet. They choose the destination and plan the trip surfing the Google and social networks. They are interested in price, offer characteristics, information on household, experiences of other people. They want to see the photos of the surrounding and rural tourism households in order to have visual presentation about the village or about the household before they make decision where they want to spend the vacation [10].

Besides this important relationship improvement with the clients, it is extremely important for the households that the commercial volume and price ratio is pretty favorable than in the paper media or electric media. There are no limits of the letters and the time. The costs are very low if we consider all the benefits that the Internet brings to the household, especially if we take into account that getting loyalty and keeping existing clients is five time cheaper than looking for the new ones. Today, people who offer tourism services are much closer to the tourist than ever before. They don`t have to open an office in big boulevards and avenues, they don't have to wait for the clients to come and make reservations. All the tourism facilities, like the rural tourism households, get unlimited market, continuous commercial, low promotion costs, easy results and effects control of all the marketing activities on the Internet by posting the information on services they offer on the Internet. The rural tourism households can promote themselves on the Internet posting their own web site or placing the information about their offer onto some Internet portals for the rural tourism promotion or on the web site of the local tourism organization The aim of Internet Marketing Strategy from 2011 is that Internet becomes the main promotion instrument of direct and indirect selling of the rural tourism products. There are the following suggestions:

- creation of the proper rural tourism multimedia web location adopted to users and connected to already existing locations, like web locations of Serbian Tourism Organization, local and regional tourism organizations, rural tourism facilities, rural tourism activities and accommodation.

- use of the web platform for the improvement of relationships with clients towards adoption of various e-marketing instruments.

- promotion of just high quality content in order to create identity and increase clients fidelity.

- Web location should be developed so as to attract the visitors to symbols and colours, liked by the visitors, inviting them to discover Serbian village.

- providing central portal where all the information regarding village activities and accommodation is centralized.

- reservation on the Internet providing indirect approach to rural accommodation.

- providing rural travel tours combining the activities and accommodation.

- use of chat on social networks connected to the location where the visitors can share their Serbian villages experiences with other people.

The Internet should be used as a strategic measure for client attraction in rural Serbia and relationship development with rural Serbia. Today, tourists can get connected to the Internet 24 hours a day, seven days per week and their leisure time is dedicated to Internet. From this reason, attractive web location with specific content for the target user segments will occupy attention of the users and will increase the number of repeated visits to that location of rural tourism. All the elements that the web location includes should be closely connected between themselves and when the user chooses one option should also see other available options for other main categories. For example, if the user chooses one destination, he/she should see at the same moment all the activities they can participate in and the best accommodation they can get during the trip. Besides being visually attractive, the Internet reservation system should also be simple and intuitive, offering minimum number of necessary steps for making reservation and making the user feel completely sure and safe [5].

In the realization of the project entitled "Promotion of Serbian rural tourism" in 2005, all municipalities and tourism organizations of Serbian municipalities and towns having tourism offer in their villages were involved in it. In 2006, over 200 householders being

registered in data base get 90% of tourist towards this portal, making it one of the most successful business models in Serbian rural development. In 2007, the site was visited by 300.000 visitors, which makes it one of the most visited tourism web sites in Serbia. Promotions of rural households on the site www.selo.rs and its information are completely free. This Association participated in rural households promotion organization on the fair of Serbia rural tourism - International fair of tourism in Belgrade in 2008, 2009 and 2010. Association Members organized more than 30 seminars, round tables and workshops regarding the rural tourism development and promotion in Serbia. The Association participated in organization of the First Rural Tourism Congress of Serbia in 2010. Serbian rural tourism organizes all the project activities for the purpose of development of Serbian rural tourism, being supported by the European Union, Ministry of Economy and Regional Development of the Republic of Serbia, Ministry of Agriculture, Fishery and Water Economy, the World Tourism Organisation, United States Embassy, UN Development Program. Association of Serbian Rural Tourism got the prize of "Tourism flower" from the Tourism Organization of Serbia ,the biggest national prize in tourism in category of promotion of Serbia in electronic and press media. Owing to the results of the web site selo.rs, the national association of rural tourism of Serbia is also a member and active participant of Serbia in European Foundation for Rural Tourism Development [9]. The web site www. selo.rs is the leading website of rural households promotion in Serbia. Publishing information about the rural households tourism offer on the Internet portal selo.rs is very simple and available to all the people having the basic knowledge of informatics. The portal includes precise instruction on how to fulfill all the information so the householders can put the photos and information by themselves and if they do not have any conditions to do that local tourism organizations or portal administrator will do that for them for free. When the householder got registered on the portal www.selo.rs he can approach to the panel to fill out some personal data such as the name, location, type of accommodation, household characteristics, prices, structure of accommodation, appliances, tourism programs if they are organized in the place or in the surrounding and it is possible to have all the information in different languages. This precise input of information allows tourist to search the households on the web site www.selo.rs according to location, type of accommodation, type of household, prices, services or additional activities in the village. Various comments left on the site by the people who had already

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visited the village can help other people choose the most adequate household. Promotion on this web site is completely free of charge, without commission and membership fee and the householders using this site carry out from 300 to 1.500 nights per year. Experienced householders do not write just about their offer but share useful information about their villages, surrounding, nearby attractions, manifestations and so forth. Less promoting material and more useful material is something that attracts future tourists [7]. Creators of this web site have also opened the pages on the currently most popular social networks such as Facebook and Instagram. Various offers of rural households have been published there and the people just liked it. The interest was pretty big and at the same time the demand has increased and the page got almost 8.000 potential tourists that have been following this portal over the last couple of months. Well created commercial was seen by more than 12.000 users, especially those who wanted to spend their vacation in the countryside. People were interested in every post published, they left the recommendations, asked for the contact of the householder and finally made reservations based on these posts. Therefore, it can be concluded that there is certain number of those who visit such sites and it is necessary to get them well informed and leave an adequate message to them. Knowing well that people spend their free time on the Internet, telephone or computer, the message of rural households should be posted right there where they are. Other social network have also been involved, like email and site commercials, with a total of 8.000 followers and potential tourists. This Association has also developed effective marketing system over email. It means that there are more than 2.000 users in the base wanting to get offers of rural tourism vacation throughout special emails, so called newsletter. The total number of followers and potential tourists on social networks is 8.000, plus 2.000 registered users on mailing lists and the visitors of the website ww.selo.rs [8]. Future activities and site improvements will surely bring even better results, thus making the rural tourism offer much closer to tourists.

CONCLUSION

Internet promotion has recently brought about numerous changes in rural tourism of Serbia. The Internet moved all the boundaries and established clear connection between the tourism offer and demand with the efficient two-way communication and exchange of information regardless of the geographical distance. As the time goes by, the number of web sites presenting the tourism and hospitality offer of Serbia on the Internet is increasing. Social networks also play an important role in that process. Some of them are perfect to share information about rural tourism offer. Nowadays, people who offer tourism services are much closer to the tourist than ever before. The aim of Internet Marketing Strategy is that the Internet becomes the main promotion instrument of direct and indirect selling of rural tourism products. We should use the Internet as a strategic measure to attract potential clients to rural tourism destinations in Serbia.

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THE IMPORTANCE OF SUSTAINABLE RURAL TOURISM DEVELOPMENT IN SERBIA

Milena Podovac[1],
Melita Jovanović Tončev[2]

[1]University of Kragujevac,
Faculty of Hotel Management and
Tourism in Vrnjačka Banja,
Vrnjačka Banja, Serbia

[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Tourism largely exploites resources that are not renewable. Due to the mass tourist travel destinations, the environment suffers negative consequences of such development. All these reasons cause the development of sustainable forms of tourism, in those aspects which do not cause the pollution of nature and its resources. The implementation of the concept of sustainable development of rural tourism has ensured that this form of tourism has nowdays become specific market niche, which attrackts tourists to spend time in rural environment. Rural tourism contributes to the revitalization of the village through the involvement of rural households in the provision of services to tourists, marketing of agricultural products on the tourist market as well as the promotion of cultural heritage and traditions of the village. The potential of rural tourism is also reflected in the preservation of natural resources.

This paper analyzes the current situation of rural tourism of the Republic of Serbia with an emphasis on the examples of good practice. With the aim of emphasizing the opportunities for further development, the authors disclose the example of rural tourism destinations in Serbia. In the concluding remarks, guidelines for improving the existing rural tourism supply in Serbia are provided.

Key words:

rural tourism, sustainability, development, Republic of Serbia.

1. INTRODUCTION

The concept of development based on the principles of sustainability emerged in the early 90's of the 20th century, in response to the need to establish a balance between the uncontrolled and unplanned development. This development has resulted in the disruption of the Earth's eco-system, as well as the resources necessary for the cited development, and therefore the whole of human society. Due to the synergetic effect of economic, environmental, social, cultural and other dimensions of sustainable development, it was necessary to create an integrated approach that would have complied with all of these components based on the principles of sustainability. From this point of view, it could be said that sustainable development represents *an integral economic, technological, socio-cultural development, in line with the needs of safeguard, protection and improvement of the environment, which enables current and future generations to meet the needs and improve the quality of life* [12]. The link could be observed between sustainable development and tourism as an

Correspondence:

Milena Podovac

e-mail:

milena.podovac@kg.ac.rs

industry that recorded the highest level of development in the 20th and at the beginning of 21st century and sustainable development is more than obvious. Development of tourism uses and gradually destroys the natural resources which essentially constitute the basis for its further development. So, if tourism would be developed on the principles of sustainability and responsible behaviour towards the resources used in this way it would protect the base for further development. According to the simplest definition, rural tourism is defined as any form of tourism that takes place in the countryside [1]. By staying in the village, tourists enjoy the natural environment; they're engaged in activities typical of rural areas and learn about the culture and traditions of the community being in contact with the population. In this sense, rural tourism contributes to the revitalization in the economic, ecological and socio-cultural sense with the aim of improving the status and life standard of local inhabitants. In this paper, the authors give the analysis of the importance of sustainability for development of rural tourism in the Republic of Serbia through the theoretical analysis and presentation of examples of good practices.

