

LATENT STRUCTURE OF STANDARD INDICATORS OF SITUATIONAL EFFECTIVENESS IN BASKETBALL IN BOSNIAN LEAGUE 6

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Original scientific paper

Summary

The aim of this research is to determine latent structure of basketball by applying Factor analysis (alpha method) on 15 standard indicators of situational effectiveness (FIBA), on the sample of 30 games in Bosnian Basketball League 6 for the champion of Bosnia and Herzegovina. Initial co-ordinate system is transformed by nonorthogonal rotation according to Oblimin criterion. By analyzing situational indicators that influence successfulness of the strongest basketball teams that reach the playoffs of Bosnian League 6 in battle for the championship trophy, four latent dimensions which present the structure of basketball have been identified in this research. These dimensions are: effectiveness of scoring from close range, effectiveness of scoring from mid-range, overall defensive effectiveness of players and specific defensive agility. For a complete analysis of the structure it is necessary to expand the basis of situational indicators.

Key words: latent structure, factor analysis, situational indicators, shooting accuracy, defensive effectiveness, system matrix, extracted factors.

INTRODUCTION

The research is aimed at providing a closer look as much as possible at professional and scientific conception of basketball, so that its impact contributes to theory and practise, all this with one main goal – that basketball offers its most exciting features to spectators and at the same time to be on the top level of game quality. Driving force of the development of basketball is creativity and brains, in other words intellectual and creative resources. Development of science that deals with basketball issues depends on the used state of accumulation of acquired knowledge, intellectual and creative potentials.

Process of winning trophies in basketball depends on creating a strong team, which is defined by individual quality of its players (Dezman, B. et al. 2002). By analyzing situational indicators which influence successfulness of basketball teams, our intention through this research is to identify structure of the game of basketball, the strongest teams that reach the playoffs on Bosnian League 6 and fight for championship trophy of Bosnia and Herzegovina.

The aim of this research is to determine latent structure of basketball by applying Factor analysis (alpha method) on 15 non-standard indicators of situational effectiveness (FIBA), on the sample of 30 games of Bosnian League 6 for the

championship trophy of Bosnia and Herzegovina. Standard indicators of situational effectiveness in the game do not occur in an isolated state, therefore one can assume that it is important to determine their correlations for defining latent structure of basketball game and by that way determine latent dimensions by which basketball game can be well interpreted. (Trninić S, et al.1995).

RESEARCH METHODS

Entity sample

Data is collected on 30 games of Bosnian League 6 for the championship trophy of Bosnia and Herzegovina. Teams competing in the league are top 4 teams in the first part of Bosnian championship and 2 regional league (Goodyear – now known as NLB) members from Bosnia, KK Bosna Sarajevo and HKK Široki Brijeg. Home teams recorded their games and sent video material for the needs of this research. Total number of 30 recorded games was collected, in other words 60 entities (2 teams on every game). Every team played 10 games during League 6.

Variable sample

Activity of a basketball team is objectified by statistics, and it can be recorded through action successfulness. Structure of parameters in competition activity presents basis for comparative

analysis of teams, analysis of structural characteristics of the game itself, and the results by these analysis are starting point for more successful selection of players in team building process, more efficient programming of training camp and better choice of tactical concept in the game of basketball (Hajnal, L. Et al. 1990).

FIBA has standardized 13 indicators of situational effectiveness and you can find them in this research as demonstrating variables. Standard indicators of situational effectiveness (all in the game) are: number of made shots from two point range (S2US), number of missed field goal attempts from two point range (S2NE), number of made shots from three point range (S3US), number of missed attempts from three point range (S3NE), number of made shots from free throw line, one, two or three (SBUS), number of missed free throw attempts (SBNE), defensive rebound (SO), offensive rebound (SN), assists (A), personal fouls (OG), turnovers – lost balls (IL), steals (OL) and blocked shots (B).

We have expanded standard indicators of situational effectiveness with two more indicators: number of made layups (S2PO) and number of slam dunks (S2ZA). Data registration was made by official statisticians specially trained for that job.

DATA PROCESSING METHODS

With respect to the aim of research, alpha factor analysis is applied. For collection of demonstrating variables, this analysis evaluates factors in such a way that it shows us that they have maximal correlation with factors from universe. The basic data was processed by programmes for analysis of variable reliability and factor analysis for determining latent structure of basketball features. Guttman – Kaiser criterion was used for determining number of significant components, and for transformation of initial coordinate system Oblimin sloping-angle rotation.

