Original Article

Structure of efficiency factor at XIII, XIV, XV, and XVI World Championship in basketball

SLOBODAN SIMOVIĆ[1], BOJAN MATKOVIĆ[2], MIHAJLO MIJANOVIĆ[1], MIODRAG KOCIĆ[3], MILENKO VOJVODIĆ[1]

[1]*Faculty of Physical Education and Sport, University of Banja Luka, Bosnia and Herzegovina*
[2]*Faculty of Kinesiology, University of Zagreb, Croatia*
[3]*Faculty of Sport and Physical Education, University of Nis, Serbia*

ABSTRACT

Simović S, Matković B, Mijanović M, Kocić M, Vojvodić M. Structure of efficiency factor at XIII, XIV, XV, and XVI World Championship in basketball. *J. Hum. Sport Exerc.* Vol. 7, No. 2, pp. 527-543, 2012. Applying the method of main components by Hotelling and the method of rotation of the main components, i.e. Varimax rotations by Keiser, the latent structure of basketball efficiency was established. It was based on the fourteen manifest indicators of efficiency. Our findings refer to the sample comprised of the game-winning teams at the World Championships: in Greece, 62 basketball teams; the USA, 62 basketball teams; Japan, 80 basketball teams; and Turkey, 80 basketball teams. Factorization was performed on the entire sample of all game-winning teams, that is 284, as well as on the single game winners at the championships in Greece, USA, Japan, and Turkey. There was the total of four factor analyses and within each of them five to seven latent dimensions, i.e. factors based on the fourteen manifest efficiency parameters were extracted. Katell method of landslide indicates a clear elbow between the third and fourth component. These first three latent dimensions in all four factor analysis exhibit the stability of factors and high saturation on the side of the manifest variables. The factors have been defined as: general offensive efficiency factor, three-points shot factor and free throw factor. Having the variables that account for the total number of attempted and made shots dominant within the structure of these factors, it can be concluded that general latent structure of basketball efficiency is indeed explained by means of shot efficiency. These findings confirm both empirical and theoretical speculations of basketball experts, i.e. the overall basketball efficiency is primarily dependent on the shot efficiency, what seems entirely logical. **Key words**: LATENT STRUCTURE, FACTOR ANALYSIS, WINNER, SHOT

Corresponding author. Faculty of Physical Education and Sport, University of Banja Luka, Bulevar Vladike Petra Bojovica 1A, 78000 Banja Luka, Bosnia and Herzegovina.
E-mail: ssimovic@hotmail.com
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INTRODUCTION

All individual and team sports recognize the processing of team efficiency results based on statistical data as valid. Thanks to the long tradition and rich experience in this field of science, statistically speaking, basketball has been ahead of other sports.

Only accurate statistical data pertaining to the game events, which have been noted, recorded, analyzed and interpreted, can serve as a basis for later assessment of individual and team efficiency. They can also be used in order to reach an objective conclusions relating to the efficiency of both individual and team.

In the beginning the efficiency analysis of basketball statistics was merely the simple arithmetic quantification. Coaches, by rule being the most interested party for the data analysis, soon realized that simple calculation and percentage extraction would not be sufficient to perform a more thorough analysis of all events happening during a game.

Being so, the next step was the extraction of relative indicators. As early as 1951, an approach called Simson's Paradox was introduced into the field of statistics. This paradox showed that relative indicators may lead to misinterpreted reasoning of statistical data.

Smith and Spear (1982) designed a system of statistical evaluation called „ball possession evaluation“. The system was made public in his book titled, Basketball – multiple offense and defense. This approach represented a significant step forward in data collection and analysis.

The last few years witnessed an increase of interest in basketball statistics. It is no longer object of interest of basketball coaches exclusively, who use it successfully in the analysis of individual and team game. It has become interesting for media and general audience as well.

Thanks to modern multivariate statistical methods, kinesiologists have been trying to reduce this plentitude of data to a common denominator of assessment known as basketball efficiency.

Up-to-date research of basketball efficiency can be divided into two groups. The first group of works has dealt with the standard indicators of situational efficiency. The following papers comprise the first group: Akers et al. (1991); Brdarić et al. (2003); Dežman et al. (2002); Elbel and Allen (1941); Golubović-Jovanović (2005); Gómez et al.(2008); Gómez et al.(2009); Ibáñez at al. (2009); Ibáñez at al. (2008a); Ibáñez at al. (2008b); Ibáñez at al. (2003); Lukšić (2001); Nakić (2004); Milanović (1979); Pojskić at al. (2009); Sampaio at al. (2010); Sampaio at al. (2004); Sampaio and Janeira (2003); Simović (2008); Simović and Komić (2008); Trninić at al. (1995); Trninić at al. (1997); Trunić (2006).

The second group pertains to the works assessing different methods for an individual player's evaluation in a game, and was not discussed here. Our paper is to be categorized within the first group.