2. SUSTAINABLE TOURISM

Abandoning the concept of tourism development solely on economic basis, which included the attainment of greater profit, many world tourist destinations are starting to apply the concept of development, which implies respect for social, environmental and cultural interests of receiving countries. It is concerned with the socially responsible tourism development, which involves meeting the needs of tourists and creation of profit and delivering value for money, but also the establishment of corporate social responsibility in business. The literature often defines sustainable tourism as a positive approach seeking to reduce tensions that are the result of complex interactions between the tourism industry, visitors, environment and society as a host [2]. The impact of tourism on the environment of the host countries can be positive and negative. Positive effects include: renewal and restoration of existing historical sites, buildings and monuments, transformation of the existing old buildings and places in tourism facilities, protection of natural resources, adoption of various administrative and planning measures for the protection of certain areas, improving the availability of space and creation of new tourist areas, building environmental awareness and the like [2]. However, uncontrolled and non-strategic tourism development in the particular area may have negative effects such as: pollution of the area due to the

construction of tourist facilities and equipment, pollution of air, water, soil, noise pollution, depletion of natural and agricultural areas, destruction of flora and fauna, degradation of the landscape, as well as historical and cultural monuments, cluttering of space, geological forms of degradation, spatial redistribution of the population and generalization of space [4].

In order to minimize the negative effects of tourism development of specific destinations and maximize the positive ones, it is necessary to establish the balance between the needs of visitors, the tourism industry, the environment and local communities [22]. In order to establish the mentioned balance, it is essential that the sustainable tourism [21]:

- makes optimum use of to environmental resources that constitute a key element in tourism development, maintaining essential ecological processes and helping to preserve the natural heritage and biodiversity,

- respects the socio-cultural authenticity of host communities, protects their built and modern cultural heritage and traditional values, and contributes to understanding and tolerance between cultures,

- provides sustainable long-term business, creating socio-economic benefits, which is fairly distributed to all stakeholders, including stable employment, opportunities for income generation and welfare of host communities, as well as contributing to poverty reduction,

- sustains a high level of tourist satisfaction enabling them to acquire unique experience, developing their awareness about sustainability issues and promoting sustainable tourism.

Therefore, it is essential to apply strategically planned approaches to the use of natural resources at their disposal and simultaneously respect the tradition and culture of the local population, in order to achieve continuous tourism development. Establishing a balance between the need to get more profits and sustainability is the basic principle on which we should base the development of tourism in the 21st century.

3. RURAL TOURISM AND THE CONCEPT OF SUSTAINABILLITY

With the development of mass tourism travel and standardization of tourist's services, people have turned to natural, preserved and clean environment, such as rural

areas in search of an authentic experience. The attraction of rural areas for tourists is connected with the possibility of satisfying needs for vacations, relaxation, activity holidays, gaining knowledge about the way of living in the country. The beginnings of development of the rural tourism are linked to the distant past when the privileged social class (the feudal lords, the bourgeoisie, the aristocracy) spent their leisure time in rural areas [20]. On the other hand, intensive development of tourism in rural areas is linked to the year 1970 in developed countries, which has contributed to the strengthening of villages in economic and social terms [16]. The fact that the development of rural tourism was intensified in the second half of the 20th century points to the importance of this form of tourism for improve the status and existence of people who live in the countryside. The expansion of tourism in rural areas enabled [17]:

- creation and maintenance of local income, employment and growth,
- creation of resources for economic and social infrastructure,
- encouraging the development of the industrial sector,
- creation of local content and services,
- creation of conditions for the preservation of culture and cultural resources.

There are different interpretations of various forms of tourism in the literature. Difficulties in defining the concept of rural tourism are conditioned by the fact that it is very broad concept that includes not only a vacation in the countryside, but also all other tourist activities in rural areas [19]. Middleton assumes that rural tourism is recognized as synonymous for the good life, which is reflected in the fresh air, spending time in the natural environment and life in harmony with nature and the community [13]. Rural tourism can be defined as a vacation, during which tourists use most of their free time to deal with recreational activities on the farm, ranch, country or its surroundings [6]. Kušen analyzes the concept of tourism on family farms, which he considers a form of rural tourism that allows households in villages to expand their activities and increase the price of their products [10]. From the above it follows that the definition of rural tourism provides activities for tourists during their stay in the country, which has resulted in diversification of economic activities of rural households. Generally accepted definition implies that rural tourism *includes a wide range of activities, services and additional contents that provide a host (farmers, peasants) on family farms and estates to attract tourists to their area in order to create additional income, respecting the principles of sustainable development and conservation of natural resources* [15]. Modern tourism demand requires continuous innovation of rural tourism demand and development of new activities for tourists who want the full experience. Accordingly, the following forms have been identified [8]: agro-tourism, nature activities, eco-tourism, rural experience, cultural tourism and other forms of combination of special tourism interest. Difficulties in identifying forms of rural tourism are connected with the fact that this form of tourism has a lot in common with other forms of tourism. For example, villages, which have a rich culture and history, may, in their tourist offer activities include visits to sites of cultural and historical heritage, which let you create links between rural and cultural tourism.

The long-term successful development of rural tourism depends on the quality and availability of natural resources. Accordingly, the concept of sustainable development represents an indispensable segment of tourism development in rural areas. Sustainable rural tourism can be defined as an activity that contributes to positive economic and social development of rural areas and at the same time does not violate the social and natural environment [9]. Rural tourism is in correlation with the environment, as indicated by three basic characteristics [23]:

1. Low population density and relatively small size of settlement. For the definition of rural areas, it is important to observe and compare the potential tourists from the environment in which they live (usually urban) and characteristics of the certain area that make it rural. In this sense, rural areas with low population density and relatively small size of the settlement represent more pronounced attraction for tourists.

2. A way of land use and economic activity, that relies on agriculture, forestry and the use of raw materials. Depending on the differences between rural areas in terms of economic growth is determined by the attractiveness of these areas for potential tourists. Underdeveloped rural areas, which are relied on traditional agricultural small-case production, are more attractive to tourists, because they, among other things, seek to diversify development.

3. Traditionalism of social structures. Rural areas are characterized by a strong sense of community, local rather than cosmopolitan cultures and way of life that is *slower*, less materialistic and less *complicated* compared to urban areas. The growing interest of modern tourists for cultural heritage highlights the importance of these features of rural areas.

The link between sustainable development and rural tourism is manifold. In the first place, tourism in rural areas provides livelihoods of the local population through job creation, encouraging public-private partnerships and boosting agricultural production. The development of tourism in rural areas improves the relationship between people of different demographic characteristics, respectively people from urban and rural areas. In this way, it is increasing the attractiveness of the local culture and traditions, in which the tourists are particularly interested. Benefits for rural areas are implemented through the interpretation of the environment. This is an activity, in which tourists are walking or driving along the roads, which are marked by certain information boards and signs and very often with information about the environment in order for tourists to gain some knowledge about the natural and cultural resources [7]. However, the concept of sustainability in rural tourism contributes to the realisation of multiple objectives [11]: preservation of local culture and character of the local community, preservation of natural landscapes and natural "habitat", sustainable development of rural economy, sustainable development of tourism industry in the long term, the development of understanding, leadership and vision of decision makers in the fields that they consider to be of danger for tourism and reliance of the same on them and continue to work towards achieving a balanced and diverse rural economy.

4. EXAMPLES OF GOOD PRACTICE AND SUSTAINABLE RURAL TOURISM IN THE REPUBLIC OF SERBIA

The Republic of Serbia is rich with resources for development of rural tourism on the principles of sustainability. Rural areas possess the high-quality natural resources, rich cultural and historical heritage, traditions, events, and all elements that are necessary for creation of an integrated offer in villages. However, the development of sustainable rural tourism is quite disorganized and characterized by the absence of public sector support in the legal, financial and institutional sense. Rural areas in Serbia cover 85% of the total territory, with 55% of the population, and achieve more than 40% of the total GDP [14]. Rural economy in Serbia is based on agricultural production with about 75% of the rural population engaged in agriculture, which creates conditions for the placement of agricultural products through tourism [3]. Serbia is rich in flora and fauna (428 protected animal and 215 protected plant species) and 1300 protected

natural objects (5 national parks, 22 regional parks, 122 nature reserves, 375 natural monuments.) [17]. Numerous experts evaluated the situation in many rural areas of Serbia favorable for the environment, which is less burdened by chemical contamination and other waste. This, almost heretical, state brings the public into believing that the abandonment of the rural areas has its upper side. However, the truth is that the environment is burdened by different influences of the rural economy, depending on which part of the country is being observed. Intense pressure on the natural resources of agriculture in lowland areas results in depletion soil, and highly contaminated surface water and groundwater. The risk of pollution of water sources can be degreased by reducing the use of species of fertilizers in marginal mountain areas. On the other hand, complete abandonment of the application of agricultural technology can contribute to the degradation of the physical properties of the soil and threaten its fertility [5]. These data point to the existence of great opportunities for the exploitation of rural areas in order to develop tourism on farms. On the other hand, the events of the 1990s, migration from village to town, the economic crisis and other factors have influenced the economic extinction of Serbian villages. In an effort to identify the similarities and differences between the rural areas of Serbia, as well as their strengths and weaknesses, their typology has been developed [5]:

- Type 1: highly productive agriculture and integrated economy. This group of rural municipalities includes municipalities in Vojvodina and northern parts of Serbia around the Sava and Danube rivers. In these areas, the highly productive agriculture is presented with a better structure of households (households with more productive soils) and vertical integration with the agriculture and food sector. Also the services and industrial sectors in the context of Serbia are better developed here.

- Type 2: small urban economies with intensive work in agriculture. The cluster-region geographically extends through the rural municipalities along the river valley and is located on the main roads in Serbia, which has radial expansion from Belgrade to Montenegro, Bosnia and Macedonia. These areas were identified as the so-called urbanized villages, located close to major Serbian cities. Their intensive agricultural production is market-oriented, while their rural economy is diverse - developed services and small and medium-sized enterprises.

- Type 3: predominantly mountainous economy is oriented to natural resources. This cluster-region includes the mountainous rural municipalities of Southeast Serbia. It is characterized by low population density and negative demographic changes. This economic structure has lower productivity in agricultural production, certain industrial activities, developed services and tourism potential. It is basically a rural region oriented toward natural resources, with unused natural resources and tourism potential, as well as the possibility of exploitation of rural benefits: natural resources, rural environment, cultural heritage.

- Type 4: large tourist facilities and poor agricultural structure. This cluster of rural municipality is located in the western part of Serbia, and has large touristic capacities. The index of the number of hotel rooms per 1,000 people in this cluster is three times higher than the national average. However, agricultural structures are the worst among all the types described herein.

