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INNOVATION OF THE KNOWLEDGE ABOUT STANDARDIZED COMPUTER NETWORKS AND COMMUNICATIONS

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Abstract:
In this paper, the part of multicriteria analysis of road knowledge innovation in ICT subfields are segregated and grouped according to the international classification standards (ICS). Correlations between innovation and standardization of communications, local area networks (ICS-2 = 35.110), the global communications and the internet (ICS-2 = 35.100) are presented.
Presentation of research innovation sources of knowledge are based on the result of years of study. Results from the overall population of creativity with over 72.340 standardized knowledge sources (ISO standards and SRPS) are segregated for these standardized subfields. Clustering, PDCA methodology (Plan-Do-Check-Act) and other research methods are applied. The focus is on the subfields of the highest intensity of innovation. There are original results: trend analysis, original dimensions, quantity indices, indices of setting values, indices of innovation knowledge resources, etc. The results indicate a correlation of standardization and innovation in the time dimension of the concept of PDCA.

Key words:
computer network,
ICT,
improving of learning,
knowledge-based innovation,
PDCA.

INTRODUCTION

The needs for innovation of individual and team skills are diversed, especially in the ICT networks. Roads of knowledge lead from knowledge resources through innovations in the standardization of the collective knowledge base. Searching of innovations of examples of in the global ISO/IEC and local SRPS platform (standards in Serbia), is adapted with the needs of education by using PDCA methodology. Many years of research and monitoring trends of development and standardization of ICT enable the representation of their specificity correlated with innovation.

ISO/IEC - SRPS platforms are compared using by statistical sampling and multi-criteria analysis. Analysis by subfields are presented according to the International Classification of Standards (ICS) in ICT, global communications and ISO/OSI model Internet (ICS-2 = 35.100) and local area networks (ICS-2 = 35.110), with a comparison with related sub/box fields international studies with the aspect of [1], [2], and local standardization point of [3]. In this paper, some studies/ research are shown, and segment statistical analysis of trends SRPS and ISO standardization by the specified subfields ICT are separated comparatively.

As part of long-term research and monitoring of standardization, significant details (the results) are presented in the paper: a comparison of trends of knowledge, the analyzed subfields, directions for further development of new units of knowledge through new projects, as well as possibilities of comparison with the ISO standardization mere local (national) level in the same in all other fields of creativity (for ICS = 01 to 99).

Initial hypotheses and objectives of the work leading to the innovation of the knowledge base, through the implementation of activities in the PDCA quality spiral.

Plan-hypothesis

Predictions of future resources, activities, financial need for units valued knowledge and responsibilities in the subfields of ICT innovations are possible. It is possible responses on the question of who will plan and which resources to research "layers" of standardized collective knowledge of computer networks and communications, taking into account trends in innovation ISO/IEC and SRPS database as a source of knowledge.

Do- hypothesis

Research and evaluation of knowledge units provide creation of explicit mathematical relation as regression lines of trend knowledge. It is possible to response on the questions about the scope of adaptive learning and how

much are the differences between global (ISO) and local (SRPS) trends innovation platform standardization.

Check- hypothesis

It is possible to determine the clear correlation of obligation and knowledge with the intensity of innovation valued innovated unit of knowledge on relations ISO - SRPS. It is possible to specify the innovation index based on the actual amount of new projects in ICT and comparison with all standardized fields. It si possible to response on the question: how frequently to update the knowledge base (KB), check, test - with timely analysis, internal and external assessments (audit) etc.

Act- hypothesis

It is possible to define the relations between the continuous and discontinuous innovation knowledge in ICT. It is possible to accomplish final aims improving of teamwork and innovating of industrial products on the platform SRPS and ISO standardization. It is possible to response on the question: how?

Standardized fields are researched, subfields of telecommunications and knowledge unit into two subfields within IT in education services and examples of adaptive learning to the overall collective knowledge, in the way of quality products. Basis KB thematic subfields standardized ISO - SRPS documents as binding on 164 ISO member countries. The research focus is on subfields with highly valued skills in ICT network, by defining the intensity of innovation. It will be best to create a knowledge base, group and update the development field of standardization, the above subfields and units, and the technical committees and subcommittees (JTC 1/SC 6, JTC 1/SC 25, JTC 1/SC 38, etc. [2]).