Standard indicators of situational efficiency are not to be seen as isolated phenomena in the course of a game of basketball. It is possible to assume that there is a latent structure which simplifies the interpretation of its influence on the final result of a game. There are very few researches relating to factors and their latent structure of basketball efficiency.

Trninić at al. (1995) applied the alpha factor model with Guttman-Kaiser criterion and Oblimin transformation. Sixty-four (64) games of the WC in Toronto in 1994 were observed, and thirteen (13) indicators of situational efficiency were noted. Four latent dimensions were isolated, and they account for 45.4% of the total variability. The first latent dimension was best determined by variables of players being active in the paint. The second latent dimension was best determined by variables innate to players at outside positions. The third latent dimension was reserved for variables of offensive efficiency, and, finally, the fourth one was for 3-point shot percentage.

Sporiš at al. (2006) monitored one hundred and thirty-four (134) games of the regional Goodyear league in the season of 2004/05. Also, thirteen standard indicators of basketball efficiency were monitored, and the same statistical methodology was used. Six latent dimensions were isolated and they account for 67.5% of the total variability. The isolated factors were labeled as follows: the basic offensive efficiency factor, the 3-point factor, the factor of wrong defense set and free throw percentage, the factor of back line defense and back line offense efficiency, the factor of aggressiveness on player possessing ball and offensive aggressiveness of the ball-possessing player, and the factor of basic defensive efficiency.

Šeparović and Nuhanović (2008) established the latent structures of basketball efficiency applying the factor analysis of fifteen (15) standard indicators. The sample refers to thirty (30) games in the national league of Bosnia and Herzegovina. The identical methodology was used here as with the two previous researches. The four latent dimensions were extracted and labeled as: the efficiency of scoring from close range, the efficiency of field goals, the general defensive efficiency of players, and specific defensive maneuverability. The total percentage of the accounted variance was 70%.

Džajić at al. (2009) established the latent structure of situational characteristics of basketball players at the Olympic Tournament in Beijing 2008. The sample referred to one hundred and twenty-one (121) players and showed that two latent dimensions were extracted, namely free throw and 2-point shot efficiency, and rebounds, 3-point efficiency and assists.

Simović and Nićin (2011) established the latent structure of basketball efficiency by applying the method of main components by Hotelling and the method of rotation of the main components, i.e. Varimax rotations by Keiser. Six factors have been isolated by means of which the accounted variance has been 77.161%. Factorization was performed on the entire sample of all game-winning teams that is 220. Latent dimensions, i.e. factors have been extracted on the basis of 13 manifest parameters of efficiency.

Jeličić at al. (2010) examined the latent structure of situational efficiency among top level players under 19 at XIX U-19 Basketball Championship in Zadar 2000. They applied the exploratory strategy of factor analysis of the main components of thirteen (13) standard indicators of situational efficiency. The research included the players with eight minutes per game in more than three matches, and they were selected from eleven (11) teams that played forty-six (46) matches combined. Two relatively independent latent dimensions were extracted, and they were labeled as: situational technical and tactical activity of (a) inside and (b) outside players. The conclusion argued that neither the application of standard indicators of situational efficiency nor the application of the respective latent dimensions derived from within was sufficient to account for the explanation of the structure of game of basketball. These researches confirmed the hypothesis that indicators of situational efficiency can be reduced to fewer numbers of latent dimensions.

Simović at al. (2011) established the latent structure of basketball efficiency by applying the method of main components by Hotelling and the method of rotation of the main components, i.e. Varimax rotations by Keiser. Seven factors have been isolated on the basis of 15 manifest parameters of efficiency. The extracted variance is 87.304% (criterion $\lambda \geq 1$). Scree Plot indicates a clear elbow at the meeting point of the fourth and fifth component. Factorization was performed on the entire sample of all game-winning teams, that is 80.

These researches confirmed the hypothesis that indicators of situational efficiency can be reduced to a fewer number of latent dimensions. The aim of this research was to establish and confirm the latent structure of standard indicators of situational efficiency at the latest four World Championships in Basketball. The comparative analysis provided an insight into differences and similarities based on the latent dimensions and manifest indicators of basketball efficiency.

MATERIAL AND METHODS

Sample of entities

The research included: 62 games at the XIII World Championship in Basketball in Athens, hosted by Greece, from July 29 to August 9, 1998 ("1998 World Championship for Men", 2011); 62 games at the XIIV World Championship in Indianapolis, USA, from August 9 to September 8, 2002 ("2002 World Championship for Men", 2011); 80 games at the XV World Championship in Basketball in Shizuoka, Miyagi, Hokkaido, Hiroshima, and Saitama, Japan, from August 19 to September 3, 2006 ("2006 World Championship for Men", 2011); and 80 games at the XVI World Championship in Basketball in Ankara, Izmir, Kayseri, and Istanbul hosted by Turkey, from August 28 to September 12, 2010 ("2010 World Championship for Men", 2011), retrieved from: http://www.archive.fiba.com.

