

## Specific features of 3×3 basketball: factor analysis of the key performance indicators and their impact on game performance in the elite leagues

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### Abstract:

**Background:** Brought from the streets to the Olympics, the 3×3 basketball has gained relevance in worldwide sport over the last few years. Yet, available literature about its specific features is still scarce. We identified the specific features of elite 3×3 basketball and investigated the factors that determine the success of 3×3 basketball teams in official competitions. **Method:** This study analyzed 11 Masters stages and the final of the FIBA 3×3 World Tour (November 2–3, 2019, Utsunomiya, Japan), in which 56 teams participated. To assess the factors with the greatest impact on the percentage of wins of teams in the tournament, a regression analysis was performed. The percentage of wins (W%) in the total number of games played was taken as a performance indicator. To build a regression model, various game indicators were chosen, which are factorial manifestations. The obtained results revealed that W% was most influenced by the average turnovers and average rebounds per game. It was determined that the difference between the number of shots made per game under the basket and beyond the arc was insignificant (only 1-2 shots for some teams). In addition, a shooting map showed that some teams were more successful at shooting from outside the arc than from the middle range or behind the basket. To assess shooting activity, all final games were analyzed by video review. **Results:** The turnovers per game (TOPG) has the greatest influence on the share of wins, i.e., 56.4%. Nevertheless, the rebounds per game (REBPG) factor also has a significant influence, i.e., 23.7%. If we increase TOPG by 1%, W% decreases by 0.3%. Moreover, if REBPG increases by 1%, W% increases by 0.12%. The TOP-10 3×3 teams (according to FIBA 3×3 World Tour 2019) perform an average of  $15.5 \pm 1.7$  attacks in the paint and from an average distance (one-point shots),  $12.3 \pm 1.7$  2-point shooting attacks and  $3.84 \pm 0.6$  free throws per game. On average,  $8.9 \pm 0.9$  attacks from the paint zone and from an average distance were successful per game in the league (one-point goals). **Conclusions:** Our findings highlight the importance of long-range shots to win games in 3×3 basketball and improve our understanding on how teams offensively prepare themselves to beat their opponents. Coaches are recommended to pay more attention to throwing exercises beyond the arc with the resistance of a defender, from uncomfortable situations. A high proportion of training exercises should be aimed at working on blocking the opponent after the attack and fighting for the rebound of the ball. The pace and complexity of the throws should be as close as possible to the game situation. To achieve high results, it is also necessary to minimize the average turnovers per game.

**Keywords:** performance analysis, game-related statistics, elite players, 3×3 basketball, team sport

### Introduction

Three-on-three basketball is a relatively new discipline. The starting point for 3×3 basketball is considered to be 2007. In 2007, FIBA included this sport as an experiment in the Youth Olympic Games (YOG), which were held in Singapore in 2010.

Since 2011 official international competitions in this sport have been held throughout the world. Nevertheless, 3×3 basketball quickly attracted a large audience and gained popularity because it is dynamic and spectacular. On June 9, 2017, FIBA included 3x3 basketball in the 2020 Summer Olympics. Eight men's and women's strongest teams of the world participated in the main tournament of the fourth anniversary, which was held in Tokyo in 2021.

In the scientific literature, only a few studies are devoted to the topic of 3×3 basketball and its features (Montgomery et al., 2018; Conte et al., 2018, 2019). In the works of Montgomery PG there are several conclusions about certain physiological characteristics. The author states that 3×3 players demonstrate general physical characteristics similar to those of some positions described in traditional basketball (McCormick et al.,

2012; Scanlan et al., 2015; Schelling et al., 2016). Nevertheless, the physiological capabilities of 3×3 basketball players may differ significantly in comparison with the characteristics of basketball players in elite leagues. For instance, the average level of heartbeat rate during a game is  $165 \pm 18$  and  $164 \pm 12$  beats per minute-1 (bpm-1) for male and female players accordingly. At the same time, the author indicates that men's heartbeat rate ranges from 112 to 211 beats per minute during games. As for the women's heartbeat rate, it ranges from 105 to 198 beats per minute (Montgomery et al., 2018).