RESULTS AND DISCUSSION

Table 1 provides measure of sampling adequacy with the value of 0.468. It is desirable that this value is big (maximum 1), but with regard to number of analyzed games (30 games) one could not expect bigger value. If we have less number of games this value will be even smaller and therefore it will practically prevent us from getting valid scores through factor analysis. In the second part of table 1, we can see result of Bartlett's χ^2 sphericity test which has the aim to show that correlation matrix differs from system matrix. In opposite case, every variable would be independent factor and the application of techniques of multivariate analysis would be questionable regarding non-correlation of certain variables.

Table 1: Measure of Sampling Adequacy and Bartlett's sphericity Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.468
Bartlett's Sphericity Ttest	Approx. Chi-Square	229.233
	df	105
	Sig	0

Table 2 shows number of significant extracted components. Distinctive values of components bigger than 1 (according to GK criterion) are in bold. Percentage of explained variance by certain components and cumulative percentage of explained variance are shown in the table as well. The last column shows distinctive values after made rotation aimed at better presentation of results. Total number of six factors is extracted, during which the first three are much more significant than the other three. First three components explain 45% of variability, while the next three explain additional 24%. Total percentage of explained variance is near 70% which is normal for these types of problems, although one can find smaller values in professional literature, and sometimes these values can reach up to 80%.

Table 2: Distinctive values of extracted components and percentage of explained variance

Component	Total Variance Explained			
	Extraction Values of Squared Loadings			Rotation Values of Squared Loadings
	Total	% of Variance	Cumulative %	Total
1	2.51729	16.78192	16.78192	2.35530
2	2.22623	14.84156	31.62349	2.07427
3	2.03783	13.58551	45.20900	1.97607
4	1.35128	9.00850	54.21750	1.46048
5	1.19252	7.95015	62.16765	1.36153
6	1.05755	7.05031	69.21796	1.48974

One can see from scree plot (Picture 1) that the first three extracted factors are much more significant from the other three. Picture 1 shows

distinctive values (eigenvalues) in component number function. Strong downfall is obvious after the third distinctive value.

Picture 1: Scree plot of distinctive values by factors.

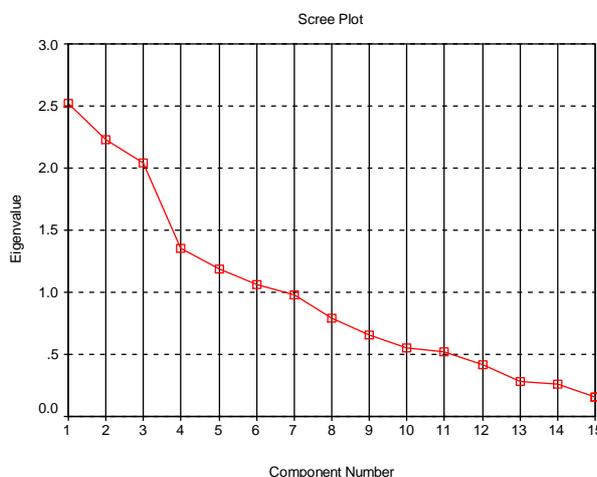


Table 3 shows system matrix. This matrix provides insight in parallel projections of certain variables with Oblimin factor and therefore it gives information about which variables mostly define certain latent dimensions of basketball in Bosnian League 6. One can clearly see from this table that all variables more or less participate in each of the components. However, for the first two components, and partially for the third, it can be concluded that they are almost completely defined by some variables that participate very little in

other factors, while other three factors share variables that participate much more in each of the factors, or just in the first three factors. Therefore one can expect bigger correlation between second three extracted factors, unlike the first three which are pretty much independent, especially among each other. Sign before values supports the fact that some demonstrating variables are in opposition by their influence on the game (e.g. made and missed shots, turnovers and steals – lost and won balls etc.), and in that opposition they can still define some latent dimension.

Table 3: System Matrix

System Matrix						
Var	Component					
	1	2	3	4	5	6
S2US	0.8381	0.0446	0.1587	-0.0287	-0.2897	-0.1179
S2PO	0.7214	0.2846	0.2214	-0.0800	0.0445	0.0135
S2ZA	0.5736	0.0458	-0.4422	0.0949	-0.2280	-0.0497
A	0.4690	0.7237	-0.0035	0.0742	0.0748	0.0656
S2NE	0.0229	-0.7122	0.4327	-0.1907	0.0300	-0.0337
S3US	-0.2685	0.6942	0.0798	0.1133	0.3580	-0.1119
SN	0.3448	-0.4318	0.3283	0.1124	0.1014	0.2533
SBUS	0.1955	-0.4865	-0.6186	0.2756	0.1853	0.0574
OG	0.0537	0.1754	-0.5171	-0.1174	0.3920	0.4902
SBNE	0.3298	-0.2837	-0.4665	0.3008	0.3232	-0.0565
OL	0.2391	0.0473	0.3446	0.6905	0.0648	-0.3166
SO	0.2863	0.1365	-0.1436	-0.6144	-0.1736	0.0515
IL	0.0827	0.0178	0.4459	-0.2221	0.6567	-0.1434
B	0.3656	-0.1216	0.4558	0.0573	0.1558	0.5662
S3NE	-0.3531	0.2406	0.2304	0.4249	-0.3569	0.5178