The statistical processing encompassed the results of game-winning teams. As there were two hundred and eighty-four (284) games, the total number of game winners corresponded to that number, i.e. the group entities.

Sample of variables

The manifest variables were commonly observed parameters of basketball efficiency as defined by FIBA[2]. We labeled the following manifest variables, i.e. parameters of basketball efficiency: points scored total (PST), two-point made total (M2), two-point attempted total (A2), three-point made total (M3), three-point attempted total (A3), free throws made (MFT), free throws attempted (AFT), offensive rebounds (OR), defensive rebounds (DR), assists (AS), personal fouls (PF), turnovers (TO), and steals (ST).

Apart from these thirteen commonly observed variables, our research includes one derived variable: total number of team offenses (TOTOF) – this variable was calculated according to Dean Smith's equation,

Research procedures

In order to form a database, we used the standard indicators of basketball efficiency as defined by FIBA, which were registered in the time span of eight (8) years at World Championships in Greece 1998, USA 2002 and Japan 2006.

[2] FIBA (International Basketball Federation)

The data were obtained from the official FIBA web site, i.e. archive historical data from FIBA and FIBA zones events since 1930 – archive.fiba.com. The evaluation of standard indicators of efficiency was put in place under the same conditions. The data gathering process is regulated by World Regulations – Official Statistics Sheet and Basketball Statistics Manual. The process is carried out by two data keepers using the computer software designed for this specific purpose. One data keeper is in charge of data input. The other, known as prompter, is specially trained to identify, in a proper manner, the standard indicators of situational efficiency in basketball, and to present data to the operator. In case of incorrect data gathering, there are sanctions imposed on the responsible person and the game organizer.

Statistical analysis

Following the main intention of this work, i.e. to establish the latent structure of basketball efficiency at the last three World Championships in Basketball, we used adequate methods in terms of factor analysis. Of course, the number of statistical procedures, known as descriptive statistics or basic statistics, had been carried out prior to the process of factorization. A maximum reduction of matrices and statistical indicators were developed due to a large number of both of them. We presented only the tables that are the matrices, on which our discussion and conclusions were based. Therefore, we put the communality matrix on the first, main component; the component (factor) extraction matrix with the criterion of characteristic value of roots being $\lambda \geq 1$; and, the orthogonal projection of components matrix known as the rotation method, i.e. Varimax with Kaiser Normalization. The matrices of trigonometric functions, indicating the degree of factor rotation, were not shown as they were not mentioned in the discussion of this paper.

RESULTS

The first column of Table 1 presents the acronyms of manifest variables of basketball efficiency as proposed by FIBA. The values in the second column are the constants, i.e. the maximum value of collective subject of measurement. The columns 3, 4, 5, and 6 have the extraction value for each of the manifest variables. The column 3 values refer to the values of all game-winning teams at the three World Championships in total, i.e. 284 of them. The column 3 values include the game-winning teams from the World Championship in Greece, i.e. 62 of them. The column 4 values refer to the game-winning teams from the World Championship in USA, i.e. 62 of them. The column 5 values refer to the game-winning teams from the World Championship in Japan, i.e. 80 in total. The column 6 values refer to the game-winning teams from the World Championship in Turkey, i.e. 80 in total.

Table 1. *Factor Analysis-Communalities.*

Variables	Initial	Extraction Greece - 98	Extraction USA - 02	Extraction Japan - 06	Extraction Turkey - 10
1	2	3	4	5	6
PST	1.000	0.821	0.907	0.939	0.914
M2	1.000	0.837	0.902	0.860	0.904
A2	1.000	0.868	0.928	0.825	0.903
M3	1.000	0.857	0.863	0.869	0.891
A3	1.000	0.828	0.855	0.864	0.915
MFT	1.000	0.936	0.932	0.873	0.955
AFT	1.000	0.934	0.916	0.898	0.953
OR	1.000	0.477	0.825	0.808	0.864
DR	1.000	0.477	0.459	0.844	0.790
AS	1.000	0.683	0.798	0.756	0.721

Variables	Initial	Extraction Greece - 98	Extraction USA - 02	Extraction Japan - 06	Extraction Turkey - 10
1	2	3	4	5	6
PF	1.000	0.447	0.684	0.476	0.919
TO	1.000	0.898	0.875	0.376	0.795
ST	1.000	0.929	0.455	0.634	0.962
TOTOF	1.000	0.889	0.937	0.946	0.964