METHODOLOGY AND RESEARCH FRAMEWORK

Applied PDCA methodology is standardized (ISO/IEC 20000-1, 2005), but the all relevant standards are not mentioned in this paper. As presented in previous papers ([4], [5], in the XXI century), the key belonging to some of the elements of modeling excellence in PDCA spiral can easily determine the quality of research:

- (Plan) of planning resources, the process of acquiring knowledge through services and other products,
- (Do) through implementation and defined the index of quantity, value, innovation intensity sources of knowledge as elements of the *knowledge base* (KB) in ICT,
- (Check) the accompanying checks innovation, defining the innovation index, to a *knowledge base system* (KBS),
- (Act) with the aim of excellent products based on the standardization of ICT, such as adaptive learning [6] in a spiral PDCA quality, for improvement results.

Statistical research methodologies are applied, web browsing, with deductive - inductive inference methods for improving the adaptive learning, as well as numerous other methods: analysis - synthesis, abstraction - concretization, generalization - specialization, classification - description, sampling methods, modeling, etc.

Statistical analyzes are performed on samples of relevant ISO and SRPS documents in the fields and subfields to ICS, ICS-1, ICS-2, ICS-3 (for example, ICS-1 = 35, ICS-2 = 35.110, ICS-3 = 35.100.70, [1, 2, 3]). For the research, analyze of the results, systematization and presentation of the results the own Java softwarewe is used [7].

The methodology of PDCA clustering enables more practical checks to complement the theoretical results of application software [8]. Frame standardized methodology PDCA concept and standards (ISO/IEC 20000-1:2005) has been applied. Clustering methods for these subfields of research complement PDCA methodology. Originality comes from the real needs of monitoring innovation (yearly, monthly, weekly or daily) at a certain time.

A multi-criteria analysis to planning resources

Statistical and multi-criteria analyzes are performed on samples of SRPS and ISO frame of research. In these subfields of ICT, the results have been updated each calendar year of the XXI century. The samples are separated from the population $Iqs_{/1\text{-}99/ISO} > 41.141$ and $Iqs_{/1\text{-}99/SRPS} > 31.199$. Indices quantities $\mathbf{Iq}_{/ICS/ISO\pm SRPS/year}$ and indices values $\mathbf{Iv}_{/year}$ provide further numerous comparisons, analysis and reasoning towards improvement. **Iqs** - sampled documents (samples), of which the **Iqp** - number of current published standards, **Iqw** - withdrawn from use, **Iqu** - in various stages of development (under development, new projects - NP) and **Iqd** - projects deleted (deleted NP in the past 12 months). In general, the amount of indexes defined relations to equation (1).

$$Iqs = Iqp + Iqw + Iqd + Iqu \quad (1)$$

Web applications to trend line innovation

The survey can be repeated every day, but with the help of software applications. The aforementioned Java application (or Web application) enables efficient statistical analysis. The results are represented by indexes corresponding amount of standards ISO and SRPS. Indicators allow comparisons in cases of classified fields of creativity, the ICS-1 = 01 to 99, for all subfields second level of classification ICS-2 (for each ICS-1), and the third level of the standardized classification or ICS-3. By using this software, all of the search and the original data is On-line. Featured relevant results (sections at least once each calendar year), are analyzed and join PDCA spiral. Value indices (Iv) monitor the quantity index (Iq) for a summary of the results and the trends (ISO and SRPS):

a) including temporal aspects for the entire study period - the age of publications, $\sum Iv_{/year}$ (for example, 1994–2011, the ISO, ICS-1 = 33, figure 1, and

b) trend lines (Exponential, Linear, Logarithmic and Polynomial), according to data from previous years and formed the regression equations $y_{ICS/SRPS}$, $Iv_{/year}$ (for example, with the trend of planning needs $y_{/35/ISO/2000-2010} = -186.7\,x + 2014$, created 01-01-2011, and for 2012, by function (2) the most intense innovation (01-01-2012), from all fields of creativity - as figure 4 and the function (1.2) in [4].

$$y_{/35/\,ISO/2005-2011} = 2687\,x + 14815 \qquad (2)$$

Check-stage to check the intensity of innovation

Based on PDCA and values defined index range of development projects (Iqu) and index range of innovation (Iqi phase Do), index (or "level") of innovation is determined by the temporal dimension (Ity or $It_{/year}$). Period of test (Audit-Check) innovation in certain fields or subfields is just dependent on the time index of innovation Ity. This index measures the groups or classes/clusters of innovation and is assigned a value of periodic check (Check) research to practice. Iti = 0, 1, 2, 3 or 4; 1 - year 2 - monthly 3 - weekly or 4 - daily (0 - "zero" innovation). This is achieved by defining the index ranking (Iti = 1, 2, 3 and 5) as the criteria for grouping the corresponding subfields and/or fields of creativity in the appropriate (teaching) group [8].