The highlighted typology indicates the existence of opportunities for promotion of rural tourism development almost in all parts of Serbia to a greater or lesser extent. The economic importance of rural tourism is more than important for the revitalization of Serbian villages. In our country until 2012, 950 households were categorized engaged in this form of tourism. Totally about 300 households are engaged solely in tourism while on average from 750 to 1500 overnight stays are being realized per year per household [24]. According to the Master Plan for Sustainable Development of Rural Tourism of the Republic of Serbia, the following guidelines have been defined for positioning Serbia as a rural tourism destination [3]: development of a holistic experience in rural tourism, which consists of integrating rural activities, rural housing and development centers for activities, development of quality standards for products and services throughout the entire value chain so as to ensure that the rural activities, rural accommodation, activity centers and other services are in line with international quality standards, the development of a multi-layered approach to USP, development of an integrated operational marketing plan that supports communication and commercialization of rural tourism and allows the visitors/tourists to pack their own experience of rural tourism, the establishment of service centers for development of human capacities, establishing a global system management, with special emphasis on children's and family tourism.

However, rural households are facing numerous problems in an effort to ensure all necessary conditions for providing services to tourists with limited financial resources to invest. In continuation, the emphasis is on good practices for rural tourism development while respecting the principles of sustainability.

Koštunići village is located on the slopes of Mount Suvobor and is the largest village in Gornji Milanovac by its surface (4,736 ha). It is located 30 km from Gornji Milanovac. By its area of 4,736 ha, Koštunići is the largest village in the municipality of Gornji Milanovac. Through the village flow four mountain rivers Grab, Bukovača, Čemernica, Šiban, which are habitats of numerous species of river fish and crabs. This area is characterized by exceptional ecological and landscape values, such as the valley of mountain rivers and streams, with clear pronounced agrarian, forest and meadow ecosystems, rich with a variety of medicinal herbs, forest fruits. Koštunići has a mild and pleasant climate and has a good average annual temperature of 18 °C degrees, with warmer autumn than spring season. Thanks to the preserved environment, this is the only ecological village in Serbia. In 1996, the ethno-project was launched with the aim of returning to healthy food, clean water and natural products. The plants were built there producing natural brandy, apple vinegar, herbs dryer, refrigerator for storing of raspberries, blackberries and berries. In the center of the village, ethno-complex *Anđelija Mišić* with ethno-house was built in, which holds the folklore of skilled weavers, embroiderers and yarn; apartment complex in the form of traditional wooden houses; ethnographic museum in which objects are kept by the people of this region used in the 18th and 19th centuries and a museum dedicated to Duke Živojin Mišić where twelve squares keep the relief space where Suvoborska battle occurred in the World War I [26]. This complex is an example of good practice in terms of unifying the offer in the form of traditional ecologically produced products, folk art and cultural and historical heritage.

Zlakusa is an example of the village, which seeks primarily socio-cultural sustainability through preservation of national creativity and presenting the same to tourists. It is located in western Serbia, in Zlatibor district and belongs to the territory of Užice, the headquarters of this tourist region. This village is known for its pottery craft. The tourist offer of this village includes: Ethno park of Terzić garden, which dates from the early 20th century and is a typical farm from the vicinity of Užice, with old houses and garden; rural tourist households, which are equipped with 50 beds, which are categorized and supported by the launch of Homeland Ethno Association; footpaths, respectively 4 circular footpaths with a

total length of 60 km linking the most important tourist facilities in Zlakusa and the environment and Potpeć cave, which is located in the village of Potpeć, Zlakuse village, 14 km from Uzice, and is one of the monumental pieces of nature [27] This village is an example of good practice regarding the design of the attractiveness of the destinations on the artistic value and preserve them in contact between locals and tourists.

Ethno village Latkovac was originated on the place of the hearth older more than two centuries. Two decades ago, this place became a tourist resort thanks to its untouched nature, mountain water, local food, *etc*. It is located 220 km from Belgrade and 3 km from Aleksandrovac. The hamlet consists of five houses, stables and a barn. For tourists especially interesting is the library with over 3,000 books and Echo shop, where one can find homemade products [25]. Combination of pristine nature and environmentally responsible food production is a key tourist attraction that would attract both domestic and foreign tourists. The holders of rural tourism in Serbia have to formulate an appropriate product to meet the tourist demand, which would be equally interesting to the younger and older population. Integration of such offers with the products of spa and wellness tourism could contribute to greater popularization of this kind of tourism in Serbia, and certainly stimulate the local and national economy, as well as the universal well-being of the local population.

5. CONCLUSION

In this paper, the authors have analyzed the resources of the Republic of Serbia, which can be used for development and improvement of sustainable rural tourism as well as examples of good practice, which are the holders of the tourism offer of the same. Rural areas in Serbia have potentional to develop tourism with the sustainable use of resources. The wealth of water, climate, clean air, natural environment, gastronomy, as well as the traditions and culture of the rural households are comparative advantages for responsible development of rural tourism. In addition, rural tourism based on the principles of sustainability does not only mean the responsible use of natural resources in the long run, but also organic food production, which is part of the village's offer and can be commercialized through tourism.

The problems with which the villages are facing can be overcome by the development of rural tourism on the basis of sustainable production, the traditional way of doing business and the inclusion of local people in the process of providing services to tourists. In further development, destination management must focus their attention towards integrated planning of resource use with defining a framework for the application of sustainable development principles. Bearing in mind that tourists are increasingly more directed towards natural ambient, rural areas are gaining in importance as a destination where tourists spend their holidays. However, it is very important to raise the awareness of all participants of rural tourism on the necessity of responsible behavior towards natural resources which represent the resources for their further development. All participants of this form of tourism should be aware of their roles and responsibilities in the development of rural tourism in compliance with the principles of sustainability.

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THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN GUEST SATISFACTION ANALYSIS IN HOSPITALITY

Slobodan Čerović,
Miroslav Knežević,
Dušan Borovčanin

Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

The aim of this paper is to demonstrate the extent to which information and communication technologies (ICT) are used in the analysis of hotel guest satisfaction in Serbia. Moreover, this paper examines modern solutions in the field of ICT and benefits that they are providing for hotel managers. We started by analyzing theoretical background which considers the influence of IT on hospitality, following the research that was conducted on the level of ICT implementation in the analysis of guest satisfaction in hotels in Serbia. In addition, we wanted to show that the usage of ICT in this domain is much more rational regarding some major economic principles such as efficiency and profitability.

Key words:

ICT, guest satisfaction, hotel, on-line reputation.

1. INTRODUCTION

Globalization and development of the tourism industry has increased and accelerated greatly the need for information, without which doing business in tourism and hospitality could be hardly imaginable. Moreover, with the development of modern ICT the need for their application in business becomes the key for the competitiveness of hotel industry. [1] ICT development has created numerous changes in promotion and sales of hotel services. Management, revenue management, capacity optimization, establishing and developing of relationships with customers and other activities are acquiring a new look influenced by modern technologies. There are four key elements that affect and shape modern business. [2]

- Digitalization and relationships
- Internet expansion
- Contemporary intermediation methods
- Adaptation to the needs and expectations of consumers.

Since consumers are the starting and the ending point of all business processes in a hotel, their satisfaction is one of the most important elements that has a considerable impact on the results achieved in the hotel

Correspondence:

Dušan Borovčanin

e-mail:
dborovcanin@singidunum.ac.rs

business. In addition, technological progress and tourism have been going hand in hand for years. [3] The internet and communication technologies are creating new opportunities and resources to improve the competitiveness and profitability of tourist destinations and enterprises in the future. [4] [5] From a business perspective, contemporary trends in the field of e-tourism are focused on consumers, as well as the advantages offered by creation of network and partnerships with other tourism enterprises (companies) that provide complementary services. [5]. Based on the analysis of trends and opportunities arising from the development of modern information technology, the habits and consumer expectations have changed profoundly. Tourists are more demanding and they require differentiated and personalized services. In accordance with these, tourism businesses should collect information about tourists at every stage of the tourist experience (before, during and after travel). This should be in particular the information created by the tourists themselves on the Internet, which should be used to better understand the needs and attitudes of users, and to offer more personalized services and, in general, to develop user-oriented promotional strategies. [6]

Modern ICT tools can help tourism enterprises to increase profitability, but also to significantly improve the quality of their services. First of all, ICT tools provide an opportunity to create and develop direct relations with customers, which contributes to sales and reduces the amount of fees payable to various intermediaries and other distribution channels. Furthermore, enabling web reputation management provides an opportunity to improve hotel reputation and identity. In addition, the internet and communication technologies are indispensable support within the following activities: [7]

- Market segmentation
- Price optimization
- Demand forecasting
- Supplies allocation
- Sales *etc.*

When it comes to the benefits arising from the creation of the partnership, it is known that the tourism product is actually a set of services that is diverse in nature, and that the evaluation of the quality basically depends on the user's overall experience which is a result of the mix of services offered by different companies. [8]

Having in mind everything mentioned so far, the research in this paper was conducted in order to determine the percentage of software usage for the analysis of guest satisfaction in hotels in Serbia.

2. GUEST SATISFACTION AND MODERN INFORMATION TECHNOLOGIES

Numerous studies have dealt with the issue of customer satisfaction. In the second half of the twentieth century, Peterson and Wilson (1992) estimated that 15,000 studies were done on consumer satisfaction or dissatisfaction. [9] Other researches showed *that operational productivity and customer satisfaction are the important performance indicators in the hotel industry*.[10] A large number of definitions associate user satisfaction with product quality, or the quality of delivered services. Therefore, the quality of the service provided in the hotel industry has to be viewed from the perspective of the final user,which is in this case hotel guest. Bearing in mind that the consumer satisfaction represents, in fact, only the perception of the value delivered, hotel managers have to find out what is actually a value for the consumer [2] Certainly, this is much more important given that the difference between consumer expectations and perceived performance of products and services, represents satisfaction or dissatisfaction of guests.
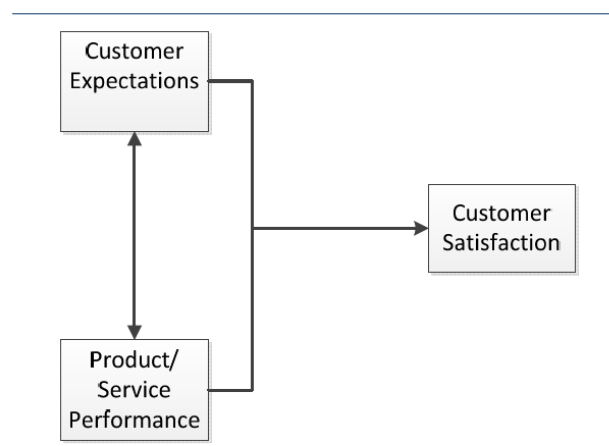
Figure 1. Customer satisfaction model[1]

Satisfaction and dissatisfaction analysis is one of the important preconditions for the successful hotel business, bearing in mind the above-mentioned importance of satisfaction. However, in satisfaction analysis, modern information technologies are irreplaceable compared to traditional methods in terms of basic economic principles such as efficiency, productivity and profitability. As regards guest satisfaction in hospitality and their relation

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1   Adapted from: *"An Integrated Model for the Effects of Perceived Product, Perceived Service Quality, and Perceived Price Fairness on Consumer Satisfaction and Loyalty"* 2001 Ti-Bei L. *Journal of Consumer Satisfaction, Dissatisfaction and Complaining Behaviour*

to information and communication technologies, we primarily refer to marks that guests leave on the Internet distribution systems (IDS) and the comments as well. In this paper, we will also present a specific method of semantic processing of words in situations where hotel was mentioned in any context on the Internet.

