Analysis on the competition ability of men's 3x3 basketball Team in Tokyo Olympic Games Based on TOPSIS-RSR analysis

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Abstract—To explore the rationality of the men's three-person basketball team's ranking of offensive and defensive capabilities and the rationality of equipment division in the Tokyo Olympics, the three players participating in the Tokyo Olympics were analyzed using literature, video observation, TOPSIS and RSR methods. The offensive and defensive indicators of the eight basketball teams are statistically analyzed. The research results showed that the eight competing offensive and defensive CI values were significantly correlated with the actual rankings ($P<0.05$). The Russian team had the highest gross Ci value; the Latvian team had the highest defensive Ci value; the Serbian team had the highest overall offensive and defensive Ci value. In terms of division, there are 3 teams in the first division (Latvia, Serbia, and Russia); 4 in the second division (China, Holland, Belgium, and Japan); and 1 in the third division (Poland). This study uses the TOPSIS method and the RSR method to comprehensively quantify the competition ability analysis and gear division of the eight participating teams in the Tokyo Olympics, and provide a reference for future three-person basketball analysis.

Keywords-Tokyo Olympic Games; Three-man basketball; Attack and defense ability analysis; TOSIS - RSR method

1. INTRODUCTION

According to a study conducted by the International Olympic Committee, three-on-three basketball has become the most popular sport played in cities around the world[1]. At the 32nd Summer Olympics (Tokyo Olympics in 2020), three-person basketball entered the Olympic arena for the first time, greatly enhancing the international influence of three-person basketball. Therefore, by combining the TOPSIS method and the RSR method, the offensive and defensive indicators of the eight teams participating in the three-player basketball match of the Tokyo National Games were analyzed, and the equipment was divided. This article summarizes the competitive performance characteristics and landscape of the three major categories of men's basketball in the world through a comprehensive quantitative analysis.

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2. RESRARCH OBJECTS AND METHODS

2.1 Subjects

The research object is the performance of the Three men's basketball team in the Tokyo Olympic Games against the eight teams (Latvia, Russia, Serbia, Belgium, Netherlands, Japan, and Poland).

2.2 Research methods

2.2.1 Video observation method: By repeatedly watching all the men's three-man basketball games in Tokyo Olympic Games, the focus is on selecting and applying the players' skills in the competition and the problems in the basketball match and obtaining first-hand information by recording.

2.2.2 TOPSIS analysis: TOPSIS method, first proposed by C. L. Wang and K. Yoon in 1981, is a commonly used intra-group comprehensive evaluation method. It can make full use of the information from the original data, and its results can accurately reflect the gap between the evaluation schemes. The basic process is to find the best and worst schemes in the limited scheme by cosine method based on normalizing the original data matrix, and then calculate the distance between each evaluation object and the best and worst scheme respectively, and obtain the relative proximity and optimal scheme of each evaluation object as the basis for evaluation. This method has no strict data distribution and sample size limitation, and data calculation is simple and easy.

2.2.3 RSR analysis: RSR method is an evaluation method that reflects the comprehensive evaluation of multiple indicators in different measurement units based on the average value of row or column order. According to the characteristics of the RSR method, it can be concluded that the greater the VALUE of RSR, the stronger the team strength, and vice versa.

3. RESULTS AND ANALYSIS

3.1 TOPSIS analysis of the competition ability of each team in men's three-man basketball event of Tokyo Olympic Games

3.1.1 Selection and normalization of attack and defense indicators: In order to meet the demands of this study, based on relevant experts' consultation, consult literature as well as to the Tokyo Olympic Games after the official statistics, the averaged, 1 points to a number, 1 points and shoot number, 1 PPG shooting 14 indexes such as well as the evaluation index, of which only averaging tos as negative indexes, the rest are a positive indicator. Subsequently, 5 indexes including points lost per game and shots blocked per game were selected as defensive evaluation indexes, among which only the number of shots blocked per game was a positive

index, and the rest were all negative indexes (see Table 1 and Table 2), in order to reflect the comprehensive ability of the team[1].