Methodologically, simplify the expression for KB in the time dimension of innovation approximate equality (3).

$$KBti \approx Iqu + Iqi_{/year} \qquad (3)$$

Innovated system knowledge base to model excellence

In particular, the end-users of ICT products are important, but they are "outside" the 12 elements of the model (Fig. 9 in [4]). At this level, ISO and SPRS platforms, such as sources of knowledge, on which further enhance the KB system and network resources, environmental quality end products in the paper. Completed the importance of at least 12 elements of the excellence, Quality Management (QM, Figure 9 in [4]).

$$Model \approx ICS \,\&\, \Sigma\,(PiDiCiAi \,\&\, KBti) \times QM12 \qquad (4)$$

RESULTS

Results of the analysis of standardization knowledge in ISO/IEC documents and SRPS standards represent the comparative indices and charts. Analysis of the international ISO aspects are separated by subfields ICT [1], [2], and the aspect of local SRPS standardization [3]: *global communications and internet* (ICS-2 = 35.100), with $Iqs_{/35.100/ISO} \geq 1235$ and $Iqs_{/35.100/SRPS} \geq 222$ samples and local *area network* (ICS-2 = 35.110), with $Iqs_{/35.110/ISO} \geq 127$ and $Iqs_{/35.110/SRPS} \geq 84$ samples.

The highest level of innovation in the IT (ICS-1 = 35)

In this paper, the previews of three-year study at the beginning of the second decade of XXI century are separated, with highlights of the day 01-01-2014, Table 1.

Table 1. Comparative analysis of knowledge pathways ISO/IEC–SRPS (for ICS-1 = 35, 2011/2012/2013)

ICS-1 =35	Samples (Iqs)		Published (Iqp)		Year (Iqi)		(CHF) $Iv_{/year}$	
Year	*ISO*	*SRPS*	*ISO*	*SRPS*	*ISO*	*SRPS*	*ISO*	*SRPS*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
2011	5853	895	2975	782	337	314	38066	7745
2012	6174	1211	3118	1057	307	342	33952	11898
2013	6445	1463	3273	1308	251	261	29094	9679

The results are graphically represented collectively through standardization trends:

a) including temporal aspects for the entire research period - by year of publications, $\Sigma Iv_{/year}$ (eg, 1973 to 2014, the ISO, ICS-1 = 35, Fig. 1, and

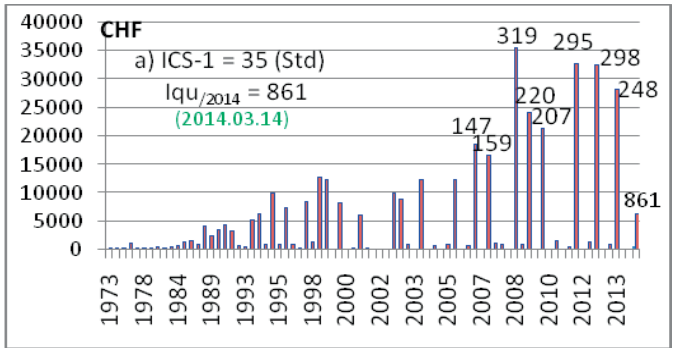


Fig. 1. Analyses of IT – the ICS-1 = 35 (14-03-2014 – ISO)

b) trend lines (Exponential, Linear, Logarithmic and Polynomial), according to data from all of the previous seven years and formed regression relations $y_{ICS/SRPS}$, $Ivi_{/year}$. For example, the trend of planning needs $y_{/35/SRPS/2014} \approx 30000$ CHF to in 2014. year, according to a growing trend of innovation (5.1), as well as to other functions in Fig. 2 (01-2014).