Daniele Conte, with the help of the "Longomatch" software (version 1.3), made several significant conclusions about the training process of the 3×3 basketball players. For instance, it should be characterized by short phases of rest between training (Conte et al., 2018, 2019). In the author's point of view, 3×3 basketball training should be focused on tactical skills' enhancement. It deals with minimizing the number of turnovers and maximizing the ability to control the ball in order to reduce the frequency of rival's offence. In his research, the author highlighted the importance of free throws.

Despite its similarities with traditional basketball (Bredt et al., 2018; Vázquez-Guerrero et al., 2019; Nieman et al., 2019), 3×3 basketball is a unique discipline since it requires specific technical, functional, tactical and psychological training. Nevertheless, in the scientific literature, only a few studies are devoted to such themes as model characteristics of 3×3 basketball or proper analysis and evaluation of statistical data. In addition, the physical and physiological characteristics of elite 3×3 basketball players competing at various international levels have not been sufficiently studied (Sampaio et al., 2006; McGown et al., 2020). The aim of the study was to identify the specific features of 3×3 basketball and analyze the factors that determine the performance of 3×3 basketball teams in official competitions.

The FIBA 3×3 World Tour is especially popular nowadays. It has been held by FIBA since 2012, and it consists of several stages that take place around the world (Pojskić et al., 2014, 2015; Sampaio et al., 2006). Only the best 12 teams get to the end of the entire season of the 3×3 World Tour. These teams should go through the Masters stage as well as Satellites stage (Cabarkapa et al., 2021; Erculj et al., 2019; Andrianova et al., 2021).

## Material & methods

### *Sample*

The FIBA 3×3 World Tour is the most prestigious among many tournaments held outdoors. The study analyzed 11 Masters stages and the final of the FIBA 3×3 World Tour (November 2-3, 2019, Utsunomiya, Japan), in which 56 teams took part (men  $n = 243$ ,  $28.4 \pm 4.1$  years,  $92.3 \pm 18.7$ kg,  $192.8 \pm 7.9$ cm). To obtain more reliable information, 29 teams were selected that won at least one victory in the tournament and played more than three games.

A deep statistical analysis of the indicators of the best FIBA 3×3 World Tour 2019 teams was conducted in order to determine the specifics of 3×3 basketball and identify the characteristic features of this sport. Shot analysis was carried out for the TOP-10 3×3 teams based on the results of the tournament, which advanced to the final stage. The data for this study was taken from statistical protocols that are publicly available on the official website of the FIBA 3×3 World Tour <https://worldtour.fiba3x3.com/2019/>.

### *Procedure*

In the first part of the study, to assess the factors that have the greatest impact on the percentage of wins of teams in the tournament, a regression analysis was conducted. All data for regression analysis were taken from statistical protocols that are publicly available on the official website of the FIBA 3×3 World Tour <https://worldtour.fiba3x3.com/2019/>.

The second part of the study was devoted to assessing the throwing activity, percentage of one-point and two-point goals realization. All final games were analyzed by video review by an experienced scouter who has 20 years of basketball experience and 5 years of basketball coaching experience. In order to analyze shots in a more detailed way, a special technique was developed. According to it, the 3×3 basketball players attack zone is divided into 14 sectors.

The first sector is a three-point zone in the corner, and the 14th sector is the paint zone. The number of attacks and the number of goals scored are presented in the table. Then, the percentage of shots from each sector is calculated. The final product is a scheme that allows you to identify the most dangerous areas of the opponent's attack and, in addition, those sectors that do not pose a particular threat.

### *Variables*

The percentage of wins (W%) in the total number of games played was taken as a performance indicator. To build a regression model, various game indicators were chosen, which are factorial manifestations. All these indicators were divided into 8 groups (Table 1).

The influence of each individual block of indicators on the effective ones was considered. Based on the consistent exclusion of factors that had a slight dependence, as well as on the results of the multicollinearity test, the most significant indicators remained for further analysis.