Various studies indicate the importance of the comments and ratings of other guests when choosing a hotel, while individuals go a step further and directly link hotel revenues with a score at IDS. There are several factors to confirm this. First, *the percentage of consumers consulting reviews at TripAdvisor prior to booking a hotel room has steadily increased over time, as has the number of reviews they are reading prior to making their hotel choice.* [11] Second, in general, over 70% of respondents usually start researching on-line before they decide how and where they want to travel. [12] In addition, various studies demonstrated that if a hotel increases its review scores by 1 point on a 5-point scale (*e.g.*, from 3.3 to 4.3), the hotel can increase price by 11.2 percent and still maintain the same occupancy or market share. [11] Furthermore, the occurrence of recent positive reviews can over-ride or moderate the effect of a set of negative reviews, in respect of booking intentions. [13] All this is the reason why we consider the analysis of guest satisfaction crucial in modern business, while in the continuation of work we focused on ICT solutions that are created for more efficient and better approach to this issue and their implementation in hotels in Serbia. All of the above mentioned clearly demonstrates why we consider the analysis of guest satisfaction crucial in modern hotel management. Therefore, research below was focused on ICT solutions that were created for more efficient and better approach to this subject and their implementation in hotels in Serbia.

3. THE USAGE OF ICT IN GUEST SATISFACTION ANALYSIS IN HOTELS IN SERBIA

Over the past 5 years, the hotel industry in Serbia has been significantly growing. The overall structure is still dominated by small and medium-sized enterprises (SME's) despite a considerable share of international corporate hotel chains in Belgrade.[14] The aim of the research was to determine the level of usage of software in guests satisfaction analysis in hotels in Serbia. A total-sample comprised 31 hotel in Serbia. When designing

this sample, special emphasis was placed on excluding corporate hotel chains that use corporate questionnaires for guest satisfaction analysis, like heartbeat from IHG. In the total sample, mountain hotels represented 19.35%, Spa hotels 6%, while the rest 74.65% were city hotels. This structure is primarily the consequence of the fact that the vast number of hotels in Serbia are located in urban centers.

The results obtained from the research show that only 3% of hotels use software to analyze guest satisfaction, ie. only 1 out of 31 hotels surveyed. [figure 3] After the quantitative data, we decided to do an interview with the manager of hotel that use software to analyze customer satisfaction and requested that he presents the main advantages of software usage.
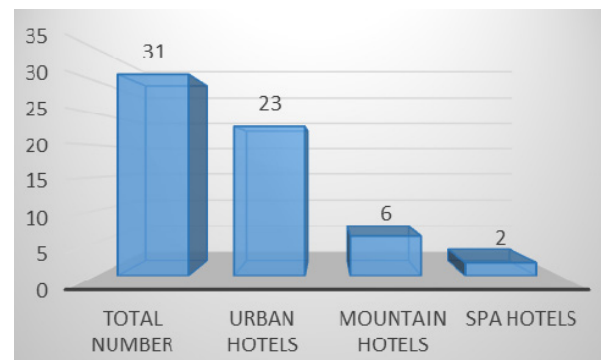
Figure 2. Sample statistics

One of the major advantages is analysis of online reviews and online presence in real time in one place, which is confirmed by comments collected from an interview that say *"insight and analysis of all comments and marks on IDS portals are the biggest advantage for us, and at the same time it serves us as an insight into the quality of service we provide, everything in real time".*

Thus, despite the fact that these tools allow managers to manage guest comments and marks in real time on all IDS's, they automatically serve as well, as an imputs for taking corrective action if they notice a negative trend in specific business segments.

The results that we have also come to by interview are as stated *"greater ability to continue building relationships with guests after their stay and thus affect their loyalty. We realized that a higher percentage of guests prefer to expresses their dissatisfaction when not directly contacted by the staff"*

However, when we sought to determine the disadvantages or deficiencies which could be defined, only the two could be singled out:

- Automatically sent questionnaries to guests after a night audit (regular guest paradox)
- Some things that are not directly related to the quality of service can affect the overall assessment, which automatically becomes publicly available

The first disadvantage mentioned is due to the fact that the system automatically sends a questionnaire to the guests who spent the night in the hotel. This can become burdensome for those who have a very large number of overnight stays in a hotel regulary.

Also, the implementation of such solution requires certain level of readiness for transparency and the desire to be open in communication with former and prospective guests. This means that guests are given the opportunity and insight into all the good and bad comments that former guests stated during their stay. Some sort of comments like "unfriendly taxi driver, bad weather, etc." can spoil guests experience. Although this assessment is not directly linked to the quality of the service provided, those reviews automatically go public, and can influence future guests that are reading those reviews.
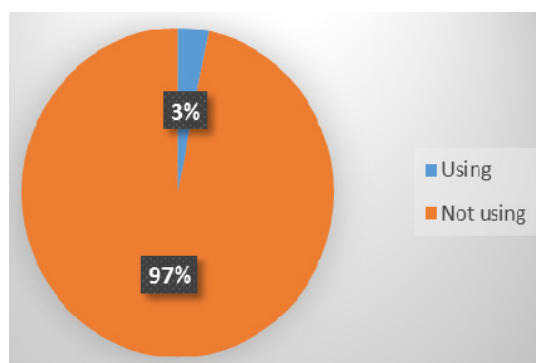
Figure 3. Sample statistics

However, after interviewing the management, we have found that the benefits and advantages of using this software go far beyond that, as confirmed by the following statement:

"The fact that we can track, and we can make operational plans based on the comments means a lot to us, as well as the ability to track and monitor our competition."

After all that we have examined, we decided to test one of the solutions in the field of ICT in this area. The test results are presented below.

4. ICT TOOLS FOR HOTEL GUEST SATISFACTION ANALYSIS

There has been a large number of softwares that were created so far, which enables modern managers to analyze the level of guest satisfaction in a more efficient way. Some of the most commonly used are: *ReviewPRO, Customer Alliance, Revinate etc.*. Every software is different, even though it basically provides almost the same or similar functionality for the hotel managers. The main benefits are: simple, efficient and reliable on-line reputation management of the hotel. In addition, such analysis reduces the pressure from hoteliers, says Susan Ganeshan, chief marketing and product officer at newBrandAnalytics.[2]

Below we will explain how these software can help in the analysis of guest satisfaction or dissatisfaction with hotel services.

Figure 4 (look in the appendix) shows the initial view or a dashboard of the *"Customer Alliance"*, which gives manager an overview of all IDS channels on which the hotel is advertised. Furthermore, the graphical display on the right side indicates the share of each IDS according to the number of reviews. In this way, the hotel manager can simultaneously obtain information on which IDS guests are the most active, *i.e.* on which IDS they leave the largest number of reviews and comments. Managers can, of course, edit the look of their dashboard. However, the distribution of a review-by IDS's actually represents one of the basic data, which is why we decided to present it in this dashboard. Managers are given the freedom to choose information on the dashboard from the following filters: specific IDS's, average rating by IDS, descending and ascending trends IDS's and by the number of total reviews on IDS.

Figure 3 shows some of the basic statistical data such as:

- Count of total reviews
- Average score on IDS
- Trend in a given period of time
- The percentage of guests who leave their comments (comment rate)

It should be noted that the manager has the option of creating an independent statistical display according to the two important categories:

- Time period
- Individual or group

2 Digital Marketing, March 2013, interview on topic "Reputation Management, Social Media gets Visual"

However, in addition, managers have at their disposal a detailed segmentation according to the comments:

- Demographic characteristics (age)
- Behavioral characteristics (new user, re-users *etc*.).
- Aspects of quality (Cleanliness, Staff friendliness, comfort of rooms, location)

The next essential component that ICT allows is semantic processing of words from reviews, but not only from reviews but from public portals, public profiles on social medias well. This important component enables managers to define the context in which guests usually mention the hotel, , as well as the keywords used in a positive or negative context.

Figure 5, on the left side, shows the table which sorts the keywords that guests most commonly use in their reviews. Software sorts them into two groups: 1) positive and 2) negative.

The groups are marked with plus and minus so that the manager can clearly see what are the keywords that lead to satisfaction or dissatisfaction.

With graphical display, on the other side of the figure, manager can perceive that currently prevails a positive or a negative trend. In the same figure, we can see that the words ''Hotel'' and ''Breakfast '' are the two most commonly mentioned words and that there is a positive context which prevails when they are mentioned. By simply clicking on any word, the software allows hoteliers to accurately see which user, at what time, on which IDS in particular, mentioned hotel in a positive or negative way. It allows hotel managers to thank for a comment or a suggestion to the guest directly.

In addition, the next component that we considered as important is the analysis of the competition. This kind of ICT solution allows tracking of main competitors, and gives an insights into trends of their comments and marks on IDS's.

Figure 7 shows the trend observed in 5 competing hotels and changes in their score and comments on IDS over time. In this way, the hotel manager can get a real-time benchmark analysis of its property and the competitors on IDSs. Thus, a hotel manager can determine strong and weak points following its own rating and the rating of its main competitors, and set up a simple SWOT analysis based on guest satisfaction.