$$y_{/35/\,ISO/\,2007-2013} = -4923\,\ln(x) + 21254 \qquad (5.1)$$

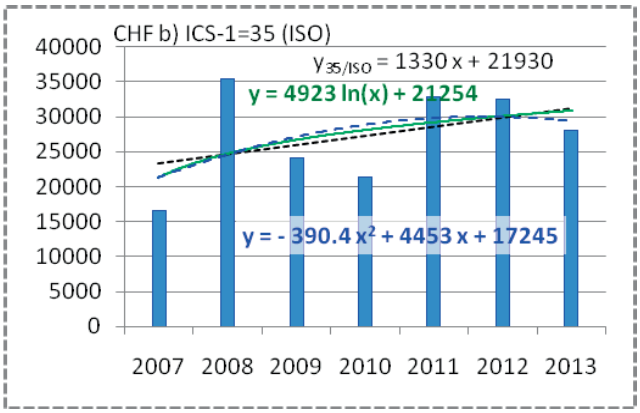


Fig. 2. Analyses of trends for ICS-1 = 33 (01-2012 – ISO)

The results of comparative analysis of innovation in the field of ICS-1 = 35 (on SRPS platforms) are available:

a) including the summary analysis to the obligations SRPS standards, for the period 1981 up to 2014,
b) the trend of the planning needs of $y_{/35/SRPS/2014} \approx$ 12000 CHF to in year 2014, according to the functions of a growing trend of innovation (5.2) and (5.3) [11]:

$$y_{/35/SRPS/2007\text{-}2013} = 5458 \ln(x) - 3055 \quad (5.2)$$
$$y_{/35/SRPS/2007\text{-}2013} = 1929 x - 1681 \quad (5.3)$$

Subfields of the ISO/OSI model (ICS-2 = 35.100)

Samples on a global platform ISO standardization has not changed much in the years of the XXI century in subfields (ICS-2 = 35.100). For example, at the beginning of the second decade of XXI century ($Iqs_{/35.100/ISO/2010} = 1195$ sources), a statistical sample consisted of: $Iqp_{/35.100/ISO/2010} = 413$ published, $Iqu_{/35.100/ISO/2010} = 65$ under development, $Iqw_{/35.100/ISO/2010} = 708$ out of service and $Iqd_{/35.100/ISO/2010} = 9$ deleted projects. In relation to this »reference design – 01-01-2011« less the overall index: publications, projects under development, the lower the index value of the subfields lower level and entirely (Iqp, Iqu, Iv, ΣIv). The data provide a comparative analysis of several aspects: temporal, geographic location, quantitative, qualitative and innovative etc.

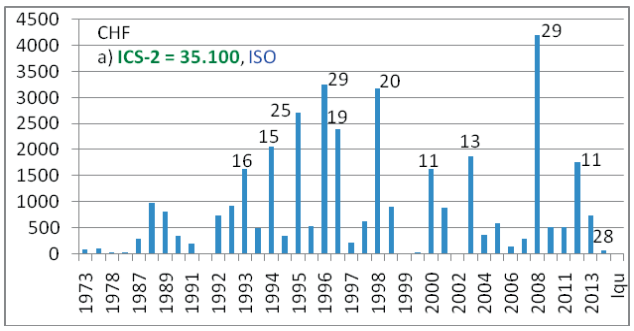
Let us segregate some of the ISO platform of numerous specific subfields of ICS-2 = 35.100:

- *results enable analysis according to the classification of the third level (ICS-3): 1) OSI model - in general - 35.100.01 2) multilayer applications osi model - 35.100.05 3) physical layer of the osi model - 35.100.10 4) layer data link - 35.100.20 5) network layer - 35.100.30 6) transport layer - 35.100.40 7) session layer - 35.100.50; 8) presentation layer - 35.100.60; 9) application layer – 35.100 .70,*
- *one of the few subfields of IT with monthly checks innovation (Iti =2, for 10 ≤ $Iqi_{/35.100/2013}$ ≤ 50), but with a reduction in the total number of valid publication, reducing the total amount etc.*
- *for example, $Iqp_{/35.100/ISO/2010} = 413$ (from 1973 to beggining of 2011), and the total value of the sample $\Sigma Iv_{/35.100/ISO/2010} = 40472$ CHF, which includes a larger number of $Iqu_{/35.100/ISO/2011} = 65$ developing standards (14 Amd, Cor 14 and 37 standards - 230 CHF). Development of 65 documents included several subcommittee: JTC 1/SC 6 (63), JTC 1/SC 25 (1) and JTC 1/SC 38 (1),*
- *with new, relatively small number of documents (2010: 5 Std and 1 Cor), the number of amendments (Amd) has been reduced from 144 to 93, the correction (Cor) from 243 to 65, and the annual needs ΣIv,*
- *the publication Iqp = 400, it is necessary to $\Sigma Iv_{/35.100/ISO/2014.01} = 36524$ CHF = (average 91 CHF/Std), and the Iqu=28, it is necessary 66 CHF only.*