Table 1 Some offensive and Defensive skills of men's Three-man basketball Teams in Tokyo Olympic Games (1)

Team	PPG	1 goal (per game)			2 goals (per game)			Free throws (per game)		
		1PTA	1PTM	1PT%	2PTA	2PTM	2PT%	FTA	FTM	FT%
Latvia	19.6	14.7	9.5	64.6	12.2	3.9	31.9	2.7	2.1	85.2
Russian	17.6	15.4	9.1	59.1	12.1	3.2	26.4	2.8	2.7	75.0
Serbia	18.8	15.0	10.6	70.4	8.9	2.8	31.3	3.1	2.3	85.7
Belgium	16.0	14.1	8.9	62.8	14.9	4.0	26.9	3.0	2.1	66.7
Netherlands	18.9	15.8	8.0	50.7	10.9	3.1	28.6	2.4	2.0	72.7
Japan	17.6	15.4	8.1	52.8	11.3	3.9	34.4	2.3	1.8	77.8
Poland	17.1	13.7	7.6	55.2	14.6	4.4	30.4	1.3	1.8	55.6
Chinese	17.0	17.0	10.6	62.2	9.4	2.1	22.7	3.3	2.1	65.2

Table 2 Some offensive and Defensive skills of men's Three-man basketball Teams in Tokyo Olympic Games (2)

Team	TEAPG	KASPG	OREBPG	DREBPG	TFPG	PAPG	BSPG	TOPG	RLPG
Latvia	6.3	4.1	5.8	8.9	7.0	17.3	1.0	4.2	11.8
Russian	6.8	3.4	6.0	9.0	6.0	17.5	0.5	4.9	11.3
Serbia	7.0	4.7	4.3	9.3	6.7	13.6	0.8	4.8	13.5
Belgium	6.7	2.7	4.9	7.7	6.9	18.8	2.0	4.4	15.5
Netherlands	7.6	3.6	4.9	10.3	6.6	18.8	1.3	3.6	16.7
Japan	6.9	2.1	5.0	9.4	6.8	19.4	1.0	5.9	14.7
Poland	6.0	2.7	4.7	9.9	7.6	18.6	0.6	4.0	17.7
Chinese	6.9	4.0	5.3	10.3	6.9	20.3	1.4	4.1	15.4

First, the indexes of all the participating teams were standardized, and the original index data was set as $X_1, X_2...X$, standardized matrix Y is obtained after standardizing the data of each indicator

$$Y_{ij} = \frac{X_{ij} - X_i^{min}}{X_i^{max} - X_i^{min}} \quad (1)$$

3.1.2 Determine the positive ideal solution and negative ideal solution of attack and defense indicators: At the same time, according to the standardized attack and defense matrix Y, the optimal solution set S of each attribute index is obtained from the ideal solution formula and the negative ideal solution formula$^+$ And the worst solution set S of each attribute index$^-$. The calculation formula is:

$$S^{+} = \max(r_{1j}, r_{2j}, \cdots\cdots, r_{mj}) \tag{2}$$

$$S^{-} = \min(r_{1j}, r_{2j}, \cdots\cdots, r_{mj}) \tag{3}$$

The optimal solution vector and the worst solution vector of the attack index and defense index of each team in the Tokyo Olympic Games are:

S^{+}_{OFF}= (1.6542, 1.9626, 4.8741, 2.3517, 3.9525, 2.4580, 2.2922, 3.6487, 2.0441, 8.5420)

S^{-}_{OFF}= (0.5922, 0.5888, 0.5703, 0.5409, 0.6324, 0.4916, 0.5960, 0.6203, 0.6746, 0.7689)

S^{+}_{DEF}= (0.5009, 0.7233, 0.6203, 0.6349, 0.8012, 0.6006)

S^{-}_{DEF}= (1.9265, 4.8219, 3.6487, 3.9680, 1.1958, 9.3846)

3.1.3 The distance between ideal solution and negative ideal solution of each team's offensive and defensive indicators: Then the distance between the index vector and the superior solution is obtained. D_i^{+}Is the distance between each team's indicator vector and the ideal solution, and D_i^{-} is the distance between each team's indicator vector and the negative ideal solution (see Table 3).