PST *– points scored total;* ***M2*** *– two-points made total;* ***A2*** *– two-points attempted total;* ***M3*** *– three-points made total;* ***A3*** *– three-points attempted total;* ***MFT*** *– free throws made;* ***AFT*** *– free throws attempted;* ***OR*** *– offensive rebounds;* ***DR*** *– defensive rebounds;* ***AS*** *– assists;* ***PF*** *– personal fouls;* ***TO*** *- turnovers;* ***ST*** *- steals;* ***TOTOF*** *– total number of teams offenses.*

The next step in factorization includes the relevant data shown in Table 2. It points out the components and size of characteristic roots as distributed by components. The same table also gives the size of variance with the collective subject of measurement both individually and cumulatively. It is worth noticing, as a sort of reminder, that the standard criterion of the number of latent dimensions or factors, $\lambda \geq 1$, reproduced five of them on both levels-the level of all three World Championships taken together and the level of Championships observed individually. The individual variance values are presented in Table 4 for the WC in USA, Table 6 for the WC in Japan, and Table 8 for the WC in Turkey.

Table 2. *Factor Analysis WC Greece – 1998.*

Total Variance Explained									
Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**3.836**	27.401	27.401	3.836	27.401	27.401	3.139	22.422	22.422
2	**2.629**	18.777	46.179	2.629	18.777	46.179	2.691	19.220	41.643
3	**2.059**	14.709	60.888	2.059	14.709	60.888	2.074	14.813	56.456
4	**1.274**	9.101	69.989	1.274	9.101	69.989	1.640	11.717	68.173
5	**1.083**	7.739	77.727	1.083	7.739	77.727	1.338	9.555	**77.727**
6	.957	6.832	84.560						
7	.712	5.083	89.643						
...	…	…	...						
13	0.027	0.194	99.998						
14	0.000	0.002	100.000						

Extraction method: principal component analysis.

Table 3. *Factor Analysis WC Greece-1998.*

Rotated Component Matrix[a]					
Variables	**Component**				
	1	2	3	4	5
PST	**0.836**				
M2	**0.756**	-0.389			
OR	**0.680**				
A2	**0.677**		-0.460		
AS	**0.597**	-0.446			
MFT		**0.935**			
AFT		**0.924**			
PF		**0.559**			
M3			**0.917**		
A3			**0.818**		
ST				**0.953**	
TOTOF	0.631			**0.650**	
DR				**-0.390**	
TO					**0.932**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. ***PST*** *– points scored total;* ***M2*** *– two-points made total;* ***A2*** *– two-points attempted total;* ***M3*** *– three-points made total;* ***A3*** *– three-points attempted total;* ***MFT*** *– free throws made;* ***AFT*** *– free throws attempted;* ***OR*** *– offensive rebounds;* ***DR*** *– defensive rebounds;* ***AS*** *– assists;* ***PF*** *– personal fouls;* ***TO*** *- turnovers;* ***ST*** *- steals;* ***TOTOF*** *– total number of teams offenses.*

Table 4*. Factor Analysis WC USA-2002.*

Total Variance Explained									
Component	**Initial Eigen values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**3.868**	27.632	27.632	3.868	27.632	27.632	3.230	23.075	23.075
2	**2.616**	18.685	46.317	2.616	18.685	46.317	2.394	17.097	40.172
3	**1.925**	13.748	60.066	1.925	13.748	60.066	2.235	15.965	56.137
4	**1.670**	11.931	71.996	1.670	11.931	71.996	2.118	15.131	71.268
5	**1.258**	8.985	80.982	1.258	8.985	80.982	1.360	9.713	**80.982**
6	0.873	6.234	87.216						
7	0.651	4.653	91.869						
...	...	...	...						
13	0.000	0.002	100.000						
14	1.E17	8.591E-17	100.000						

Extraction Method: Principal Component Analysis.

Table 5. *Factor Analysis WC USA-2002.*

Rotated Component Matrix[a]					
Variables	**Component**				
	1	2	3	4	5
PST	**0.904**				
M2	**0.793**	-0.488			
AS	**0.775**				
TOTOF	**0.683**			0.651	
ST	**0.536**				
M3		**0.875**			
A3		**0.865**			
A2	0.510	**-0.598**		0.469	
MFT			**0.942**		
AFT			**0.935**		
OR				**0.898**	
PF				**-0.685**	
TO					**0.924**
DR		-0.381			**0.426**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalizatio. ***PST*** *– points scored total;* ***M2*** *– two-points made total;* ***A2*** *– two-points attempted total;* ***M3*** *– three-points made total;* ***A3*** *– three-points attempted total;* ***MFT*** *– free throws made;* ***AFT*** *– free throws attempted;* ***OR*** *– offensive rebounds;* ***DR*** *– defensive rebounds;* ***AS*** *– assists;* ***PF*** *– personal fouls;* ***TO*** *- turnovers;* ***ST*** *- steals;* ***TOTOF*** *– total number of teams offenses.*