There are results of the analysis with the ISO source of knowledge

a) including qualitative and quantitative elements in time - the period from 1973 to 2014, figure 3,
b) the trend of planning (annual) financial needs of over $y_{/35.100/ISO/2014} = 1000$ CHF, according to equation (6.1), ie according to the updated trendline innovation (6.2), figure 4.

$$y_{/35.100/ISO/2000\text{-}2010} = -39.52 x + 1630 \quad (6.1)$$
$$y_{/35.100/ISO/2000\text{-}2013} = 0.72 x + 1120 \quad (6.2)$$



Fog. 3. Analysis of the sources of knowledge, the ICS-2 = 35.100 – OSI model (ISO)

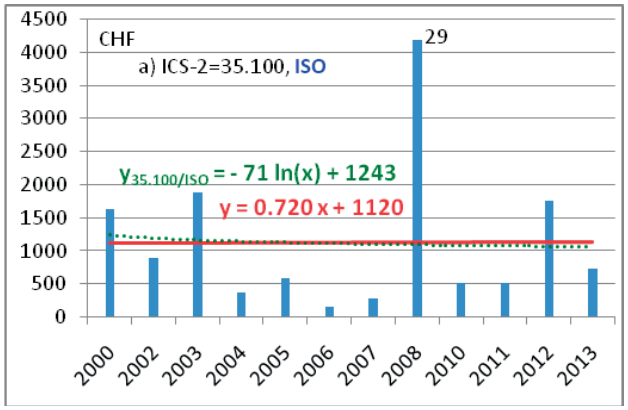


Fig. 4 Analysis of the results for the ICS-2 = 35.100 – OSI model (ISO)

Statistical sample $Iqs_{/35.100/SRPS/2010} = 116$ more intensely increased each subsequent year, concurrently, the local SRPS platform standardization, in the ICS-2 = 35.100, at the beginning of the second decade of the XXI century. The sample is an integral part of the elements of the national body for standardization of Serbia serves to create "layers" and the knowledge base to the SRPS, figure 5.

Compared to the previous function according to ISO trends (6.1) and (6.2), SRPS sources indicate a growing trend of innovation by function (6.3), figure 5.

$$y_{/35.100/SRPS/2007\text{-}2013} = -52.63 x^2 + 765.2 x - 773.8 \quad (6.3)$$

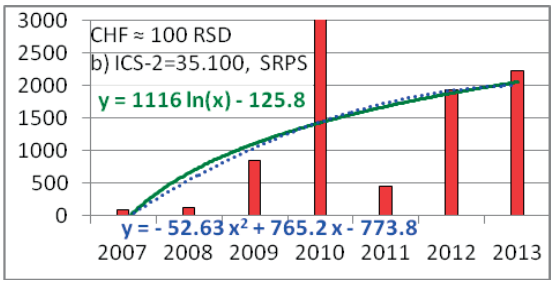


Fig. 5. Analysis of the results for the ICS-3=35.100 – OSI model (SRPS)

Levels of innovation knowledge in fields of networking (ICS-2 = 35.110)

Networking (35.110) includes LAN (Local Area Networks), MAN (Metropolitan Area Networks), WAN (Wide Area Networks), PISN (Private Integrated Services Network) etc. For a comparative analysis of the LAN to other fields of the same period from the previous results perennial analysis of trends and the level of innovation is segregated. At the beginning of the second decade of the XXI century, the statistical sample (at the global level, ISO/IEC, in early 2011), consisted of: $Iqs_{/35.110/ISO/2011}$ = 102 sources, consisted of: $Iqp_{/35.110/ISO/2011}$ = 37 published, $Iqu_{/35.110/ISO/2011}$ = 21 under development, $Iqw_{/35.110/ISO/2011}$ = 44 out of use.