$$D_i^{+} = \sqrt{\sum_{j=1}^{n}(r_{ij} - r_j^{-})^2} \tag{4}$$

$$D_i^{-} = \sqrt{\sum_{j=1}^{n}(r_{ij} - r_j^{-})^2} \tag{5}$$

3.1.4 Calculate Ci of the relative proximity between attack and defense indexes and ideal solution: The last step is to calculate the performance evaluation value *C* of different indicators of each team$_i$(See Table 3), where $0 \le C_i \le 1$, the closer *Ci* value is to 1, the closer *Ci* means the evaluation object is to the ideal solution. The closer the value is to 0, the closer the evaluation object is to the negative ideal solution. In short, the greater the performance evaluation value, the better the performance[2].

$$C_i = \frac{D_i^{-}}{D_i^{+} + D_i^{-}} \tag{6}$$

Table 3 TOPSIS analysis of each index of the three-man basketball teams in Tokyo Olympic Games

Team	Rank	OFF			R	DEF			R	OFF and DEF			R
		d^{+}	d^{-}	C_i		d^{+}	d^{-}	C_i		d^{+}	d^{-}	C_i	
Latvia	1	0.290	0.403	0.581	1	0.349	0.393	0.530	2	0.317	0.390	0.552	1

Russian	2	0.273	0.413	0.602	3	0.412	0.451	0.523	1	0.331	0.412	0.555	3
Serbia	3	0.322	0.428	0.570	2	0.395	0.443	0.529	3	0.326	0.443	0.577	2
Belgium	4	0.386	0.313	0.447	5	0.424	0.383	0.475	7	0.398	0.341	0.461	6
Netherlands	5	0.390	0.322	0.452	6	0.431	0.309	0.417	5	0.403	0.322	0.444	5
Japan	6	0.452	0.272	0.375	7	0.458	0.252	0.355	6	0.458	0.266	0.368	7
Poland	7	0.507	0.262	0.341	8	0.570	0.181	0.241	8	0.530	0.244	0.315	8
Chinese	8	0.363	0.374	0.508	4	0.457	0.328	0.418	4	0.400	0.361	0.474	4

As can be seen from Table 3, Latvia, Russia, and Serbia, which won the first, second and third place respectively in the three-person basketball event of Tokyo Olympic Games, ranked C in the index of offensive ability Serbia narrowly won the first place, followed by Russia and Latvia. In contrast, China, The Netherlands and Belgium ranked the middle with 0.504 points, 0.458 points and 0.453 points, respectively. Japan and Poland scored only 0.373 points and 0.346 points respectively, ranking the last. According to the analysis of the offensive Ci value of the eight teams in Table 4 and Pearson's match ranking, the gross Ci value of the men's three-person basketball team of the Tokyo Olympic Games and its actual ranking have a correlation coefficient of R =725 and P<0.05. It indicates that the mean Ci value can objectively and accurately reflect the overall offensive strength of the eight teams.

Table 4 Correlation between the actual ranking and Ci value of men's three-man basketball teams in Tokyo Olympic Games

		OFF CI value	DEF CI value	OFF and DEF CI value
The actual ranking	Pearson Correlation	0.725*	0.798*	0.749*
	Sig. (2-tailed)	0.042	0.017	0.032
	N	8	8	8

Note :* represents P <0.05 with significant difference,** represents P <0.01 with very significant difference

Latvia, Russia, and Serbia all scored more than 0.5 points in terms of defensive ability, and the gap is small, belonging to the solid defensive team. Belgium, China, and the Netherlands ranked 4th, 5th, and 6th respectively in scoring, while Japan and Poland struggled a little defensively and ranked bottom with 0.355 and 0.241 points. In addition, the correlation coefficient r=0.798(P<0.05) from the correlation between the defensive *Ci* value of each team and the actual ranking also indicates that the defensive *Ci* value has a specific influence on the actual ranking.

In terms of comprehensive offensive and defensive ability, the top three teams are Also Serbia, Russia, and Latvia, with the three teams scoring more than 0.55 points, reflecting strong offensive and defensive balance. In the middle position, the Chinese team, the Belgium team, the Netherlands team attack, and defense ability are general. Japan and Poland are still at the bottom because of poor performance at both ends of the attack and defense. In addition, the correlation coefficient r=0.749(P<0.05) between the *Ci* value of each team and the actual ranking shows a significant correlation, indicating that the *Ci* value of each team can reflect the

offensive and defensive capabilities, and the *Ci* value of each team has a ~~great~~ significant influence on the actual match.