Table 6. *Factor Analysis WC Japan-2006.*

Total Variance Explained									
Component	**Initial Eigen values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**4.043**	28.880	28.880	4.043	28.880	28.880	3.144	22.454	22.454
2	**2.889**	20.636	49.516	2.889	20.636	49.516	2.395	17.106	39.560
3	**1.642**	11.727	61.242	1.642	11.727	61.242	2.163	15.452	55.012
4	**1.263**	9.019	70.261	1.263	9.019	70.261	1.884	13.455	68.466
5	**1.130**	8.073	78.334	1.130	8.073	78.334	1.381	9.868	**78.334**
6	0.938	6.697	85.031						
7	0.783	5.590	90.621						
...	...	...	...						
13	0.001	0.006	99.999						
14	0.000	0.001	100.000						

Extraction Method: Principal Component Analysis.

Table 7. *Factor Analysis WC Japan-2006.*

Rotated Component Matrix[a]					
Variables	**Component**				
	1	2	3	4	5
M2	**0.892**				
A2	**0.772**			0.429	
PST	**0.745**	0.500			
TO	**-0.530**				
M3		**0.904**			
A3		**0.750**			
AS	0.431	**0.746**			
MFT			**0.915**		
AFT			**0.915**		
OR				**0.871**	
TOTOF	0.556			**0.715**	
DR					**0.909**
ST	0.387			0.465	**-0.505**
PF	-0.356				**-0.435**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. ***PST*** *– points scored total;* ***M2*** *– two-points made total;* ***A2*** *– two-points attempted total;* ***M3*** *– three-points made total;* ***A3*** *– three-points attempted total;* ***MFT*** *– free throws made;* ***AFT*** *– free throws attempted;* ***OR*** *– offensive rebounds;* ***DR*** *– defensive rebounds;* ***AS*** *– assists;* ***PF*** *– personal fouls;* ***TO*** *- turnovers;* ***ST*** *- steals;* ***TOTOF*** *– total number of teams offenses.*

Table 8. *Factor Analysis WC Turkey-2010.*

Total Variance Explained									
Component	**Initial Eigen values**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**3.603**	24.022	24.022	3.603	24.022	24.022	2.797	18.647	18.647
2	**2.441**	16.277	40.299	2.441	16.277	40.299	2.283	15.219	33.866
3	**2.046**	13.641	53.940	2.064	13.641	53.940	2.117	14.114	47.980
4	**1.547**	10.315	64.255	1.547	10.315	64.255	1.836	12.241	60.221
5	**1.391**	9.270	73.526	1.391	9.270	73.526	1.572	10.478	70.669
6	**1.059**	7.063	80.589	1.059	7.063	80.589	1.356	9.037	79.736
7	**1.007**	6.715	87.304	1.007	6.715	87.304	1.135	7.568	**87.304**
8	0.636	4.237	91.541						
9	0.466	3.107	94.648						
…	…	…	…						
14	0.002	0.015	99.998						
15	0.000	0.002	100.000						

Extraction Method: Principal Component Analysis.

Following the utilization of Varimax factor rotation in Table 3 (WC 1998), Table 5 (WC 2002), Table 7 (WC 2006), and Table 9 (WC 2010), the relevant coefficients have been given in bold text. The values have been classified by numeric representation, with the factor saturation by manifest variables clearly seen.

Table 9. *Factor Analysis WC Turkey-2010.*

Rotated Component Matrix[a]							
Variables	**Component**						
	1	2	3	4	5	6	7
PST	**0.871**						
AS	**0.801**						
M2	**0.773**	-0.452					
TO	**-0.534**				0.461		0.433
M3		**0.885**					
A3		**0.881**		0.347			
MFT			**0.971**				
AFT			**0.971**				
OR				**0.897**			
TOTOF	0.392			**0.667**		0.514	
A2	0.497	0.529		**0.571**			
DR					**0.847**		
ST						**0.969**	
PF							**0.934**

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

DISCUSSION AND CONCLUSION

Based on the initial factor matrix, i.e. the numeric value of communality of the measured object labeled as the basketball efficiency, it can be noticed that the basketball efficiency stands as a real, and as a general dimension, which is in this example determined by fourteen (14) observed manifest variables. The analysis of structure and value of communality draws a conclusion that the manifest variable communalities for points scored total, total number of team offenses, two-points made total and assists, are larger in number compared to the others. The personal fouls communality is slightly smaller (Table 1).

We find it necessary to point out here that factor analysis is a research method, with interpretation of results and their utilization left at author's discretion in terms of further processing; therefore, it is not to be seen as being subjected to any firm or strict statistical regulations (Pallant, 2009). A high-quality analysis of differences and similarities and factor loadings induced by manifest variables, can only be provided by those who were present on and off the court during a basketball game. The results presented in this paper are, therefore, real, impartial, and accurate; a more detailed insight is impossible without a deeper and further understanding of basketball on a global level.