5. CONCLUSION

Numerous studies have shown us how the Internet and ICT have changed the tourism industry. In 2014, the Internet became the most commonly used method of holiday organization. [15] One of the reasons why passengers have more confidence in the internet is the development of CGM (Consumer Generated Media). A strong part of CGM are guest reviews.

Although there are still authors who do not link the use of information and communication technologies and guest satisfaction, [16] the prevailing point of view is that ICT significantly affect the performance of the hotel, which clearly leads to a higher quality of services provided, and clearly to the satisfaction of guests and finally a large number of reservations and loyal guests. After all, a large number of managers in the leading hotels have supported this statement in their interviews, such as Sven Appelt, Best Western Plus Director who says that ''this significantly affects our internet bookings ''

Based on the results of the survey, it could be observed that the percentage of hotels in Serbia using ICT solutions in the satisfaction analysis remains extremely low. Even though a lot of managers around the world talks about the benefits from using this software, it remains to determine the reasons for such a low implementation of the software in Serbia, which will certainly be the subject of our further research, as well as the use of other ICT solutions in the field of hospitality.

In additions to the results of the research conducted herein, the authors have presented the benefits of using the software that helps hotel mangers to analyze the level of guest satisfaction. It is shown how it could be easy to monitor all marks and reviews as well as the semantic analysis of all public posts that mention a particular hotel, and finally the benchmark with competitive facilities and their ratings.

It also allows the hotel management to promptly and with high security determine specific weak points and make the right decision in order to live up to its customers' expectations.

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APENDIX
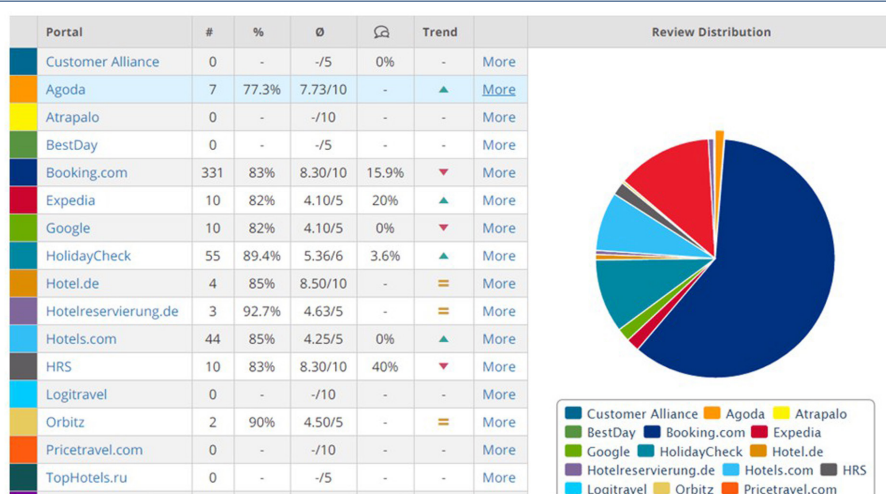
Figure 4. Customer Alliance Dashboard[3]

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3   Snapshot from https://go.customer-alliance.com/, January 2016
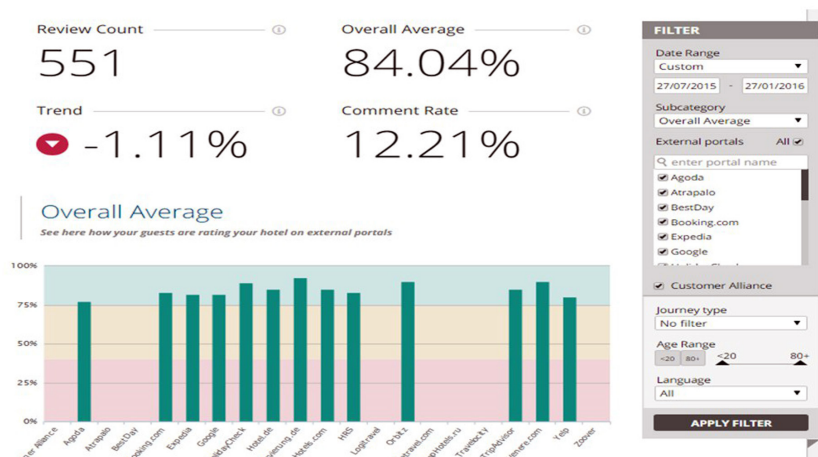
Figure 5. Customer Alliance Statistics[4]
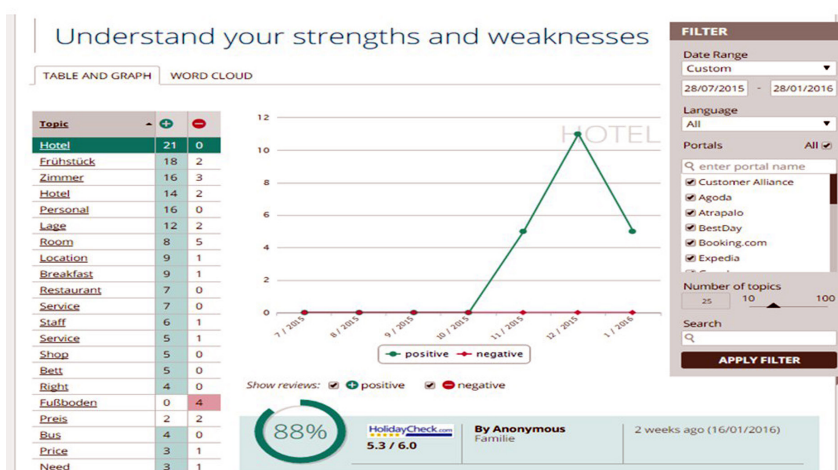
Figure 6. Customer Alliance Semantics[5]
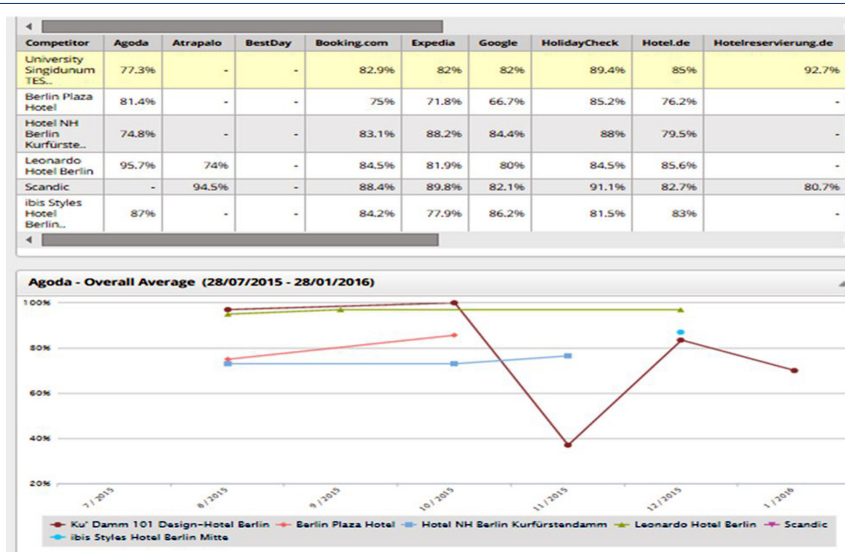
Figure 7. Customer Alliance Competition[6]

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4   *Ibid.*
5   Snapshot from https://go.customer-alliance.om/, January 2016
6   *Ibid.*

ICT IN PHYSICAL EDUCATION AND SPORT SCIENCE

NETWORKING BASE OF SPORTS FACILITIES IN THE ORDER OF THEIR PRESENTATION TO A WIDER AUDIENCE

Sretenka L. Dugalić

Singidunum University,
Faculty of Physical Education &
Management in Sport
32 Danijelova Street, Belgrade, Serbia

Abstract:

This paper seeks to examine and highlight the importance of modern electronic communication with the widest sports audience in order to speed up traffic and capacity utilization of the sports facility. The state, country, owners, professional managers, athletes, sponsors and visitors benefit from transparent high-quality and comprehensive network of sports facilities. The required information in this communication spectrum includes the capacity of sports facility, especially the field of play and content for visitors, diversity of programs it offers, spectacles that encourage interest of visitors, the quality and comfort of accommodation, security, location, history (tradition), design, decor, club colours and the like. Serbia does not have a single database of their valuable property in the system of sports. The Rule on the national categorization of sports facilities in 2013, and the Strategy of development of sport in the Republic of Serbia 2014-2018, provided the evidence established by the end of 2016. It could be useful for commercialization and practice to make it in electronic, standardized form. This would increase the chances of obtaining the championship, which would justify the mission to build sports facilities and their existence, and multiple maximizing the economic and other benefits.

Key words:

management of sports facilities, sport standardization, the categorization of sports facilities, electronic register of sports infrastructure.

1. INTRODUCTION

According to the Sports Act (2016, Article 145), sports facilities are arranged and equipped surfaces and facilities for the performance of sports activities. Sports facility, in addition to space intended for sports activities, may have content (sanitary, dressing, storage, stands, *etc.*), and installed equipment (construction and sports). The Rulebook on Precise Requirements to Performing Sport Activities and Sport Business (2013) assumes that sports organizations must have adequate space (facility). The space and facilities requirement (according Article 6) in which they organize competitions must fulfil the safety standards (Article 7). It has at least one visitors first-aid room (Article 8), and must allow visitors with disabilities to watch an event in the sport facility, in the same way as the rest of visitors (Article 9). The provisions of the Sports Act and the Rules have been transfused into a strategy (Strategy for Development of Sport in the Republic of Serbia for the period 2014-2018). It is estimated in part

Correspondence:

Sretenka l. Dugalić

e-mail:
sdugalic@singidunum.ac.rs

3.5., of the strategy (sports facilities) that many sports facilities, primarily because of inadequate management and maintenance in times of crisis, have very poor conditions. Therefore, there is a great need for revitalization of existing and constructing of new sports facilities. But the strategy provides an improvement of their capacities as well as building of new facilities. Action Plan for the Implementation of the Strategy of Development of Sports in the Republic of Serbia 2014-2018, defined two broad goals relating to the creation of conditions for systematic planning of the construction and renovation of sports facilities and financing, as well as work on building national training centers. Sports Act provides that on the basis of the analysis of the current situation, the Republic Institute for Sport performs the categorization of sports facilities in order to define priorities in the planning of reconstruction and construction of the sports facilities. According to the Rule Book on National Categorization of Sports Facilities (2013), the goal is standardization and quality management of content of facilities it has and offers to visitors. The deadline for registration and creation of a unique register of sports facilities is the end of 2016, but only 60% has been done (Danas Conference Center, 2015).

