



A REVIEW OF STATISTICS IN BASKETBALL ANALYSIS

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Abstract:

In the past, basketball statistics were a luxury available only to big professional clubs. For average coaches, statistics were a real nightmare, requiring a large amount of time and effort to collect data and then to manually calculate various statistical parameters. For most coaches going through this process, statistics were not worth the effort. However, computers have brought about a huge change in this field. Today, the prevalence and relatively low price of computers and their software makes statistical information available to everyone. Certain studies have shown that coaches are able to see only 30% of the events on a field or court during a game. Therefore, feedback in the form of statistics in sports provided by new technologies is the most important factor in improving the performance of athletes during training and in competitive conditions. Statistics in sport concerns the analysis and presentation of the most important results of teams or players with the aim of enhancing both their performance and results. In this study, based on the reviewed literature, certain statistical methods and the importance of statistics in basketball are presented.

Keywords:

Statistics, Basketball, Application, Analysis, Player.

INTRODUCTION

Modern sport is an important social phenomenon through which progress and a significant degree of development can be achieved. The participation of a large number of children and adults in sport activities of developmental, recreational and top-tier professional sports makes this activity a sociological phenomenon. Modern basketball is characterized by rapid and dynamic changes, and the culture of modern sports is marked by fierce competition with a strong desire for victory. Furthermore, the age category for top tier basketball players has been on a downward trajectory in recent years.

Basketball is a polystructural sport, which implies varying conditions in which a player's motor activity takes place. The dynamism of basketball and an unlimited number of motor movements and the conditions in which they take place make it a multidisciplinary study area, which requires a synthesis of knowledge from different scientific fields.

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With its enormous popularity worldwide, especially among the young, basketball provides multiple opportunities as a means of physical education and preparation for a healthy and quality life [1]. Basketball players are required to have a dribbling ability, speed, explosiveness, agility, quickness, good movement with and without the ball, shooting accuracy, execution of technical and tactical tasks and, above all, a good understanding of the game. In top tier basketball today, players have pronounced athleticism and technique, which are among the main characteristics of the modern basketball player [2]. However, success in basketball means winning against the opposing team; the effectiveness of a team is measured statistically (points, rebounds, assists, etc.). Team efficiency parameters that are also important are the exact characteristics of time, length, height, game tactics, coordination, psychodynamics, etc. A wide range of success factors in basketball makes the game interesting and dynamic, which gives the game its epithet: the "queen" of sport.

Basketball is a synthesis of intelligence, precision, courage, audacity, anticipation, skill, elegance and teamwork [3]. As a polystructural sport, basketball contains cyclic movements (such as various types of running and handling the ball) and acyclic movements (various technical and tactical elements). The connection of the several appropriate structural movement models determines a situation in basketball games. Due to its nature, basketball is a game that favors players of certain anthropological characteristics and motor skills, especially those with developed situational motor skills. If the success of playing basketball is evaluated in addition to motor skills, particular data needs to be obtained. In addition, game quality is affected by some motoric dimensions that are part of a game and may determine the success of players [4]. However, computers have changed all that. They have removed a large burden and responsibility when it comes to tracking statistics by coaches, while providing them with a handful of information that was unavailable about fifteen years ago. And best of all, the prevalence and a relatively low cost of computers and software makes this information available to everyone. As the amount of collected data grew, sports organizations turned to finding practical methods of gaining knowledge from the obtained data [5] [6]. This initially led to the hiring of statisticians who would enable better performance measurements and more effective decision-making for a given organization. The second step was to find more practical methods to extract valuable knowledge, that is, to start using the data mining technique.

Properly applied data mining techniques can result in an overall better team performance by having players prepare for certain situations, identify their individual contributions, assess the play of the opposing team and explore weaknesses. Depending on the amount of available data, it is possible to extract appropriate knowledge through the application of data mining [7] [8].

2. BASKETBALL DEVELOPMENT TENDENCIES

All selection, prognostic and diagnostic procedures in basketball must have in their empirical and practical form the guiding idea presented by the profile of a successful basketball player. The crucial thing is to attempt a more precise determination of the profile or model of a basketball player in the future by taking into account the relevant facts that influence the ever-changing profile category. When defining it, a reference must be made to the past, while being mindful of the present moment, and with a view to the future. Such a vision can make a qualitative attempt to reduce the unpredictability factor in basketball prognostics [9].