Monitoring the acronyms and their meanings, the manifest indicators of basketball efficiency are clear, that this factor is best defined by variables of offensive efficiency. This factor, the general offensive efficiency factor, is stable, though with some minor margin of deviation in its structure, and appears individually as the first factor at the observed World Championships. Considering the World Championship in Greece (Table 3), the first factor includes: points scored total (0.836), two-point made (0.756), offensive rebounds (0.680), two-point attempted (0.677) and assists (0.597). Moreover, number of team offenses (0.631) has a positive projection on this factor. The appearance of offensive rebounds variable within the structure of this factor confirms the empirical opinion of basketball coaches that teams which are dominant in offensive rebounds stand greater chances of winning a game (so called – second offense efficiency). As for the WC in USA, there is an alteration in the structure of this factor, but only at first glance. The derived variable labeled as total number of team offenses appeared, whereas the variable labeled two-point attempted total disappeared (Table 5). The appearance of the first of two variables is simple to account for, as the basketball rules were changed between the championships in Greece and USA. The total offense time and back field to front field transition time were, inter alia, reduced from 30 to 24, and from 10 to 8 seconds respectively; also, an attacking team was given a new offense time only in case a ball contacted hoop, not just a shot attempt. It all contributed to an increase in number of offenses and game pace. The variable labeled as total number of team offenses was not present at the WC in Japan, for the reason that, compared to the WC in USA, adaptation to this rule had already taken place. It is now obvious why the derived variable in question is included in this research. As for the variable labeled as two-points attempted, it is apparent that it comprises the structure of second factor, with a negative projection (-0.598), but also with a positive influence on the first factor (0.510).

For the WC in Japan, the first latent factor was comprised of: two-point made (0.892), two-point attempted (0.772), point scored total (0.745) and turnovers (-0.530). The variable labeled as turnover was negatively projected on this factor. Besides these variables, the positive projection on the factor of general offensive efficiency was noted among the following variables: total number of team offenses (0.556), assists (0.431) and steals (0.387); the negative projection was reported for the variable labeled as personal fouls (-0.356) (Table 7).

For WC in Turkey inside the first factor were spotted: points scored total (0.871), assists (0.801), two-point made (0.773), and turnover (-0.534) (Table 8). Apart from them, the positive projection on this factor is seen within the following variables: two-point attempt (0.497) and total offense (0.392).

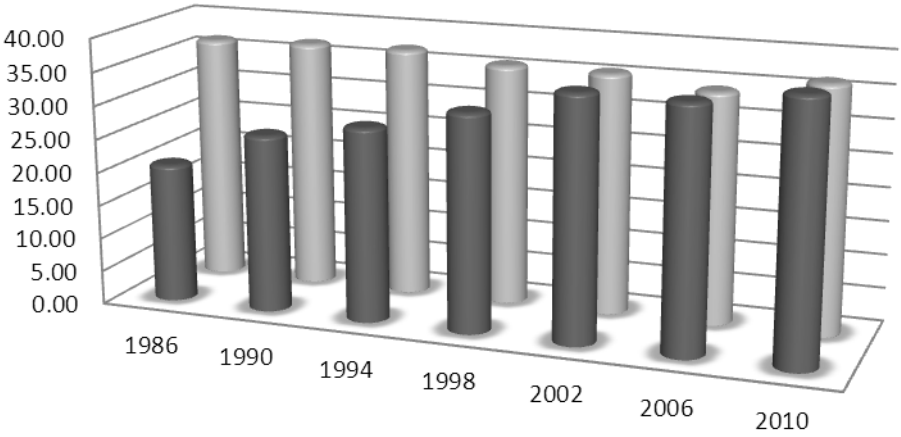
In the research, conducted by Trninić et al. (1995), of the latent structures at the WC in Toronto, Canada, the factor of general offensive was also isolated, and it was comprised of the following variables: assists, two-points made total and two-point attempted total. The research indicated the offensive rebounds variable as having a positive influence on this factor.

The second factor is determined by the following two efficiency variables: three-points made and three-point attempted. According to the structure of variables which primarily compose this factor, the factor itself was labeled – three-points shot factor. It is stable in its occurrence at the observed World Championships as well as the previous researches of latent structure of basketball efficiency. At the WC in Greece, the factor was comprised by the variables of three-points made (0.917) and three-points attempted (0.818) (Table 3). At the WC in USA, the same variables were present and also accompanied by the variable of two-points attempted, which in this case had a negative projection on this factor (-0.598) (Table 5). At the WC in Japan, the structure of factor was comprised by the following variables: three-points made (0.904), three-point attempted (0.750) and assists (0.746). The positive influence was noted with the variable of

points scored total (0.500) (Table 7). At the WC in Turkey second factor is determined by two variables, i.e. three-point made (0.885) and three-point attempt (0.881). The variables two-point attempt (-0.529) and two-point made (-0.452) have negative projections on this factor.