The facility management is a process that involves (Dugalić, 2007) 1 / planning construction and operation of the sports facility, 2 / finance the construction and ongoing operations, 3 / sports organization (training, competition) and business (maintenance, *etc.*), 4 / management of sports facilities, 5 / marketing management, and 6 / control operations (security, risk management, *etc.*). Therefore, the management of the sports facility includes: a strategic approach of facility, and business (serviscape), which is also called operations management of the sports facilities. It is important to understand the two root concepts – facility management and operations management in order to effectively understand sport facility operations management. Facility management is an all-encompassing term referring to the maintenance and care of commercial and non-profit buildings, including but not limited to sport facilities, including heating, ventilation, and air conditioning (HVAC); electrical; plumbing; sound and lighting systems; cleaning, grounds keeping, and housekeeping; security; and general operations. The goal of facility management is to organize and supervise the safe and secure maintenance and operation of the facility in a financially and environmentally sound manner. Schwarz, Hall, & Shibli, 2010, 3).

The management of sports facilities effects allotment scientific discipline of sports management in accordance with the requirements of a modern sports practice

(Parks, Zanger, & Quarterman, 1998, Fried, 2005; Mašić 2006). According to Farmer, Mulrooney & Ammon (1996), the management of the sports facility covers an issues: planning, construction, financing, maintenance, facility management operations and marketing. The emphasis is on the design of sports and entertainment complexes with the elements such as 1 / court, 2 / parking, 3 / position and orientation (toward to the latitude and major roads), 4 / sports facility capacity (measured by overall dimensions and by court in m2, m3, *etc.*), 5 / outdoor traffic flow (ramps and connection to public roads), 6 / internal traffic flow (horizontal and vertical movement of people and supplies - movement in the facility and between the level of the stands), 7 / VIP personality booths, 8 / sales area, 9 / toilets for visitors, 10 / marks that guide the visitors, 11 / security and safety (members of the public order, marshals, medical and emergency assistance, anti-fire protection, *etc.*), 12 / stands, 13 / space for players (measurement procedure, dressing room, media room..., with direct connection with a court), 14 / media space devoted to reporters, 15 / score and public adveretising screens, and 16 / space for administration, operations and maintenance (Dugalić, Krsteska, 2013). These elements must be included in the computer display offers of sports facilities. The infrastructure criteria is required by international sports associations, to achieve and maintain sport competitive advantage. Marketing is a good reason, because the integrity of the content and comfort increase the chances of obtaining the championship taking place in them. There are different sports legal frameworks and standards for infrastructure criteria in the world (Mašić *et al.*, 2011). There are also more sites in America that present a content of stadiums which are different in size and other. Below is an outline of their websites that present the network base of sports facilities in a transparent manner (Figure 1, 2, 3).

Figure 1. The World Stadium (www.worldstadiums.com)

Figure 2. The Americans stadiums by Munsey & Suppes, World Soccer Stadiums/Football Pitches, http://football.ballparks.com.
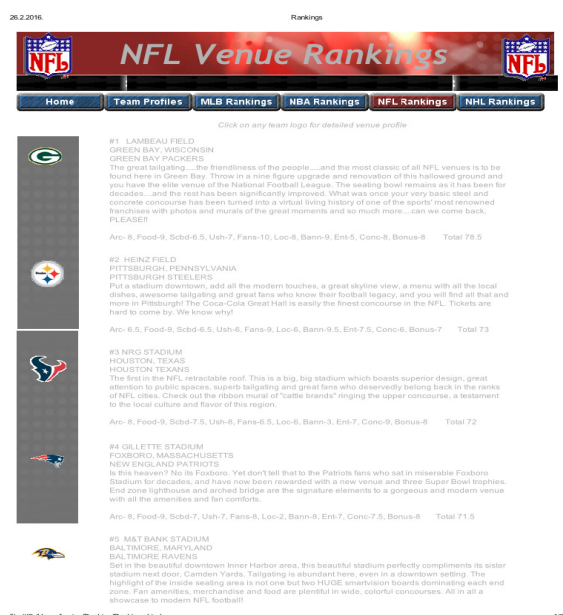
Figure 3. Categorization of American Stadium to the Kulyk, A., & Farrell, P. (2015).

For example, Union of European Football Associations (UEFA) has published a multilingual guide which sets down the requirements for stadium design and construction, so as to assist Europe's member associa-

tions in helping raise standards. It provides support to members by making a free cession type projects for the construction of the stadium (UEFA, Guide to Quality Stadiums, 2015), carried out categorization and record stadiums that meet the standards in a unique database (Fig. 4).

Figure 4. UEFA Guide to Quality Stadiums

2. INTERNATIONAL PRACTICE

According to the Schwarz, Hall, & Shibli (2010, 4), there are numerous associations that oversee the profession of facility management worldwide. These associations have further clarified the definition of facility management and also provide guidance and education for those who are employed in the field. The world's largest and most widely recognized international association for professional facility managers is the International Facility Management Association (IFMA). According to their website (www.ifma.org, Figure 5), they support more than 19,500 members in 60 countries through 125 chapters and 15 councils. They define facility management as 'a profession that encompasses multiple disci-

plines to ensure functionality of the built environment by integrating people, place, process and technology', and further clarify this definition as 'the practice or coordinating the physical workplace with the people, and work of the organization; integrates the principles of business administration, architecture, and the behavioral and engineering sciences'.
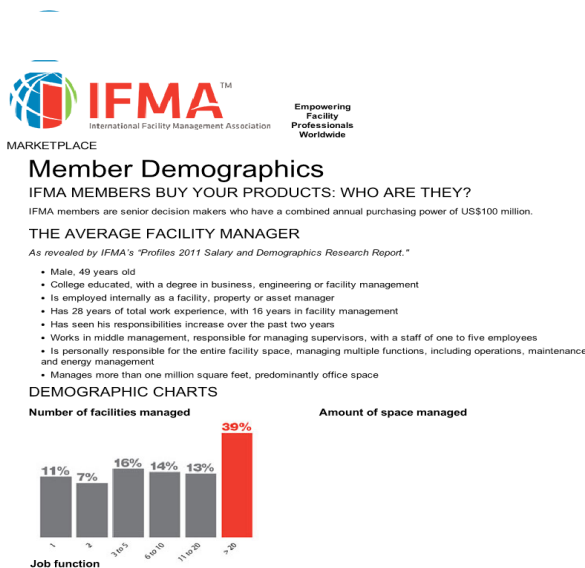
Figure 5. Demographic profile of sports facility manager (www.ifma.org)

Other organizations include the British Institute of Facilities Management (BIFM, www.bifm.org.uk), the Facility Management Association of Australia (FMA Australia, www.fma.com.au), and the International Association of Assembly Managers (IAAM, www.iaam.org). While facility management focuses on the overall maintenance and care of a building, operations management focuses on administrating the processes to produce and distribute the products and services offered through a facility. This would include the processes of production (tangible and intangible), inventory control, supply chain management, purchasing, logistics, scheduling, staffing, and general services – with the goal of maintaining, controlling, and improving organizational activities. The operations management field also has numerous associations that support the profession. The largest is the Association for Operations Management (APICS, www.apics.org), whose mission is to build knowledge and skills in operations management professionals to enhance and validate abilities and accelerate careers. Other organizations that support the profession of operations management globally include the Euro-

pean Operations Management Association (EurOMA, www.euroma-online.org/), the Production and Operations Management Society (POMS, www.poms.org), the Institute of Operations Management (www.iomnet.org.uk), *etc*.

3. SPORT FACILITIES IN SERBIA

National categorization of sports facilities requires establishing a criteria and standards for the categorization of sports facilities on the basis of the type of sports activity, technical characteristics of the sports facility and the level of competition for which meets the requirements (Sports Act, IV. Categorization in sports, article 139, paragraph 5). It shall be established on the basis of the Republic Institute of Sports that annually conducts the ranking, or categorizing for a period of 5 years (article 140).

According to the type of space in which to carry out sports facilities may be: 1) indoor sports facilities; 2) outdoor sports facilities. Sports facility is classified according to the predominant type of surface space if contents both, indoor or outdoor court. Indoor sports facilities are facilities that represent physical, functional, technical and technological unit with all installations, facilities and equipment intended to perform certain sports activities (halls, swimming pools, balloons, *etc*.). Outdoor sports facilities are specially designed areas dedicated to the performance of certain sporting activities (jogging trails, ski slopes, hiking trails and pedestrian paths, bike route, beaches, *etc*.).

Exceptionally, for the purpose of carrying out the training and implementation of competition and public road, river and lake are considered to be open sports grounds (outdoor), in accordance with the Sport Act (Article 146).

Sports facilities of national importance are facilities that have national and representative role in the development of sport and preservation of sport values. Status sports facility of national importance is acquired by an Act of the Government, at the proposal of the Ministry and after obtaining the opinion of the Serbian Olympic Committee, the Sports Association of Serbia and the Republic Institute of Sport (Article 147).

Management should be implemented and network of database structured at least in these facilities. The Article 148 stipulates that such a sports facility may revoke

the status of the object of national importance if it is: not used to carry out sports activities and sports business, and the realization of the goals of sports, not held in a manner that allows the appropriate level of performance of these activities and operations, and does not ensure safe use. The Government regulates the conditions, criteria and manner of acquisition, or withdrawal of sports facility categorized by state.

Unfortunately, there are numerous contradictions in domestic sport practice. Database of sports facilities have been made by several business entities (cities, associations and for-profit organizations create their own database). So, databases are incomplete, inaccurate, non-transparent, and thus not correspond to the demands of modern sport. There is no unique database of the most valuable state properties and equipment. It is not certain to become the categorization of sports facilities is completed on time.

Some of the websites that published partial data are presented in Figures 6, 7 and 8.

Figure 6. Sports facilities, Belgrade,
www.011info.com/sportski-objekti.