It is assumed that basketball training in the upcoming period will display a tendency to maintain the balance between all phases of game flow, with further development in game collectivity and creativity. In European basketball, there will probably be a change in the rules of the game in the direction approaching the NBA, which means that the three-point line will shift from 6.75 m to 7.24 m, the quarters will last 12 minutes, the number of personal fouls will increase to 6 per player, all of which will require certain adaptations in the training process and the approach to game problems. In modern basketball, the prevailing mindset is focused on a less impact of strength when it comes to success in basketball, while strong emphasis is attached to such qualities as speed and explosiveness of basketball players of all positions. Changing the rules of the game will require a higher level of integration of game phases, matching a controlled and fast-paced style of play and training players to be more versatile and, as such, able to respond to the demands of the modern game in all its phases.

There were similar adaptations carried out in 2000, with the last significant change in the rules of the game (shortening attack times from 30 to 24 seconds and moving the 3-point line from 6.25 meters to 6.75 meters). The tendency of further progress in terms of greater attractiveness of the game will require both coaches and players to show high levels of technical-tactical



knowledge and, in connection with this, creativity. Considering the daily improvement of basketball scouting, the possibility of achieving top results in basketball will only be possible with a high level of creativity, which works as a weapon against a one-sided and predictable game [10].

2.1. EXAMPLE: GRAPH OF BALL TRANSITIONS ACROSS ALL TEAMS

This Figure 1 shows the most frequent ball movements of the teams involved in the analysis. Edge width is a proportional factor of the transitions between players. Red edges represent a higher percentage of ball movement. Distributions of the ball from other players were mainly towards the Point Guard, which is a very interesting fact. The Shooting Guard took a 'secondary' leadership role by forming connections between the Point Guard and the Power Forward. Responsibilities of the Centre were mainly rebounding and redistribution of the ball to the Point Guard.

One of the advantages of modern basketball is the wealth of available statistics data. Teams' offensive and defensive strategies can be continuously analyzed and studied upon. By reviewing a large amount of literature on the changes of styles in modern basketball, it must be stated that changing will remain an ongoing trend.

3. STATISTICAL METHODS IN BASKETBALL

Statistics is a tool that does not intend to completely replace a coach's assessment, but serves as an aid and complement to the assessment and points to the facts that the human eye misses. Statistics based on one game can give the coach an additional insight and information that he or she can use to prepare future practice and game plans. It is also useful for players, allowing them to see objective information about their performance and work more efficiently on improving their game. In general, a web application of this type is not an application for keeping statistics, that is, a dynamic data entry during the match, but an application that will load the output file of the statistics of the entire match and then enter all the necessary data into the database. Specifically, this application is about statistics in basketball. It also enables one to create, view and delete competitions, teams and players as well as to view standard statistical categories for players, matches and competitions and several non-standard statistical indicators [11].

In the NBA, the strongest basketball league, basketball statistics are very advanced and are an indispensable tool for every coach, manager, scout and player. In addition to the basic statistical methods used in Europe, more advanced statistical methods are also used that provide users with additional information and thus improve the basketball game. Some of the more advanced statistical categories are implemented in this application.