To sum up, in the Tokyo Olympic Games men's basketball three-man team competition formed a "three-legged stand-up, the men's competition" situation. Latvia, Russia, and Serbia are equal in attack and defense and overall attack and defense analysis. The result depends on the performance of the three teams on the field, while the rest have their characteristics in different areas. It is worth mentioning that although the Chinese team's performance in this competition is not good but combined with the relevant analysis and detailed game process, not as bad as the final performance reflected. Although there is a gap between the world's top teams in all aspects, the Chinese team in this Olympic Games still show their characteristics, showing the advantages are also worthy of recognition.

3.2 RSR comprehensive strength classification and team gear analysis

RATING THE RESEARCH RESULTS IS NOT EASY because TOPSIS evaluation results are easily affected by extreme measured values. RSR can make up for the limitations of TOPSIS, and the combination of TOPSIS and RSR can overcome the loss of original information caused by the non-parametric transformation of competition statistics by the RSR method[3]. In order to understand the competition pattern of each team in the three-person basketball event of the Tokyo Olympic Games, the RSR value of each team is calculated first, and the calculation formula is $RSR=\sum R/(m\times N)$. Where $\sum R$ represents the rank sum of evaluation indexes of an integral object, M is the number of evaluation indexes, and N is the number of evaluation objects. Then, the specific low cumulative frequency of Probit value is used to understand the distribution of RSR of each team and make the optimal classification. Researchers sort the RSR values for each team from small to large, list the frequencies and cumulative frequencies for different groups, and calculate the cumulative percentage P. The corresponding probability unit value X finds the value of percentage P in the percentage and probability unit comparison table(see Table 3). f∑f is finally based on probability unit value X as the argument, RSR value as the dependent variable estimated regression equation. Secondly, a significance test was carried out on the regression equation, and the correlation coefficient r value of the regression model was 0.945, F=103.910 (P<0.01). The equation was reliable, and the coefficient had very significant significance, indicating that the linear regression equation obtained was statistically significant.

Then by using the grading principle of the RSR method and combining the best grading principle, grading number table and offensive and defensive RSR value, the eight teams of men's three-person basketball in the Tokyo Olympic Games can be divided into three grades[6] (See table 5, table 6). Among them, Latvia, Serbia, Russia team excellent performance in the first tier of offensive and defensive strength; The RSR values of China, Netherlands, Belgium and Japan's offensive and defensive strength ranged from 0.420 to 0.578, ranking in the second tier. On the other hand, Poland is a third-tier team with poor performance at both ends of the attack and defense. Cavalier statistic=0.472 according to homo VENe VARIANCE test, P>0.05, IT is considered that the variance of all levels is homogeneous, meeting the prerequisite condition of variance test. Variance test F=66.297, P<0.05, the difference between each grade was statistically significant. Pairwise comparison by SNK-Q test showed P<0. 05, and the difference

between each grade was statistically significant. Therefore, classification was considered adequate .

Table 5 Distribution of offensive and defensive RSR values of men's three-man basketball teams in Tokyo Olympic Games

Team	Rank	RSR	f	$\sum f$	$\overline{R}$	$(\overline{R}/n)*100\%$	Probit
Latvia	1	0.349	1	1	1	12.5	3.850
Russian	2	0.447	1	2	2	25.0	4.326
Serbia	3	0.479	1	3	3	37.5	4.681
Belgium	4	0.485	1	4	4	50.0	5.000
Netherlands	5	0.517	1	5	5	62.5	5.319
Japan	6	0.558	1	6	6	75.0	5.674
Poland	7	0.615	1	7	7	87.5	6.150
Chinese	8	0.631	1	8	8	100.0	6.863

Table 6 Grade classification of men's three-man basketball teams in Tokyo Olympic Games

The grade of	P	Probit threshold	RSR threshold	N	Sorting and filing
First gears	$P_{72.575}$	5.6 ~	> 0.543	2	1. Latvia 2. Serbia
Second gears	$P_{22.663}$	4.25 ~	> 0.420	5	3. Russian 4. Chinese 5. Netherlands 6. Belgium
Three gears	$<P_{22.663}$	< 4.25	< 0.420	1	7. Japanese 8. Poland