The website of the Association Sports Centers of Serbia registered 36 sports centers (www.ascs.co.rs). These data can be downloaded from the website Sports facilities, halls and gyms - Serbia, My City (http://www. mojgrad.rs/Sport-i-rekreacija/Sportski-tereni-hale-i-dvorane), as shown Figure 7.
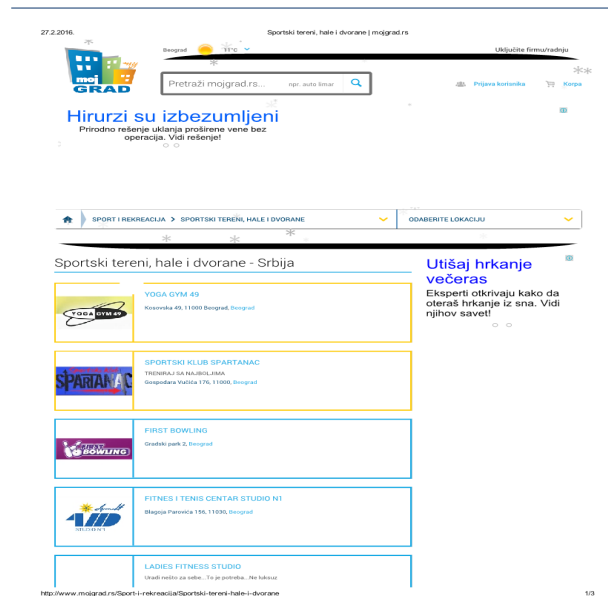
Figure 7. Sports court, halls and indoors – Serbia, My City, www.mojgrad.rs/Sport-i-rekreacija/Sportski-tereni-hale-i-dvorane.
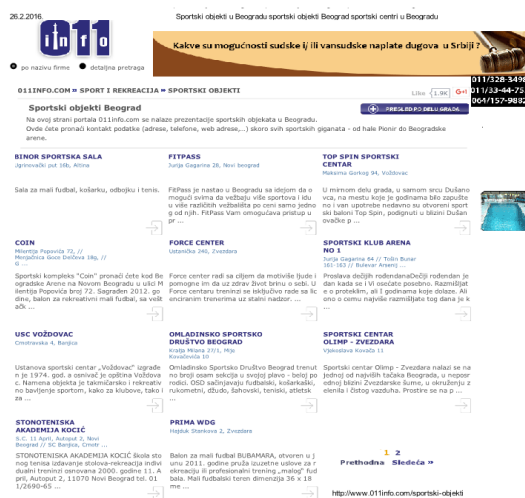
Figure 8. Belgrade City, Sport & Recreation.

CONCLUSION

According to Article 152 of the Sports Act, the owner or users of sports facility are required to: 1) to be used in accordance with the rules and purpose of the facility, including the provision of the using certificate; 2) to maintain it in good condition and ensure proper sanitary and hygienic conditions; 3) doing action that allow, prevent or reduce the risk of damage to users (and others), and affect the increased risks too. Construction, reconstruction and maintenance of the sports facilities must be in compliance with the acts of the country, as well as relevant international and national sports associations'

rules. This means that business in sports facility must be standardized according to the latest scientific achievements in the management and internet technology. The recording of these valuable state assets must also be according to the stated goals, strategy and action plan in the country.

The paper presents the experience of developed countries in managing the network database of sports facilities. Serbia needs a similar registry by a professional computer network, to achieve greater exposure, image and sales of naming rights. Through the web site, international associations provide legislative, technical, engineering and consulting support to its members. These organizations perform licensing, training for facilities management, and publish a list of jobs. Serbian practice seems poor in compared to the foreign experience. So, it is recommended make a database of sports facilities in electronic format via unique network, in accordance with the latest achievements of modern sports practice.

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ICT IN PHYSICAL EDUCATION AND SPORT SCIENCE

APPLIED INFORMATION AND COMMUNICATION TECHNOLOGY IN THE ANTI-DOPING AGENCY OF SERBIA – VIEW OF THE SYSTEM ADMINISTRATOR

Miloš Cvjetičanin,

Bojan Vajagić,

Milica Vukašinović Vesić,

Marija Anđelković,

Nenad Dikić,

Anti-Doping Agency of Serbia,
Belgrade, Serbia

Abstract:

Anti-Doping Agency of Serbia represents a rare case among governmental institutions considering that statutory job positions include the system administrator. This position is conditioned by the need for performing the following tasks: Design and maintenance of website (mainly for education of athletes, news, *etc.*), Online education via Moodle platform, Use Facebook for education and communication, Use YouTube and Google books for additional education and communication., Developing android application, Pre-press of all educational material and books. Since one of the main tasks of ADAS is education, applied information and communication technology is very important. Education is recognized as the key reason for reduction of the number of doping positive cases in Serbia during ten years of ADAS existence.

Key words:

web site, android application, online education,
facebook, information technologies in sport.

1. INTRODUCTION

Anti-doping Agency of Serbia (ADAS) was established by the Law on the prevention of doping in sport in 2005, and started with its activities in 2006.

Doping Control Officers of ADAS are trained to perform doping controls at national and international competitions. Overall, during the period from 2005 to 2015, 5,947 doping controls have been performed. Among them are 62 doping positive cases, plus 3 other doping rule violations.

ADAS has four licensed doping control officers in the Union of European Football Associations (UEFA), two licensed doping control officers in the International Federation of Mountaineering and Climbing (UIAA), two supervising doctors in International Basketball Federation (FIBA) and one Doping Control Delegate of European Athletics (EA).

A very important event in the battle against doping in Serbia is the adoption of the Law on Ratification of the International Convention against doping in sport in May 2009 and adoption of new Law against doping in sport in October 2014. By those adoptions, the Republic of Serbia has fulfilled its international obligations in fight against doping in sport and entered the category of countries that legally accept the World Anti-Doping Code. Without legal background, Serbia could be excluded from participating in major international sport events.

Correspondence:

Nenad Dikić

e-mail:

nenad.dikic@adas.org.rs

International recognition of work of ADAS is evident in the cooperation with the World Antidoping Agency in the international project "Doctors and doping in sport: experience of 8 countries of the Balkan region", cooperation with FIBA in 4 international projects, as well as cooperation with UNESCO on the project of Anti-Doping education.

Significant and educational work of ADAS, which includes holding regular annual seminars on the fight against doping in sport, lecturing activity, as well as the publishing of books and publications. In 2015, ADAS started organizing the Congress of antidoping prevention in sport.

ADAS operates as an institution, in accordance with the regulations on public services. Anti-Doping Agency of Serbia represents a rare governmental institution considering that statutory job positions include the system administrator. This position is conditioned by the need for performing the following tasks:

- Design and maintenance of website (mainly for education of athletes, news, *etc.*)
- Online education via Moodle platform
- Use Facebook for education and communication
- Use YouTube and Google books for additional education and communication.
- Developing android application
- Pre-press of all educational material including books.

2. DESIGN AND MAINTENANCE OF WEB SITE

ADAS communicates primarily with athletes and sports federations, as well as with sport workers, sport scientists, journalists and public in general. Website [1] is a basic tool for these communications. In addition, a legal obligation of ADAS, as a governmental institution, is publishing information about public procurement, as well as publishing Information Bulletin on the website.

ADAS web site went through four radically different design solutions since it was first set up in 2006. At first, site offered some basic info about ADAS as well as regular news. It was bilingual from start. Static HTML was sufficient web platform for such tasks.

By time, as ADAS engagements widened, site complexity increased as well. We added a downloads section, where various documents and fill-in forms could be downloaded. Every major design iteration brought new contents and recomposition of site sections. News arti-

cles, which were regularly illustrated with photographs, very soon became impractical to manage using regular HTML pages, so we included PHP scripts coupled with MySQL database.

After 3 years of existence, the Internet site was composed of well organized sections, for example: "Services" – detailed overview of services we offer, "For athletes" – support for athletes, "Education" – beginning of our online education efforts, "Popular links" – links to sites of various relevant organizations, "News", "Download" – legal documents and many other important documents, *etc*. This version of site also introduced regularly uploaded press clipping and later on we addedd video clipping and international news related to anti-doping struggle. Another important addition was "Doping Free" service – a way to check whether a supplement has our "Doping Free" sticker – which indicates that particular batch was tested by WADA-accredited laboratory and found to be free of certain doping substances. This site design incorporated detailed pixel graphics and artistically filtered header images, as well as Adobe Flash animated elements.

The next major redesign came in 2013, when we rebuilt site from scratch using WordPress content management system. Among other things, we added a mailing list in order to keep anyone interested informed on the subject of anti-doping, we introduced two very popular services - request for an opinion on dietary supplement / medical drug.

The site consists of the following units:

- Doping Control (Education on doping control procedure, list of doping control officers, prohibited list, *etc*.)
- TUE (Education in connection with the exemption for therapeutic use, request for an opinion on a medicinal product, *etc*.)
- Supplements (Education regarding the use of dietary supplements and the risks they carry, the request for an opinion on the supplement, *etc*.)
- ADAMS (Information regarding ADAMS system and the Registered Testing Pool)
- Education (This segment of the site contains most of educational texts and video recordings of various lectures we held to athletes, including a link to download android app)
- Information (Various information about ADAS, reports on the work of ADAS, download documents, records doping rule violation, important links, *etc*.)

Our site received about 97,000 visits and more than 163,000 pageviews since september 2008, which is when we started gathering statistical data. During this period, traffic has increased exponentially. So, over the last 12 months, the site has received about 3.000 or half of all visits of which about 6% came from Facebook.

Our recently published news article, has more than 1,800 pageviews [2]. The page "Basic Anti-Doping education", received about 7,000 pageviews [3]. Supplementation advice request page has about 5,000 pageviews.

3. ONLINE EDUCATION VIA MOODLE PLATFORM

Moodle is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments. Everybody can download the software onto his own web server or ask assistance from knowledgeable Moodle Partners.

With customizable management features, it is used to create private websites with online courses for educators and trainers to achieve learning goals. Moodle (acronym for modularobject-oriented dynamic learning environment) allows forextending and tailoring learning environments using community-sourced plugins. [4]

Athletes who receive a scholarship from the Ministry of Youth and Sports are obliged to receive annual anti-doping education. Such education os conducted mainly at our congresses/seminaries, but as large numbers of athletes are often unable to attend these lectures due to scheduled trainings and competitions, we use online course platform to educate these athletes. Our online courses are powered by open-source learning platform Moodle [5]. More than 3,000 athletes went through our Moodle courses so far.

Using Facebook for education and communication

Due to enormous popularity of social networks, we have decided to engage in this form of communication with athletes and other interested parties in order to spread our education more effectively.