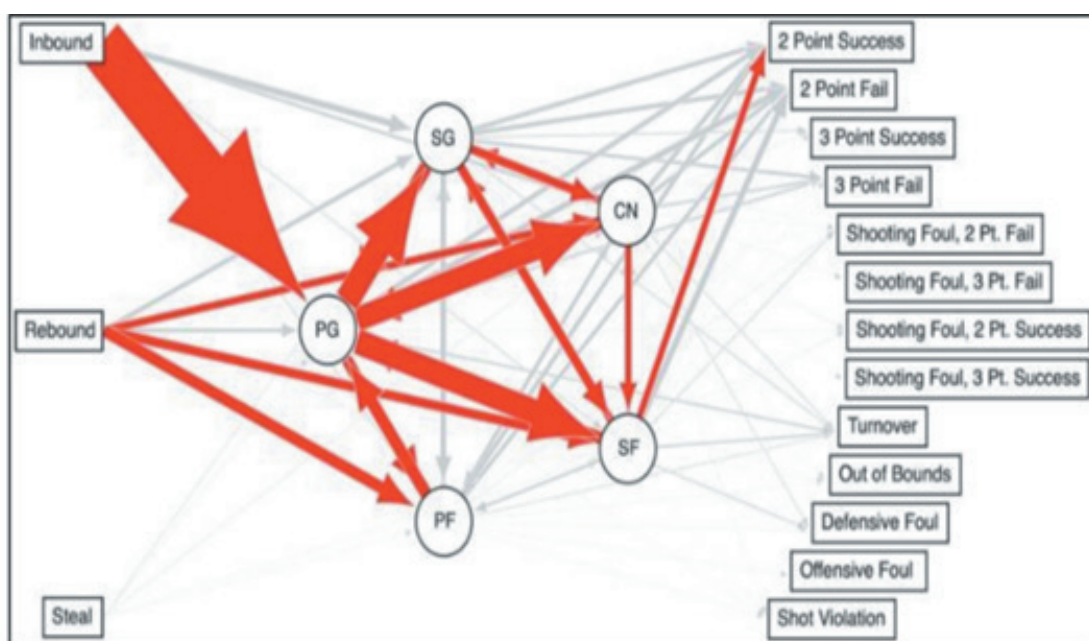


Figure 1. Example of ball transitions across all teams.



This paper will describe the technologies used to create the application, then briefly describe the basketball game and its connection with mathematics and statistics. After that, the steps in the development of the application, the functionality of the application and the statistics used in the application will be described.

4. DISCUSSION

In the past, basketball statistics were a luxury available only to big professional clubs. For average coaches, statistics were a real nightmare, requiring a large amount of time and effort to collect data and then to manually calculate various statistical parameters. For most coaches going through this process, statistics were not worth the effort. However, computers have brought about a huge change in this field. Today, the prevalence and relatively low price of computers and their software makes statistical information available to everyone. Certain studies have shown that coaches are able to see only 30% of the events on a field or court during a game. Therefore, feedback in the form of statistics in sports provided by new technologies is the most important factor in improving the performance of athletes during training and in competitive conditions. Objective tools are needed that can predict the performance of athletes with considerable reliability. One of those tools is certainly the statistics analysis of performance in sports [12] [13].

The analysis has shown the relationship between assist variables (a measure of teamwork) and teams' win-loss ratios over 5 competitive seasons in the NBA. A significant correlation was found between these two variables. It was also established that the total number of assists of an individual team recorded higher correlation coefficients with the variable ratio of wins and losses than the total number of assists of players who started the game in the top five. This research has shown that the number of points scored after the assist is a more important factor for winning than the number of points scored without the assist. The above items are a clear indication of the role of team play in the final ratio of wins and losses at the end of a season [14].

Anything that can be derived from the rules or that provides information about a player or team can be a statistical category. Other standard statistical game categories for a basketball player are missed field goals, missed free throws, offensive rebounds, defensive rebounds, assists, turnovers, steals, blocks, and total points. There are also team statistics, which are obtained when individual

performances of all players in a team are added up. In addition, there are player statistics based on all matches, which show the average performance of the players. In an analogous way, we also obtain the average statistics of a team. Sports statistics has become an important and popular science in the world today. Sports experts and coaches use statistical data to improve their players and teams, but also to see the strengths and weaknesses of opposing teams. Statistics cannot tell everything about a match, players and team; its task is to provide assistance, facilitate and supplement the real experience. In the USA, the use of statistics in sports is at a very high level and is given great importance. It helps coaches, players and experts in their everyday profession. It provides a source of entertainment for sports fans. Based on the statistics, the best ones are selected and awards are given. Statistics have become important and indispensable [15].

The application for keeping basketball statistics allows the statistician to enter statistical data while observing the game. It contains a space where the statistician can enter certain statistical data by clicking on or pressing a button. This application is not of that type, but is closely related to such an application. It allows you to load a play-by-play match file. A "play-by-play" file is a file that contains every data entry made by a statistician on a single game using a statistical program for keeping statistics. Various information can be seen from the recorded data, which are more or less standard in the usual statistical data processing. By loading such files, the application creates tables for various statistical categories, such as "Competition Statistics", "Team Statistics in Competition", "Player Statistics", "Match Statistics" and "Additional Statistics".

Performance Index Rating (PIR) is a basketball statistical formula that is often used to rate players in basketball. This formula is primarily used in European basketball leagues as a measure that attempts to evaluate a player's overall performance. It consists of simple additions and subtractions of the positive and negative factors of a basketball game. Initially, the PIR was used to help select the Most Valuable Player (MVP) award in the Euroleague. Although that process has been replaced by expert voting, the PIR measure still remains. PIR is calculated according to the following formula:
$$\text{PIR} = (\text{Points} + \text{Rebounds} + \text{Assists} + \text{Steals} + \text{Blocks} + \text{Forced fouls}) - (\text{Missed field goals} + \text{Missed free throws} + \text{Lost balls} + \text{Blocks received} + \text{Fouls committed})$$
 [16].



The limitations of the reviewed papers is that none of them mentioned scouting and newer statistical methods related to players and teams scouting.