4. DISCUSS

Latvia, Russia, and Serbia, who won the championship and the runner-up, are all ranked first, according to the ranking results of the men's three-man basketball teams in Table 6. Surprisingly, China is in eighth place, with the Netherlands, Belgium, and Japan in second place, ahead of the other three teams. It is not difficult to find the final ranking and classification results and the actual venue of the game. There is a distinct difference, especially the Chinese team. Although the ranking is at the bottom, accurate sorting and grading results are not so bad. Nevertheless, this is the TOPSIS method and RSR method to evaluate the team's overall strength of objectivity and accuracy, objectively reflecting the participation in the Tokyo Olympic Games men's three-man basketball team's comprehensive strength.

To sum up, the European teams, led by Latvia, Russia, and Serbia, showed a clear advantage in the Olympic debut of the three-person basketball tournament, with the three teams entering the top three with a more balanced attack and defense. Asian teams, represented by China and Japan, have shown strength in some respects, but there is still a gap between the overall strength of the team and the solid European team. Only six European teams competed in the men's triathlon, with the United States, Spain, and Australia missing out on the five-a-side event. It shows the leading position of European countries in the development of three-a-player basketball and reflects the completely different competitive pattern of men's three-a-side basketball and men's five-a-side basketball.

In the analysis of attack and defense indicators, it can be found that the system of players in three basketball games due to changes in the rules of the game (less and fewer players on the field, more petite balls, shorter game time, and shorter attack time), plus three basketballs are outdoors, but also by the wind, sunlight, heat and other external factors, which will lead to 6.75m after the shooting performance is worse[4]. As a result, even the team with the highest offensive Ci in Tokyo shot only 31.9 per cent from the 3-point range. At the same time, Davniukas J's research also shows that in the three-person basketball event, the average person is 42m compared with the five-a-side basketball due to the narrowing of the playing field. The average size of three-player basketball is only 27.5m^2. Moreover, in three-player basketball, the scoring type is 2 and 1, and the return on long shots is 2 times, while in five-a-side basketball, the return is 1.5 times. So teams that take more shots and play better from the 2-point line tend to do better than teams that rely on 1-point shooting[5].

5. CONCLUSION

Latvia, Serbia, and Russia have the most substantial offensive capabilities in terms of offensive strength, while China, Belgium and the Netherlands have the most potent attacks, and Japan and Poland have the weakest attacks. However, no matter which team did not establish an absolute advantage on the offensive end, and the advantage is obvious, the disadvantage is obvious. Russia leads the defensive ratings with high scores, followed by Serbia, Latvia, and Belgium, with strong defensive capabilities, while the rest of the Netherlands, China, Japan, and Poland all show different weaknesses on the defensive end.

Latvia, Russia, and Serbia are similar in evaluating the comprehensive strength of attack and defense. Serbia, the runner-up, led the way by a narrow margin, followed by Latvia and Russia, followed by China, the Netherlands and Belgium. Japan and Poland did not perform well in attack and defense, with both teams bottoming out in the overall strength evaluation.

According to the RSR value of the attack and defense ability of 8 teams, the teams that will participate in the three-person basketball tournament of the Tokyo Olympic Games are divided into three levels. Latvia, Serbia, and Russia have strong attack and defense performance, located in the first tier, while China, the Netherlands, Belgium, and Japan are ranked second, each with distinctive offensive and defensive characteristics. Poland is the worst performing team overall, only in the third tier.

Six of the eight teams participating in the men's three-a-side basketball event of the Tokyo Olympic Games are European teams, which shows that European countries take the leading

position in developing this emerging sport of three-a-side basketball and reflect the competition pattern utterly different from that of men's five-a-side.

Using TOPSIS and RSR methods against the Tokyo Olympic Games, men's basketball defense comprehensive strength ranked eighth team step, found that once dominated the bottom of the ranking of China's comprehensive strength and the actual league there is a large gap. However, the facts show that the Chinese team on the inside line showed a particular offensive and rebounding advantage, but the improvisational play needs to be improved. It is believed that TOPSIS and RSR methods have some reliability and reference value for the comprehensive evaluation and classification of the offensive and defensive strength of the three basketball.

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