By far the most popular social networking service has been Facebook, so we are therefore using that particular social networking service for communication – mostly with athletes and athletic federations. We also use our presence on Facebook to educate athletes about dietary supplementation, risks related to doping substances, and

other relevant issues. Our Facebook page [6] has about 700 likes. Related Facebook page of Sports Medicine Association of Serbia [7] has about 500. Previously mentioned news article about Meldonium had reached more than 3,000 people on Facebook.

Using Youtube for education

All our educational videos are hosted on YouTube [8]. Furthermore on, we also use YouTube for our video clipping. Our recently uploaded educational film "Doping control procedure" [9] has reached about 60,000 views. We have a total of 200 YouTube hosted videos.

Using Google Books for education

Google Books is free online service, which enables publishers to publish their books online. The Publisher is offered to specify a price for each electronic book as well as portion of available (freely visible) contents of each book. Publications hosted at Google Books are readily searchable by Google search engine, which makes Google Books the effective means of offering educational material to general public.

Anti-Doping agency of Serbia and Sports Medicine Association of Serbia have put all of the books they published on the Google Books service, free of charge and the whole text is visible online. Also, most of the lectures we gave on various seminaries are hosted at Google Books. All in all, there are about 90 titles [10]. Among most popular titles are: "Prakticna sportska ishrana" – more than 22,000 visits, "Prirucnik za klupske lekare" – about 17,000 visits, "Sportskomedicinski pregled" – about 12,000 visits…

Android application development

In the spirit of continuous education of athletes, it was natural for us to expand our educational activities to the next logical platform aimed at athletes – smartphones.

Athletes already regularly use smartphones to access their ADAMS account in order to be able to edit their whereabouts information wherever they are. Athletes are obliged to keep updated information on their physical location on ADAMS system and they often find it difficult to access regular computer at the moment they learn that their whereabouts need to change. Being used to smartphone app usage, athletes can easily start using our application as well.

We decided to use Android platform, in particular because of its ubiquity. Currently, most widely used Android version is KitKat (Android 4.4) – 34.3% of market [11]. Older versions, specially versions older than Gingerbread (Android 2.3.3 -2.6% of market) are not very frequent. However, in order to make our application available to every athlete who is using Android (even versions older than Gingerbread) smartphone, we designed app to work on Froyo (Android 2.2) and all newer versions.

We named the application "ADAS for athletes" and designed it for practical and easy use by athletes on the go [12]. Since the app is still new, the number of users is still insignificant and statistical data is not yet available. Our application offers the following options:

- Prohibited list: our app offers searchable Prohibited list (The list of prohibited doping substances) so that the athlete can quickly check whether some active ingredient present in medication/dietary supplement he/she uses is considered doping.
- Therapeutic use exemption: this option offers the detailed text on the subject of Therapeutic Use Exemption (TUE).
- Supplement/medication advice request form: this will probably be the most popular option as it offers searchable list of issued advices on various drugs and dietary supplements; description of this process: athletes submit the name of supplement, to which we respond by giving our advice about that particular supplement (whether it contains doping substance), and that advice is automatically added to the searchable list of advice available in this application option.
- ADAMS: this option represents a sort of active shortcut; the application checks whether device has ADAMS application installed (ADAMS is a comprehensive database maintained by World Anti-Doping agency which athletes use to fill in data about their whereabouts so they can continually be available for antidoping control), and in case it does, application is launched; in case ADAMS app is not present on the system, the option to install is presented to the user, and if the user doesn't want to install ADAMS app, the simple web browser opens and presents user with ADAMS web site.
- NEWS: application shows new posts from our web site in the simple manner.

We plan to continue application development, making it even more practical and usable for athletes, and implementing any new athlete-oriented project, specially educative projects into it.

4. PRE-PRESS OF EDUCATIONAL MATERIAL

Besides previously mentioned electronic means of education, we are extensively engaged in compiling books and other printed educational material. Books we have published so far cover a wide range of topics including sports medicine, ethical considerations of sport and doping, nutrition, *etc.*

Every congress we organized/co-organized was accompanied by book of abstracts and other printed material. All events (workshops, seminaries, lecturing sessions, press conferences, congresses, *etc.*) require educational material combined with branding, leading to our distinctive visual identity presented on banners, posters, fliers. Our slogan "Be healthy, play fair!" was a light motive for several banners, posters and fliers, and it contributed to our success in communicating important messages not only to athletes but to sport federations and team doctors as well.

We have been publishing annually a pocket sized prospect "A pocket guide on doping" since 2008. It presents the most important points to athletes, a list of doping substances, doping control procedure, list of few most important internet sites, *etc.* These pocket guides can also be downloaded in PDF format on our website [13].

The main tool used for pre-press is Adobe InDesign, along with Adobe Photoshop.

5. CONCLUSION

Since one of the main tasks of ADAS is education, applied information and communication technology is very important. Education is recognized as the key reason for reduction of the number of doping positive cases in Serbia during ten years of work of ADAS.

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THE IMPORTANCE OF RESPONSIVE WEB DESIGN FOR EDUCATION OF STUDENTS USING THE FACULTY WEBSITE

Pavle Dakić[1],
Stefan Kocić[2],
Dušanka Paspalj[3]

[1]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

[2]Union University Belgrade,
Banking Academy - Faculty for Banking,
Insurance and Finance,
Belgrade, Serbia

[3] University Business Academy
in Novi Sad
Faculty of Applied Management,
Economics and Finance,
Nemanjina 4, Belgrade, Serbia

Correspondence: Pavle Dakić
e-mail: pavledakic@yahoo.com

Abstract:

Modern technologies are part of student's everyday life. Utilization by students is rapidly moving from a desktop or laptop to other various sizes and device specifications. This trend is causing educational institutions to consider how to provide pleasant experience for the student who views the faculty website on different devices. For the purpose of implementation of responsive web design, we have utilized an open source Bootstrap library, jQuery UI and our own implementation of libraries for displaying website on different screen sizes and devices. This paper will present a process of optimization of the website of Belgrade Business School for supporting mobile environment, which includes a review of the current state of the website and implementation of responsive web design.

Key words:

responsive design, technology adoption, optimizing educational technology, instructional technologies, teaching and learning.

ORGANIZATIONAL FACTORS, ORGANIZATIONAL CULTURE, JOB SATISFACTION AND ENTREPRENEURIAL ORIENTATION IN PUBLIC ADMINISTRATION

Konstantinos M. Karyotakis[1],
Vassilis S. Moustakis[2]

[1]Technical University of Crete
Management Systems Laboratory
(ManLab)
[2]School of Production Engineering and
Management
Chania 73100, Greece

Correspondence: Konstantinos Karyotakis
e-mail: karyotakisk@gmail.com

Abstract:

The present paper outlines the critical role and influence of organizational culture and job satisfaction on the relationship between organizational factors and entrepreneurial orientation (EO) in the public sector through generating the theoretical framework. Upon examining these terms, a model that reflects their mutual relationships has been suggested. The amalgam of internal work environment, work discretion and rewards/recognition in combination with the appropriate degree of organizational boundaries, such as formalization, centralization, technology routines and connectedness, are crucial for fostering organizational culture and job satisfaction that lead to EO through innovativeness, proactiveness and risk taking.

Key words:

organizational culture, learning organization, job satisfaction, entrepreneurial orientation (EO), public sector.

EXAMPLES OF MULTIPROCESSOR INTERCONNECTION NETWORKS RELATED TO SOME GRAPH TYPES AND OPERATIONS

Irena M. Jovanović[1],

Dragoš Cvetković[2],

Tatjana Davidović[2]

[1]Union University, School of Computing, Belgrade, Serbia

[2]Mathematical Institute SANU, Belgrade, Serbia

Abstract:

A multiprocessor system can be modeled by a graph G. The vertices of G correspond to processors while edges represent the links between processors. To find suitable models for multiprocessor interconnection networks (MINs for short), one can apply tools and techniques of spectral graph theory.

Let G be a simple graph on n vertices with the adjacency matrix A and its largest eigenvalue λ_1. Let D be the diameter of G, Δ the maximum vertex degree and m the number of distinct eigenvalues of G. In the recent literature the following types of tightness for G are defined: *the first type mixed tightness: $t_1(G)=m\Delta$; the structural tightness: $stt(G)=(D+1)\Delta$; the spectral tightness: $spt(G)=m\lambda_1$; the second type mixed tightness: $t_2(G)=(D+1)\lambda_1$.*

Among other things, it has been proved that the number of graphs with a bounded tightness of any type is finite, and also that graphs with the small value of the second type mixed tightness appear to be suitable for designing MINs.

Therefore, this paper shall elaborate on some of the existing results. We present several graphs that could serve as models for efficient MINs based on the small values of introduced tightness. These examples of possible MINs arise as a result of some well-known and widely used graph operations like join, corona, and NEPS. We also examine the suitability of strongly regular graphs (SRGs for short) to model MINs. In SRGs, all four types of tightness are mutually equal. One of SRGs, called the Petersen graph, has already been considered as MIN in the literature. Here, we prove the uniqueness of some SRGs and suggest them as suitable MINs.

Key words:

multiprocessor systems, interconnection topologies, load balancing, spectra of graphs, graph invariants.

Correspondence: Irena Jovanović

e-mail: irenaire@gmail.com

ABSTRACT PREVIEW

LEVERAGING PROCESS DATA FROM BPM CLOUD-BASED WORKFLOWS

Deasún Ó Conchúir[1],
Lazar Dražeta[2]

[1]Scatterwork Gmbh,
CH-8593 Kesswil
[2]Singidunum University,
32 Danijelova Street, Belgrade, Serbia

Abstract:

Knowledge workers are used to working alone, based on their own competencies. In today's global economy, it is a luxury to keep the work status invisible except at reporting milestones. By sharing the status information, the work capacity, speed and quality of manufacturing and administrative processes can be optimised.

This paper shares the experience of a virtual team of knowledge workers across 12 time zones which coordinates its repetitive production work using cloud-based workflows. A sample of process data and the utility which can be obtained from it is discussed, as well as some recommendations for the management of virtual teams using cloud workflows.

In addition, possible research directions for future work relating to virtual knowledge work teams using cloud workflows are suggested. Some references to related experience for further reading are also given.

Key words:

work, workflow, time, process, cloud-based.

Correspondence: Lazar Dražeta
e-mail: ldrazeta@singidunum.ac.rs

AUTHORS INDEX