**Tab. 1.** Indicators affecting the performance of elite 3×3 basketball teams that were selected for analysis

Indicator and its characteristics		Index	Groups of indicators
1 group	SEFF (scoring Efficiency)	X <sub>1</sub>	Throws during the game
	SVAL (scoring Value)	X <sub>2</sub>	
	PTS (points Scored)	X <sub>3</sub>	
	PT1 (one-point goals)	X <sub>4</sub>	
	PTA1 (one-point attempts)	X <sub>5</sub>	
	PT1P (one-point goals percentage)	X <sub>6</sub>	
	PT2 (two-point goals)	X <sub>7</sub>	
	PTA2 (two-point attempts)	X <sub>8</sub>	
	PT2P (two-point goals percentage)	X <sub>9</sub>	
	FT (free throws)	X <sub>10</sub>	
	FTA (free throw attempts)	X <sub>11</sub>	
	FTP (free throw percentage)	X <sub>12</sub>	
	FTES (additional free throw)	X <sub>13</sub>	
2 group	DNK (dunk)	X <sub>14</sub>	Highlights during the game
	HGL (highlights)	X <sub>15</sub>	
	HGLPG (highlights per game)	X <sub>17</sub>	
	BZR (buzzer beater)	X <sub>18</sub>	
3 group	BS (blocks or blocked shots)	X <sub>19</sub>	Useful actions during the game
	KAS (assists)	X <sub>20</sub>	
	D5 (a player achieved in one game five or more scores in two of the following three stat categories)	X <sub>21</sub>	
	T5 (a player achieved in one game five or more scores in points)	X <sub>22</sub>	
	DRV (quick or skillful dribbling to move from behind the two-point arc to directly score a field goal from the restricted area)	X <sub>23</sub>	
4 group	REB (rebound)	X <sub>24</sub>	Rebounds during the game
	REBPG (rebounds per game)	X <sub>25</sub>	
	OREB (offensive rebounds)	X <sub>26</sub>	
	DREB (defensive rebounds)	X <sub>27</sub>	
5 group	TO (turnovers)	X <sub>28</sub>	Turnovers during the game
	TOPG (turnovers per game)	X <sub>29</sub>	
6 group	TF (team fouls)	X <sub>30</sub>	Fouls during the game
	TFA (fouls of an opponent team)	X <sub>31</sub>	
	TFAPG (fouls of an opponent team per game)	X <sub>32</sub>	
	TFFPG (team fouls per game)	X <sub>33</sub>	
7 group	W (win)	X <sub>34</sub>	General rating of wins and loses
	L (lose)	X <sub>35</sub>	
	GP (games played)	X <sub>36</sub>	
	WBL (win before the end of regular playing time)	X <sub>37</sub>	
8 group	POSPG (possession per game)	X <sub>38</sub>	Possession during the game

*Data collection and analysis*

In the process of constructing a reasonable regression model, multicollinearity was checked and a qualitative analysis was carried out based on the calculation of the results of correlations. After iterations to build the regression model, possible indicators were excluded: BZR-buzzerbitters and REB-sets. As a result of the analysis, a multiple correlation of a sufficient connection was obtained. The “normalized R-square” (0.74) indicates the influence of all effects that are obtained in the resulting model (1). All values included in the model are significant according to Fisher's perception criterion, which is less than  $\alpha = 0.05$ .

**Results**

*Regression model*

To assess the factors that influence the winning percentage (W%) in general rating of games, various indicators were selected in order to function as sustainable evidence of regression models reasonability. It should be noted that the highest percentage of the matches won (78%) belongs to the winner-team of the tournament — “Novi Sad”. Therefore, the statistics confirms the fairness of the team’s victory in the FIBA 3×3 World Tour. It was significant to consider the impact of every group of indicators on the general performance in order to assess the performance indicator (W%). Based on both elimination of factors with insignificant correlation, and the results of the multicollinearity test, the following indicators remained for further analysis. Among them are — PT1P, PT2 P, FTP, BZR, REB, REBPG and TOPG (table 1). A qualitative analysis based on results of the received correlations demonstrated that the results gathered are significant and the correlation between the

percentage of wins (W%) and factor signs is positive. After the iteration of the regression model construction, the following indicators were eliminated: BZR and REB. After excluding these factors, a new model was built (1).  $Y = -56,68 + 0,575X_6 + 0,833X_9 + 0,359X_{12} + 3,242X_{25} - 5,105X_{29}$  (1)  
It is available to consider the results of regression analysis, which are presented in table 2.