Table 4: Structure matrix

Structure Matrix						
Var	Component					
	1	2	3	4	5	6
S2US	0.8871	-0.1415	-0.0428	0.0686	0.0530	0.1718
S2PO	0.7211	0.1775	0.0379	0.0131	0.2576	0.3044
S2ZA	0.5857	0.0506	-0.4512	-0.1261	-0.2430	-0.1280
S2NE	-0.0937	-0.7639	0.0710	0.0929	0.3145	0.2845
S3US	-0.1965	0.7299	0.2855	0.1522	0.1965	-0.1223
A	0.5388	0.6758	0.0780	-0.0021	0.0445	0.1160
SBUS	-0.0232	-0.2032	-0.8554	-0.0499	-0.1491	-0.0441
SBNE	0.1239	-0.0308	-0.7541	0.0757	0.0526	-0.0008
OL	0.2092	0.0464	-0.0107	0.8293	0.0635	0.1294
SO	0.3836	-0.0074	0.0809	-0.5997	0.0840	-0.1019
OG	-0.1081	0.4376	-0.4473	-0.4991	-0.0329	0.1740
IL	-0.0440	0.0540	0.1651	0.1037	0.8000	0.2750
S3NE	-0.2947	0.2254	0.3490	0.2405	-0.6142	0.3220
B	0.1858	-0.0835	0.0617	0.0634	0.1290	0.8259
SN	0.1610	-0.3881	-0.1289	0.1746	0.1504	0.5665

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

Table 4 or structure matrix defines correlation between some demonstrative variables and extracted factors. Of course, the biggest correlation is expected between variables that are used to define factors. It can be noticed that some variables have high correlation with some factors, and at the same time almost insignificant with the other. Example for this are variables of free throw successfulness. This means that this factor is also almost fully explained by given variables and that is highly independent from the other. Unlike this, some other variables are almost equally present in explaining factor pair. Example for this is

variable which defines assists and it has good presence in the first, and somewhat better in the second factor.

Table 5 shows correlation between extracted components. One can notice that almost completely independent components are calculated after rotation. In the first five extracted components there is no correlation bigger than 0.1 while only six factors have somewhat stronger correlation with the fourth and fifth factor. The point of certain components is that one can expect positive and negative correlation here and that resulted from the choice of demonstrative variables.

Table 5: Component Correlation Matrix

Component Correlation Matrix						
Component	Component					
	1	2	3	4	5	6
1	1.0000	0.0096	-0.0852	-0.0347	0.0633	0.0712
2	0.0096	1.0000	0.0643	-0.0462	-0.0418	-0.0453
3	-0.0852	0.0643	1.0000	0.0927	0.0709	0.0320
4	-0.0347	-0.0462	0.0927	1.0000	0.0181	0.1068
5	0.0633	-0.0418	0.0709	0.0181	1.0000	0.1128
6	0.0712	-0.0453	0.0320	0.1068	0.1128	1.0000

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

By explaining four factors we can define latent structure of basketball in Bosnian League 6 for the championship trophy of Bosnia and Herzegovina with 15 standard indicators of situational effectiveness. Sure, total structure is not possible to define based only on these indicators. The first

factor consists of variables: made shot from two point range, made shot from close range (layup) and successful slam dunk. This factor explains at most (16.78%) of total variability. Certain influence in this factor can also be made by variables of assist, offensive rebound and blocked

shot, but by their nature they belong to some other factors. This factor can be defined as **effectiveness of shooting from close range**.

First of all, this latent dimension is defined by variables that are characteristics of shooting the ball in some stages of game for each player position in a team separately. In set offensive play these variables are characteristic for low post players (centers and power forwards) whose offensive game is near the basket, and who are therefore in good position to have high shooting percentage for 2 point field goals, layups and slam dunks. It should be mentioned here that in transition stage of the game shooting from close range, layups and dunks are done also by backcourt players and small forwards. Assists are also very important feature of this factor. Large number of open 2 point shots, layups and dunks, very high percentage shots occur after a successful pass (assist).