Sporiš et al. (2006), and Trninić et al. (1995) had also isolated the same factor with the variables of three-points made and three-points attempted.

If we monitor the World Championships in general, it can be seen that the number of three-point made is steadily increasing, with an exception starting to take place from the WC in Greece, where the three-point shot efficiency started dropping. This can be due to an increase of motor abilities among basketball players manifested primarily in defense; particularly reflected in the defense on skip passes[3] (Figure 1). At the last World Championship, the trend has stopped, but it is a clear indication of a correct decision of FIBA to move the three-point line to longer distances.



	1986	1990	1994	1998	2002	2006	2010
%A3/TOTFG	20.76	26.43	28.81	32.20	36.18	36.02	38.20
%M3	36.7	37.1	37.2	35.9	35.8	34.3	36.6

A3 *– three-point attepmt;* ***TOTFG*** *– total number of field goals (A2+A3);* ***%M3*** *– three-point made percentage*

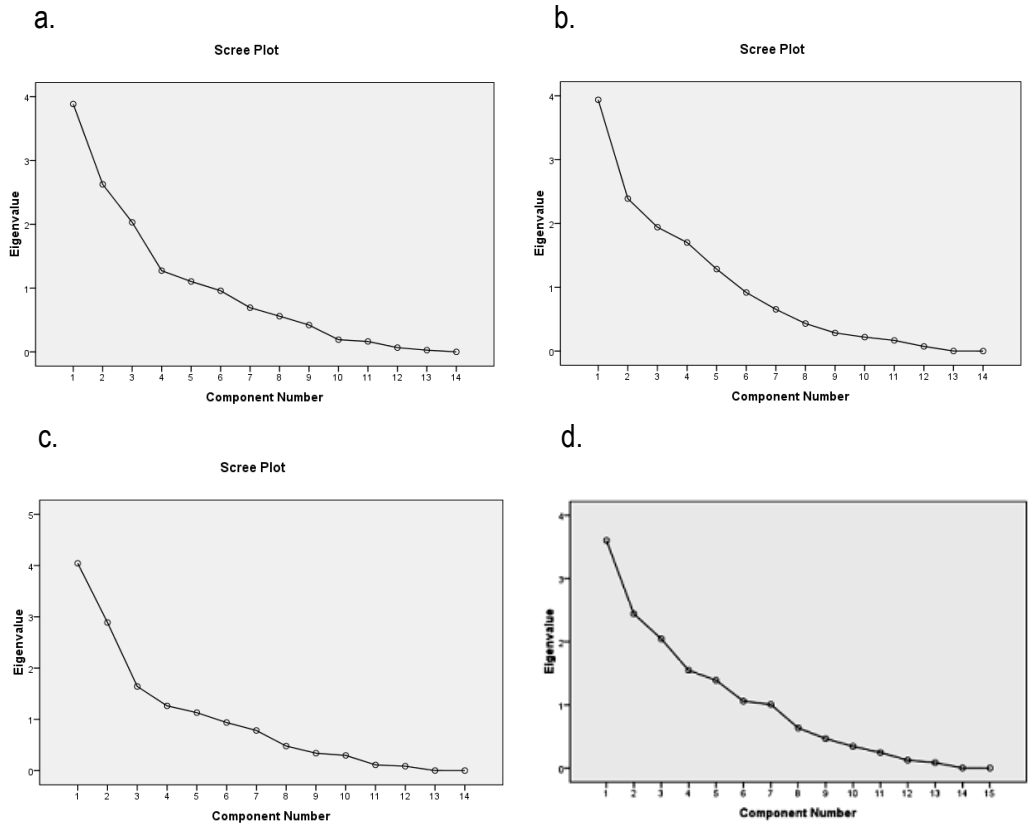
Figure 1. *Comparative analysis of three-points made percentage set against the overall number of shot attempts and percentage of their efficiency at the WCs from 1984, when FIBA introduced the 6.25 three-point line.*

[3] Skip Pass – a ball pass when a player skips the closest of his/her team members by passing the ball from a more occupied part of the field to a less occupied one, usually diagonally through spaces between the front and the back line of defense. Used for three-point attempts (Karalejić & Simović, 1996).

The third factor is defined by the following variables: free throw made and free throw attempted. This factor, due to its structure, is labeled as the free throw factor. It is stable at both previous researches of the latent structure of basketball efficiency, and at the World Championships we monitored. At the WC in 1998, its structure was comprised of: free throw made (0.935), free throw attempted (0.924) and personal fouls (0.559) (Table 3). At the WC in 2002, 2006, and 2010, the structure was the same: free throws made total and free throws attempted total (Tables 5, 7, and 9). In previous researches, such as: Trninić et al. (1995) personal fouls were extracted alongside with free throw made and turnovers; Sporiš et al. (2006) extracted free throw made, free throw attempted and personal fouls; while Šeparović and Nuhanović (2008) extracted free throw made, personal fouls and free throw attempted.