**Tab. 2.** The result of a regression analysis of indicators that affect the performance of elite 3×3 basketball teams

Regression statistics	
Multiple R-Squared	0.896162
R-Squared	0.803106
Adjusted R-Squared	0.737475
Standard error	8.671109
n	29

\*  $p < 0.05$ . n: sample size (3×3 basketball teams).

Based on the results of the study, it should be concluded that the multiple correlation is quite significant. “Adjusted R-Squared” (74%) indicates the influence of all the factors included in the model (1). In general, according to the data collected, it can be concluded that the model is adequate. Since all the variables included are significant according to the Fisher significance criterion, which is less than  $\alpha = 0.05$ . Based on the ultimate version of regression model (1), it follows that the identified factors affect the percentage of wins (W%). Hence, it means that analysis’s results can predict winners of the tournament. The influence of factors is carried out according to certain proportions presented in the table 3.

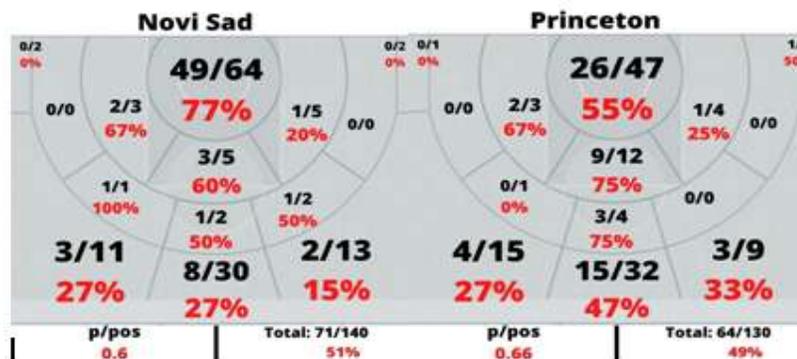
**Tab. 3.** The effectiveness of factors in terms of influencing the performance indicators

Indicators	B-coefficient	Elasticity coefficient	Delta coefficient, %
PT1P	0.007	0.659	8.996
PT2P	0.012	0.437	8.519
FTP	0.002	0.487	2.433
REBPG	0.122	1.121	23.699
TOPG	-0.398	-0.594	56.353

\*  $p < 0.05$ .