4.1. STANDARD STATISTICAL ELEMENTS

The evaluation of success in the basketball game shows the actual quality of basketball players has been researched by numerous domestic and foreign authors. The general goal of this research segment is to determine the contribution of an individual basketball player within the team, but also the success of the entire team within the framework of the real conditions of a basketball game. In basketball statistics exists a set of 15 clearly defined criteria for assessing the real quality of basketball players. Based on the proposed system of criteria, a model of scientific explanation of the success of the players during the match, their real quality, is offered [17]. This model was tested by an expert assessment of 10 basketball experts in the work when, using the AHP method, importance coefficients were determined for 15 criteria for assessing situational effectiveness and thus offered a model for assessing the effectiveness of players in the basketball game [18]. Basketball is a highly dynamic game and during which it is possible to follow a large number of events on the court. In view of that, the aim of this paper is the collection and processing of standard statistical elements in basketball. In order to do this, it was necessary to define the standard statistical elements. For this purpose, the manual for statisticians of the FIBA World Basketball Federation was used [19] [20]. In it, the following elements of the game were distinguished:

1. successfully executed free throw
2. unsuccessfully executed free throw
3. successful 2-point shot
4. unsuccessful 2-point shot
5. successful 3-point shot
6. unsuccessful 3-point shot
7. defensive rebound
8. offensive rebound
9. assist
10. stolen (won) ball
11. turnover
12. personal foul (foul)
13. technical error
14. blocking
15. time spent in a game (minutes).

It is possible to generate standard statistical reports by collecting data on the mentioned elements of the game. However, in order for the statistics to be more complete and produce additional reports, certain elements need to be supplemented. The possibilities for supplementing these elements are reflected in the following:

1. During a two or three point shot (made or missed), it is possible to supplement the action with information from which position on the court the shot was taken.
2. The lost ball action can be supplemented with information on how the ball was lost (bad handling, bad passing...).
3. In the case of a personal foul, it is possible to record against which player the foul was committed.
4. When blocking, as well as in the case of a personal foul, it is possible to record which player was blocked. During the game, various other violations occur which are most often called "fouls".

Obstructive physical contact (personal foul) is a situation in which a player is illegally prevented by an opposing player from scoring. In this situation, the player who was on the offensive end of the floor is allowed to score points from the free throw line. If the attempted shot was for three points, the player gets to shoot three free throws, and if the shot was attempted for two points, the player gets the opportunity to shoot twice from the free throw line.

Each made shot from this line brings one point to the team. When shooting for two points, three points, as well as during free throws, a player may either make the shot or miss. The ratio of made baskets to the total number of shot attempts is called shooting percentage. In basketball statistics, one-point shooting percentage, two-point shooting percentage and three-point shooting percentage are determined separately. Figure 2 shows the impact of a one-point shot on the final outcome of the game. The graph shows that the number of victories jumps sharply when the shooting percentage for one point exceeds the limit of 62%. If the shooting percentage by one point is below 65%, teams lose the game in most cases. Based on the obtained dependencies, it can be said that a one-point shot has a significant impact on the final outcome of the game. It can be seen from the graph that during the season, the ratio of shooting percentage and the outcome of the game deviated from the general rules.



Namely, it happened that a team shot over 85% for one point and still lost the game. Also, a game was played in which the team had a one-point a mere 32% shooting percentage and won the game in the end. [21]

The statistical minimum for the percentage for one point is 0%, which means that a team did not make a single free throw, while the statistical maximum is 95.2%. The average value for this shot, when looking at all games in the league, is 66.8%. The standard deviation is 0.125. For every coach, one-point shots are very important. They ask the players to practice free throws during each training break in order to raise that segment of the game to a higher level.

Research on the structure of the basketball game consists of the attack phase in a basketball game on a sample of 21 basketball games at the 1999 World Junior Championship in Portugal. From the analyzed matches, through the presentation of arithmetic means, standard deviations and percentage proportions for monitoring variables, as well as using the Chi-square test and the Kruskal-Wallis test, the following results were obtained: 74.6% of attacks are set attacks, while counterattacks make up 25.4% of total seizures in the sample. About 25% of set attacks last from 13 to 18 seconds, while approximately 70% of counterattacks last about 4 to 6 seconds on average. They also noticed that the shooting success of all teams was the best in racket throws [22].