The second factor includes assists variables (which are largely present in the first factor as well), missed 2 point shot, made 3 point shot and offensive rebound. This factor explains 12.84% of variability and together with the first factor more than 31%. Factor can partially be explained by the help of made free throws variable. This factor can be defined as **effectiveness of shooting from mid-range**. We defined the factor this way, because the highest projections with the second latent dimension have 3 point shot variable – successful (0.6942) and 2 point shot – unsuccessful (-0.7122) and assist, as a part of the game which precedes shooting, but also offensive rebound which follows shooting and which also has high projections in this factor. Rebound effectiveness on the offensive end is a compatible part of basketball in the situation when two point field goal – is unsuccessful. Assist is very often precondition for good look from 3 point range. This means that defender is not near the shooter or he is in previous play drawn away as a help. Assist which in this factor has very high projection (0.7237) dominantly determines later effectiveness of mid range shot, and just as we noticed it has very big contribution to the first factor as well.

Variables of made and missed free throw attempts and personal fouls explain the third factor which gives 13.50% of the explanation of total variance. This factor can be explained by help variables, blocked shots, turnovers (lost balls), missed two point shots, offensive rebound and steals. Factor provides essential definition of **overall defensive effectiveness of players**. This latent dimension is characterized by indicators of situational effectiveness which are distinctive features of players who play on the defensive end. Quality of

overall defensive effectiveness is demonstrated through number of personal fouls, blocked shots, and it results in possibility of free throw shots. Made and missed free throws which define this latent dimension suggest that it is about players who play all positions. It is usually the case that the backcourt players (guards and small forward) are good free throw shooters while frontcourt players (center and power forward) are not.

The fourth factor which explains 9.01% of total variance includes the most from the variables of steals and defensive rebound, but in the end it can be explained by free throw variables. This latent dimension is in the first place defined by variables that present agility, aggressiveness, explosiveness, emphasized will to take the possession of the ball, which characterize backcourt players and a small forward, but it can characterize front court players as well, but on the defensive end. In this factor, the two variables that explain it are considerably independent; therefore we can define this factor as **specific basketball defensive agility**.

Two remaining factors, the fifth and sixth, consist of one and two variables respectively. With regard to their high projections in other factors we assigned them for these factors. Blocked shots have significant projection in the third factor which we defined as overall defensive effectiveness. We can here join turnover (lost ball) variable which has isolated itself as independent in describing the fifth factor. Turnovers are direct consequence of defensive effectiveness; at least they should be on this level of competition quality, while in weak competitions we could explain it with insufficient technical quality of players.

CONCLUSION

Latent structure of basketball, in Bosnian League, functional dependence and mutual interaction, we can define as four latent dimensions: **effectiveness of shooting from close range, effectiveness of shooting from mid-range is the second factor, the third factor is defined as overall defensive effectiveness of players, and the fourth one is defined as specific defensive agility**.

In the end of this chapter, as a comparison, we would like to state results of research made by Mr. Trninic and contributors (1995). On games from World Championship in Turin in 1994, using factor analysis on 13 standard indicators of situational effectiveness, they isolated the following factors: effectiveness of back line of defence and front line of offence, effectiveness of front line of offence and back line of defence, overall offensive effectiveness and effectiveness of mid-range field goals.

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**LATENTNA STRUKTURA STANDARDNIH POKAZATELJA SITUACIONE
USPJEŠNOSTI U KOŠARCI U BOSANSKOHERCEGOVAČKOJ LIGI 6***Originalni naučni rad***Sažetak**

Cilj rada je utvrđivanje latentne strukture u košarci primjenom faktorske analize (alpha metod) na 15 standardnih pokazatelja situacione uspješnosti (FIBA), na uzorku od 30 utakmica u Bosanskohercegovačkoj Ligi 6 koja se igrala za šampiona države. Početni koordinatni system je transformisan pomoću neortogonalne rotacije prema oblimum kriteriju. Analizirajući strukturu situacionih pokazatelja koji utiču na uspješnost najačih timova koji su se borili za titulu šampiona države u košarci, vidi se da su indentifikovane četiri latentne dimenzije. Ove dimenzije su: uspješnost poentiranja sa bliskog ostojanja, uspješnost poentiranja sa poludistance, generalna odbrambena uspješnost igrača i specifična odbrambena pokretljivost. Za kompletnu analizu ove strukture neophodno je proširiti bazu situacionih pokazatelja.

Ključne riječi: latentna struktura, faktorska analiza, situacijski pokazatelji, preciznost šutiranja, odbrambena učinkovitost, ekstrahovani faktori.

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