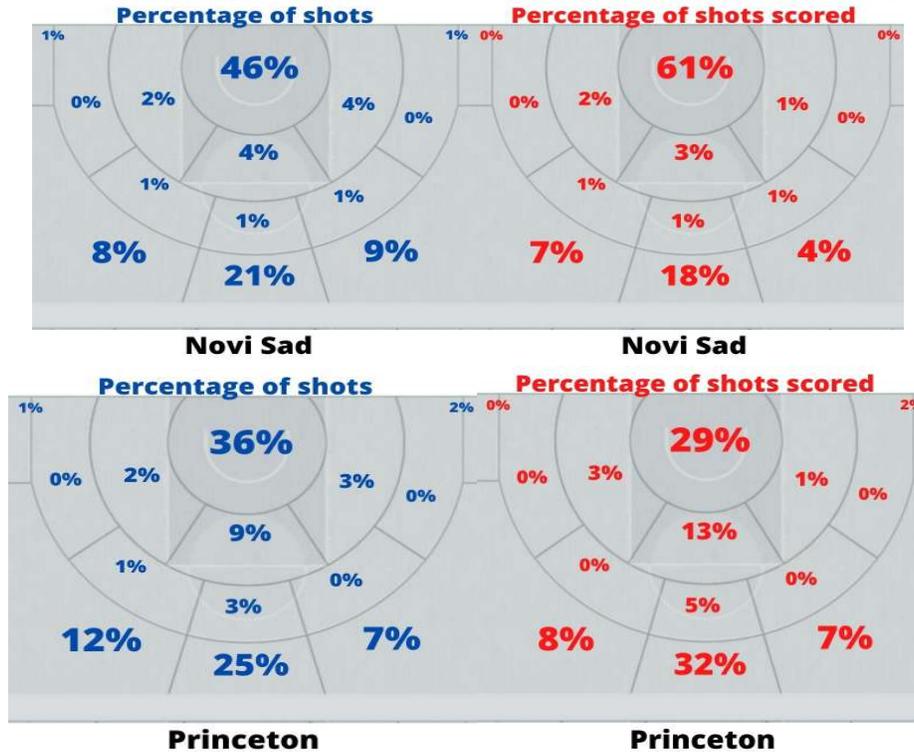
*Analysis of shooting efficiency*

On average,  $8.9 \pm 0.9$  attacks from the paint zone and from an average distance were successful per game in the league (one-point goals). From outside the arc,  $3.3 \pm 0.5$  attacks were successful (two-point goals). These numbers resulted in approximately 6.6 points per game. To continue with, players scored  $2.51 \pm 0.6$  points per game from the free-throw line. In order to analyze shots in a more detailed way, a special technique was developed. According to it, the 3x3 basketball players' attack zone is divided into 14 sectors. The first sector is a three-point zone in the corner, and the 14th sector is the paint zone (Sampaio et al., 2006; Zuzik et al., 2011; Puente et al., 2017). The number of attacks and the number of goals scored are presented in the table. Then, the percentage of shots from each sector is calculated. The final product is a scheme that allows you to identify the most dangerous areas of the opponent's attack and, in addition, those sectors that do not pose a particular threat.



**Fig. 1.** The analysis of top-teams' shots across the areas of the court at the FIBA 3×3 World Tour 2019 finals in Utsunomiya

Figure 1 graphically shows the throwing activity of the “Novi Sad” and “Princeton” teams. These teams were the leaders of the 2019 season. According to the figure, it is possible to trace zones with the greatest number of attacks and the percentage of shots scored. Therefore, “Novi Sad” performed the largest number of attacks in the paint (64 attacks with a 77% realization percentage). Furthermore, 56 attacks were made from outside the arc, with the highest proportion of throws being made in the central zone (30 attacks or 21% of the total percentage of shots).



**Fig. 2.** Percentage of the “Novi Sad” and “Princeton” team’s shots and shots scored at the FIBA 3×3 World Tour 2019 finals, Utsunomiya

Figure 2 shows that the “Princeton” team demonstrates a slightly different tactic. The strategy includes more attacks and points scored from outside the arc than in the paint (7.6 points from outside the arc and 7.4 points scored in the paint). The percentage of two-point shots from the point area was 47%, which is a very high indicator (Berkelmans et al., 2018). Also, figure 2 shows that the percentage of shots from the point area from outside the arc is higher than in the point zone in the total percentage (32% vs. 29%). Hence, the “Princeton” team focuses on shots from outside the arc, since the cost of such shots is twice as much as any other shots in 3×3 basketball.

**Discussion**

*Regression model*

Results show that the factor of TOPG (56.4%) has the greatest influence. Nevertheless, REBPG (23.7%) also has a significant impact on a game performance (table 3). If we add an increase of one percent to TOPG, the percentage of wins decreases by 0.3 percentage points. Furthermore, if we add an increase of one percent to REBPG, the percentage of wins increases by 0.12 percentage points. It is also worth considering that when applying the mean square deviation by 1% for these indicators, the ultimate result of the indicators changes by -0.594 percentage points and 1.121 percentage points accordingly. Other factors related to the performance indicator turned out to be less significant in correlation with the percentage of team wins (Fox et al., 2017).

*Analysis of shooting efficiency*

The first place in PTS (points scored) in the FIBA 3×3 World Tour 2019 belongs to the Serbian team “Liman”. The team scored 902 points in 48 matches. However, the “Novi Sad” team demonstrated the highest performance indicators per game on average (19.5 points on average per game). The “Riga” team (19.2 points on average per game) and “Liman” (18.8 points on average per game) have a slightly lower performance indicator. In summation, the factor of points scored on average was  $17.9 \pm 1.1$  for the analyzed group. More than that the “Liman” team showed the highest level of scoring efficiency and scoring value in 2019 (S-EFF — 16 and S-VAL — 32).