5. CONCLUSION

Basketball statistics have become an integral part of the game. It is used by coaches, scouts, players and lovers of this sport. It can be a powerful tool in analyzing teams and preparing for games, but also in coordinating individual and collective training. In America, basketball statistics are very advanced, which can be seen on the official website of the NBA (www.nba.com). On their website one can see a wide range of observed statistics and numerous statistics-based analyses. In addition to helping people involved in basketball, it provides fans of the sport with added entertainment and a better understanding of the game itself. The web application described in this paper contains basic statistical indicators, but also non-standard indicators such as +/- baskets, offensive and defensive rebounds, assists and PIR. This version of the application is not intended for independent use but, as already stated, it uses a file created with the FULLCOURT R application for its work. Therefore, in order for the application to be independent, it is necessary to create an interface for managing basketball

statistics in real time. Apart from the interface for tracking basketball statistics, the application offers other possibilities. If the application was to be used for professional purposes, it would be necessary to add the feature of creating a user account via e-mail. In regards to basketball statistics, the following functionalities could be added to the application:

- +/- of all basketball categories,
- EFF (efficiency),
- Create weighted +/- statistical categories,
- The relationship between PIR and +/- statistical categories could be analyzed statistically,
- Use field goal coordinates for additional statistics.

The game of basketball is advancing at a rapid pace. The number of quality players and teams has been on the rise. At high levels of competition, there are no teams that can count on a guaranteed victory by any statistical parameters. Effective preparation for the game brings a balance between mediocrity and top results. Today we live in a world of information. The basic characteristics of information, which define its quality, and therefore its value, are the following: accuracy, completeness, comprehensibility and timeliness. It is better to have no information at all than to have inaccurate, incomplete, incomprehensible or untimely information.

6. REFERENCES

- [1] O. B. G. Bar-Or, "Trainability of the prepubescent child," *The Physician and sportsmedicine*, pp. 64-82, 1989.
- [2] N. Trunić, *Trening mladih košarkaša različitih uzrasnih kategorija*, Beograd: Visoka škola za sport, 2007.
- [3] M. M. Nenad Trunić, "Osnovni principi planiranja i programiranja kondicione, tehničko-taktičke i psihološke pripreme košarkaša U16 u makrociklusu treninga," in *X međunarodna naučna konferencija*, Beograd, 2014.
- [4] P. K. N. O'Reilly, "Knowledge Management Best Practices in National Sport Organizations," *International Journal of Sport Management and Marketing*, vol. 3, pp. 264-280, 2007.
- [5] J. Angeli, "Scouting America's Top Basketball Programs," 2003.
- [6] J. Angeli, "Scouting America's Top Basketball Programs," 2004.
- [7] O. S. H. C. R. Schumaker, "Sports Data Mining," *Springer 1st edition*, 2010.



- [8] D. S. L. Filtz, "Predicton of Physical Performance Using Data Mining," vol. 1, no. 74, pp. 1-25, 2003.
- [9] M. Doyle, *Beginning PHP 5.3*, indianapolis, 2010.
- [10] C. A. K. Yank, *Simply JavaScript*. SitePoint Pty. Ltd, Collingwood, 2007.
- [11] D. Crockford, *Eloquent JavaScript* SitePoint Pty. Ltd, Sebastopol, 2008.
- [12] M. & F. I. Hughes, *The Essentials of Performance Analysis-An Introduction*, New York: Routlege, 2007.
- [13] K. L. H. M. B. R. M. J. F. I. Libermann D.G., "Advances in application of information technology to sport preformance.," *Journal of Sports Sciences*, pp. 755-6, 2002.
- [14] M. Melnick, "Relationship between team assists and win-loss record in The National Basketball Association.," *Percept Mot Ski.*, pp. 595-602, 2001.
- [15] M. Haverbeke, *Eloquent JavaScript*, San Francisco: No Starch Pres, 2014.
- [16] F. framework, <http://foundation.zurb.com/>.
- [17] S. P. A. D. D. Trninić, "Set of Criteria for the Actual Quality Evaluation of the Elite Basketaball Players.," in *Collegium Antropologicum*, 1999.
- [18] S. D. D. D. B. Trninić, "Expert Model of Decision-Making System for Efficient Orientation of Basketball Players to Positions and Roles in the Game - Empirical Verification," in *Collegium Antropologicum*, 2001.
- [19] D. Oliver, "Basketball on paper - Rules and tools for performance analysis," Brassey's, Washington DC, 2004.
- [20] S. Trninić, *Analiza i učenje košarkaške igre*, Pula: Vikta, 1996.
- [21] D. Oliver, *Basketball on paper - Rules and tools for performance analysis*, Washington DC: Brassey's, 2005.
- [22] F. G. N. Tavares, Faculty of Sport Sciences and Physical Education - University of Porto, Porto, 2001.