There are results of the analysis ISO standardization early in 2014:

a) including a summary analysis of the period from 1992 to 2006,
b) the trend of planning (annual) needs about 800 CHF, according to the relations trend of innovation for ISO (7.1) and SRPS (7.2), figure 6.

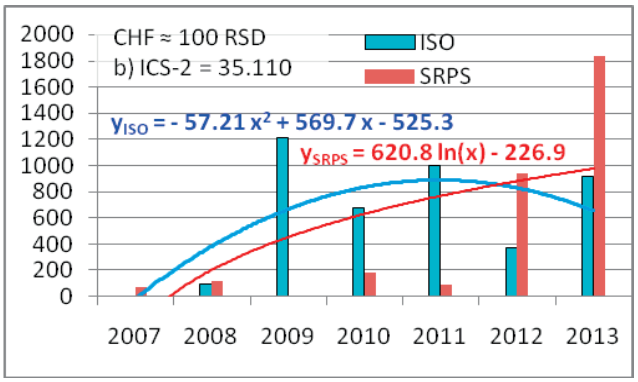


Fig. 6. Results of the analysis of local networking – 35.110 (ISO)

$$y_{/35.110/ISO/2007\text{-}2013} = -57.21\,x^2 + 569.7\,x - 525.3 \quad (7.1)$$

$$y_{/35.110/SRPS/\,2007\text{-}2013} = 620.8 \cdot \ln(x) - 226.9 \quad (7.2)$$

Apparently the "discontinuous" ISO and SRPS mathematical trend lines (figure 6). It is necessary to include other criteria and developmental specificity and the SRPS and ISO. For example, the development of the ISO/IEC projects ($Iqu_{/35.110/ISO/2011}$ = 21), future standards without Amd & Cor besides JTC 1 (8), it is included are two subcommittee, SC 6 (7) and the SC 25 (6).

DISCUSSION OF RESULTS

On the basis of these initial hypothesis, aim, preliminary results, the trends of standardization within the PDCA concept to the knowledge base are simultaneously analyzed.

Resource Planning (Plan-phase)

Researches show that for the purchase of new standards needed to plan around a lot more at the local level (SRPS) than the ISO, table 1. However, if the qualitative aspects involved and all amendments ISO (Amd & Cor) and the current local development projects, it is significantly more novelty, the necessary knowledge and money. The results show the need of the trends (Iqu) new ISO document (for ICS-2 = 35.100 and ICS-2 = 35.110), the annual knowledge innovation. Unavoidable planning - organizational and other approaches to resource management (preferably financial). In summary, for the indicated researched standardized documentation, it is (at the field) more resources than the individual financial capabilities allow (for example, figure 5). Clearly the availability of knowledge in standards is limited. It shows the trend of planning (annual) needs of over 2000 CHF, according to the relations trend of innovation for SRPS (6.3), figure 5. Development of new standards for innovative technology requires the allocation of significant human and financial resources. In the period 1995–2008, significantly increased the number of textbooks on the management of innovation, but little attention is paid to the specific relationship between innovation and standardization [12].

Analyzes provide appropriate solutions to the relations standardization - product innovation (primarily: software, hardware and services - for example, planning education).

Comparative analysis of ISO / IEC - SRPS database

Existing knowledge sources in Serbia allow further development of the SRPS standards, as well as the creation of a unit of local knowledge base. Copyright limiting distribution, although they are necessary for educational purposes. Dictionaries in IT are starting points, but in the above fields analyzed [10].

In this paper, evaluated collective knowledge is analyzed, and sources of knowledge in standardized networks (ICS-1 = 33, ICS-2 = 35 110 and ICS-2 = 35.100, as well as supporting subfields), toward the goal of adaptive learning. Standardized sources of knowledge to the knowledge base are differently valued according to SRPS ISO compared to roads (table 1, 2, figure 2 – 6).

Evaluated locally or collective-national knowledge of Serbian standards (SRPS) in these fields of IT, the ICS-2 = 35.100 and ICS-2 = 35.110 is $\sum Iv_{/35.100+35.110/SRPS/2013}$ = 12190 CHF or parallel $\sum Iv_{/35.100+35.110/ISO/2013}$ = 42804 CHF, or for the whole field IT $\sum Iv_{/35/ISO/2013}$ = 378340 CHF.