As for WBL (Win before the end of regular playing time), in 3×3 basketball a match is over when the regular playing time ends or when the first team scores 21 or 22 points (in case a team with 20 points scores a two-point goal). Judging by the WBL indicator, the “Liman” (23) and “Novi Sad” (22) teams dominate among others (table 4). BZR are the last shots scored at the end of the game or at the moment when a team reaches 21 points before the end of playing time. Also, it can be referred to in case with an equal score, which can influence the outcome of the game in favor of one of the teams during the last 5 seconds of playing time, or overtime or reaching 21 points. Judging by the BZR indicator, the team from the USA “NY Harlem” (6) was a clear leader in 2019. After analyzing the data, it was found that the TOP-10 3×3 teams (according to FIBA 3×3 World Tour 2019) perform an average of  $15.5 \pm 1.7$  attacks in the paint and from an average distance (one-point shots),  $12.3 \pm 1.7$  2-point shooting attacks and  $3.84 \pm 0.6$  free throws per game (Figure 1). The difference between the number of throws made in the paint per game and from behind the arc is quite insignificant. For some teams, this difference is in 1-2 shots.

The percentage of shots scored in the paint and from an average distance per game was  $58 \pm 4.6$  in the FIBA 3×3 World Tour season in 2019. As for shots from outside the arc, it was  $26.9 \pm 2.5$ . Finally, for free throws -  $65.2 \pm 6.1$ . The highest percentage of one-point shots scored was demonstrated by two Serbian teams — “Novi Sad” (65%) and “Liman” (65%). According to the percentage of shots from outside the arc, two American teams dominate among others — “Princeton” (31%) and “NY Harlem” (30%). The percentage of free throws scored ranged from 51% to 74% among the teams. The leader in this indicator is, again, American athletes — “Princeton” (74%). It should be noted that for some teams, in value terms, the probability of points scored from outside the arc is higher than from the middle distance and from the paint as well (“Riga” - 8.8 points from outside the arc and 8.4 points from the paint; “Princeton” — 7.6 points from outside the arc and 7.4 points from the paint). The results gathered allow us to conclude that the value of downtown shots is significant in 3x3 basketball. Generally, players and teams focus on shots from outside the arc. It is confirmed by the number of two-point attacks that teams perform on average per game.

## Conclusion

1. Based on the results of Correlation and Regression Analysis, a predictive model of the influence of certain factors on the performance indicator W% (percentage of wins) was built. The analysis of these factors included in the model allowed us to draw the following conclusions: the factor of TOPG (turnovers per game) has the greatest influence on the share of wins — 56.4%. Nevertheless, rebounds per game also has a significant share of influence — 23.7%. If we add an increase of one percent to TOPG, the percentage of wins decreases by 0.3 percentage points. Moreover, if we add an increase of one percent to REBPG, the percentage of wins increases by 0.12 percentage points. It is also worth considering that when applying the mean square deviation by 1% for these indicators, the ultimate result of the indicators changes by - 0.594 percentage points and 1.121 percentage points accordingly.

2. The TOP-10 3×3 teams perform an average of  $15.5 \pm 1.7$  attacks in the paint and from an average distance (one-point shots),  $12.3 \pm 1.7$  2-point shooting attacks and  $3.84 \pm 0.6$  free throws per game. The difference between the number of throws made in the paint per game and from behind the arc is quite insignificant. For some teams, this difference is in 1-2 shots. This fact highlights the tendency among 3x3 basketball players and teams to focus on shots from outside the arc.

3. On average,  $8.9 \pm 0.9$  attacks from the paint zone and from an average distance were successful per game in the league (one-point goals). From outside the arc,  $3.3 \pm 0.5$  attacks were successful (two-point goals). These numbers resulted in approximately 6.6 points per game. To continue with, players scored  $2.51 \pm 0.6$  points per game from the free-throw line. The percentage of shots scored in the paint and from an average distance per game was  $58 \pm 4.6$  in the FIBA 3x3 World Tour season in 2019. As for shots from outside the arc, it was  $26.9 \pm 2.5$ . Finally, for free throws —  $65.2 \pm 6.1$ . Despite the large number of shots from outside the arc, the percentage of such shots scored still requires an increase. To improve the situation, it is necessary to develop training tasks aimed at increasing the percentage of shots from outside the arc in 3×3 basketball.

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