The other isolated factor, as opposed to the previous ones, does not show stability in occurrence at the collective level and throughout the selected World Championships. Also, there are no similarities of structures of these factors with the variables which comprise the latent structure isolated in the previous researches.

Respecting the mentioned criteria in all examples, we were able to extract five latent dimensions (at WC 1998, 2002, and 2006), and seven at WC 2010. If we take a more detailed look at it, i.e. as to what has happened with this particular variance before and after the rotation of components (factors), it can be seen that the variance gets reduced, after the rotation, in favor of lower components. On the collective level, of course, it stays at the same percentage.



a. *WC Greece 1998;* ***b.*** *WC USA 2002;* ***c.*** *WC Japan 2006;* ***d.*** *WC Turkey 2010*

Figure 2. *Scree Plot of distinctive values by factors*

The extracted variance is 77.7% at the WC in Greece (Table 2), 81% for the WC in USA (Table 4), 78.3% at the WC in Japan (Table 6), and 87.3% at the WC in Turkey. There is a clear indication of a Scree Plot elbow (Katell method of landslide) at the point of separation between the second and third component. This means that components 1 and 2 account for a larger fraction of the variance than the other components (Figure 2). At the 2002 WC, λ_1=3.87 with variance of 27.63, and λ_2=2.62 with variance of 18.69, cumulative total is 46.32%. At the 2006 WC, λ_1=4.04 with variance of 28.88, and λ_2=2.89 with variance of 20.64, cumulative total is 49.52%. There is one more point of separation after the third component, which is to be taken into consideration when discussing our results. The Scree Plot of the WC in Greece and in Turkey indicates a clear elbow at the point of separation of the third and fourth component. This means that the first three components account for a much larger fraction of total variance than other components. At the 1998 WC, λ_1=3.84 with variance of 27.40, λ_2=2.63 with variance of 18.78 and λ_3=2.06 with variance of 14.71, cumulative total is 60.89%. At the 1998 WC, λ_1=3.60 with variance of 24.02, λ_2=2.44 with variance of 16.28, and λ_3=2.05 with variance of 13.64, cumulative total is 64.26%.

It is obvious to conclude that Scree Plot for two components of WCs in USA and Japan and three components of WC in Greece and WC in Turkey account for a much larger fraction of the variance in comparison to other factors. According to the diagrams, it is advised to have only two or three components (factors) extracted. Still, we have to take care of the fact that there is one more point of separation for the Scree Plots of WCs in USA and Japan, so we can conclude that it is recommended to have three components extracted for all four factor analysis.

The factor analysis with five to seven extracted latent dimensions and three components, which account for a much larger fraction of total variance, indicates that latent structure of basketball efficiency at the last four WCs in basketball including the research conducted by Trninić et al. (1995) can be explained by the following: the general offensive efficiency factor, three-points shot factor and free throws factor. As the structure of these factors is dominated by the variables of attempted shots (two-point attempted total, three-point attempted total, and free throw attempted) and total number of made (scored) points (M2, M3 and MFT) from different field positions, it can be concluded that the general latent structure of basketball efficiency is defined by the shot efficiency. This is confirmed by both empirical and theoretical opinions of basketball experts, who claim that total basketball efficiency is dependent on shot efficiency.

This stable variable structure is all the more important because of the fact that in 2000 the total offense time and back field to front field transition time were reduced from 30 to 24, and from 10 to 8 seconds respectively. These changes have aimed at an increase in game's dynamics. The concept of set offense[4], a strong defense tactics with many personal fouls and ball control, adopted by many basketball coaches in the 1990s for the reason of giving teams an opportunity to control and direct their performance to a desired game result, was threatening to make basketball a dull sport which could have ultimately led to a total destruction within the game itself. The change in rules accelerated the pace of the game. Fastbreaks, second offenses and “run and gun” attacks have taken place instead. It has also led to an increased appearance of individual talent of players in 1-on-1 and 2-on-2 offenses.

We consider it necessary to mention that our research, in terms of selection procedure, has included the specific sample of an extreme type (top-quality basketball teams that qualified for the final games at WCs); in terms of importance of games (matches for medals, high level of publicity, national prestige, etc.), but it can still account for the most important aspects of latent structure of basketball efficiency.

[4] Set Offense – action, combination, pattern (Karalejić & Simović, 1996).

In conclusion, it needs to be emphasized that a total analysis of basketball game is impossible to conduct based solely on official statistics. Basketball, as well as other sports, is much more complex and as such it is difficult to be explained by the means of basic and descriptive statistics exclusively.

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