Table 2. Comparative analysis of ways of knowledge ISO - SRPS

Subfield 2013-12	Samples (Iqs)		Published (Iqp)		Year (Iqi)		"Trend" $Iv_{/year}$	
ICS-2	*ISO*	*SRPS*	*ISO*	*SRPS*	*ISO*	*SRPS*	*ISO*	*SRPS*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
35.100	1235	222	400	204	8	50	732	2219
35.110	127	84	43	81	7	39	920	1840
∑	1362	306	443	285	15	89	1652	4059

Checks to the formation of the knowledge base

On the other hand, additional analysis of access units of the knowledge base are essential in order to improve adaptive learning and testing with the aim of supporting a higher level of quality care providers of education (one), and knowledge of the other.

On figure 7, sample populations in standardized fields of creativity (ICS-1 from 01 to 49) are presented. Compared with all other standardized fields of human creativity, the field of IT (ICS-1 = 35) is very innovative on a global platform, ISO, $Iqu_{/35/ISO/2013} \approx 800$ standards. Telecommunications sector to innovate extensively on local SRPS platform. It is obvious that both fields have high (the highest - living) the intensity of innovation (Itid). The only major index value that refers to the intensity of innovation in the field of aircraft and space vehicle engineering (ICS-1 = 49, $Iqp_{/49/SRPS/2012} \approx 900$), figure 7. Therefore, the methodology to study and compare the results in the fields of ICS-1 = 33 and ICS-1 = 35, with other fields of work and creativity - as well as to [9] (for ICS-1 = 29).

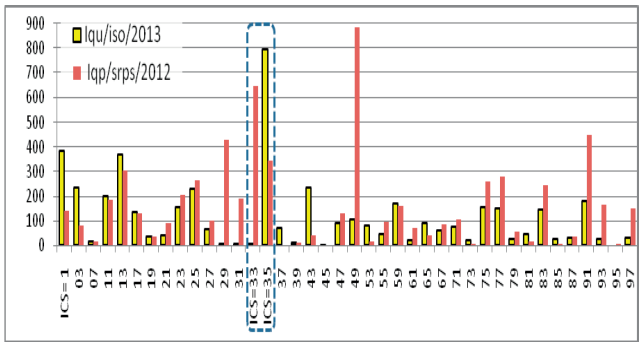


Fig. 7. Comparable amounts of innovation ISO – SRPS population standards

Discussion of results in the concept of PDCA (Act-phase)

Phase involves improving solutions for problems. Starting from a number of research approaches, financial problems are primarily taken place. But they neglected or other developmental aspects: qualitative - quantitative, temporal - spatial, hardware - software, more or less expert or user, the research - pedagogical, deductive - inductive, collective - individual, practical - theoretical, etc.

Standards provide legal certainty for innovative companies, creating a huge market and build trust among consumers [13]. According to the model of the process of innovation, standardization of business can affect all stages from basic research to product design, manufacture and market introduction [14].

CONCLUSION

Based on the results and analysis of the isolated, such as computer networks and communications, we conclude that it is necessary to continuously innovating elements of the knowledge base in a spiral PDCA quality, with the goal of adaptive learning.

Resource planning and financial needs can be for each of the segments/ subgroup in its entirety. For the above listed topics (to the knowledge base) standardized innovations base are measured over the financial ability of individuals (Exhibit **Plan**-hypothesis).

Creating a standardized database is the result shown tendencies and development projects, the mathematical relationship presented trend line (the theoretical side), with the inclusion of individual and local knowledge, primarily the development of new projects (with a practical side - evidence by **Do**-hypothesis).

The results of analyzes knowledge base, test and practice show that the standards (and associated knowledge base) financially and organizationally are not equally available, and the units of knowledge base, as well as the individual results of less or more "adaptive" and some as "a drop in the ocean "in relation to the collective, local, team, state, strategically targeted results and wide knowledge base, on the road to excellence massive quality improvement (Exhibit **Check**-hypothesis).

Results presented original analysis opens up new possibilities for improvement and further research both financial and »gap« between hetegogenih individual needs and collective standardized knowledge base. The goal is continuous improvement of adaptive learning in the time-new »slice« spiral PDCA cycle XXI century. Obtained the answers to questions such as: continuous monitoring and participation in global development in order to improve KB and adaptive learning - to a higher level of knowledge, innovation systems, processes and products (educational services) in the PDCA spiral of quality and the intensity of innovation (evidence **Act**-hypothesis).

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