

Research Article

The Research of Key Indicators of Performance to Predict to Advance the Knock Out Stage in the International Football Tournament

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The aim of this research was to analyse football tournaments, UEFA Euro 2021 and Copa America 2021, to provide statistical measurement to predict which teams were likely to be qualified to the next round in the knockout stage. The research method used to collect six key variables statistics including total attempts, on target, possession, passes attempted, passing accuracy, and corners taken from 79 matches in UEFA Euro 2021 and Copa America 2021. The data were analysed by the grey relational analysis (GRA). The results were as follows: first, this study presented variables related to goals scored and offense correlated on goals scored. Second, this study proposed a GRA model that provides an efficient way to predict match outcomes. Third, the GRA model will perform better than the FIFA world ranking when more teams participated and the world ranking were tight.

1. Introduction

Association football, or simply ‘football,’ is the most played, popular, watched, and highly remarkable sport in the world [1–5]. It constitutes a global economics and business and is the fastest-growing gambling market in the sport industry [1, 2, 5]. According to the International Federation of Association Football (FIFA) report, all teams that have advanced to the next round in the previous FIFA World Cups finals are located in Europe and South America. Obviously, UEFA European Football Championship and Copa America are the primary association football tournaments in the world. The intensity and visibility of the event even surpassed that of the World Cup.

All football fans focus on their favourite teams to win the game and advance in the knockout stage whether the game is professional or a tournament game. This study explored the team's performance on the pitch. In addition, a study on the Spanish league found that the variable including total shots, shots on target, crosses, crosses against, ball possession, and match location had the greatest discriminatory power between winners and losers [6]. Castellano et al. [7] also found that the variables such as total shots, shots on target, and ball possession had the greatest discriminatory power with regard to matches played in three World Cups (2002, 2006, and 2010). Zhou et al. [8] found that winning teams were significantly higher in the game statistics on shots, shots on target, 50–50 challenge

won, offside, sprinting distance, sprinting effort, sprinting distance in ball possession, and high-speed-running distance in ball possession. Harrop and Nevill [9] found that the teams' performance has fewer passes but completed more successful passes and shots to be successful. Based on the previous studies, team performance on the pitch is a critical factor of winning the game and advancing in the knockout stage [6–11].

Performance measurement of football teams requires taking into account various indicators [3] as a multicriteria decision making issue. There are many studies that applied the multicriteria decision making (MCDM) method to many fields, such as industry, commerce, education, transportation, tourism, management, and computer-aided engineering. [12]. However, it is rarely applied in sport particularly in football [3, 12]. Nevertheless, the MCDM method has been one of the rapid-growing decision science areas that enable decision makers to choose, rank, and sort problems among finite set of alternatives with many conflicting criteria [13]. Qader et al. [5] mentioned that the MCDM method is a simple, clear, suitable to substantiate solutions, and easily applicable in practice.

As mentioned before, winning a football match, whether it is a professional league or a tournament, means that you have to score more goals than your opponent do. Therefore, scoring goals is vital skill for a football match. Scoring a goal is generated by a series of technical variables cooperation [3, 6–11, 13]. Many studies have focused on which technical variables is significant impact on scoring goals [6–10, 14–16]. They have provided an understanding of technical variables that were important to score goals. In the past ten years, most of the research focused on professional leagues [1, 6, 8–10, 14–16] than tournaments as a research object [3, 7, 13]. Due to the differences between tournaments and professional leagues, the duration of the tournament is short and there are less matches than professional leagues. There are less statistics of scoring goals, and the winning probability only can be judged by the performance. Fortunately, in recent years, the search engine Google has provided information and related technical variables data on major sports events such as UEFA European Football Championship and Copa America. This is not only convenient for fans but also an opportunity for analysis for doing relevant research studies.

In this study, we intend to use a simple and understandable MCDM method, namely grey relational analysis (GRA). Pradhan [17] ranks the regular season in the NBA using grey relational analysis to analyse which teams' performances were better than others were in the knock stage in the international football tournament. We initially used GRA to measure criteria of technical variable. We then use GRA to appraise the overall performance of teams in UEFA Euro 2021 and Copa America 2021. In the second section of this study, we illustrate the materials and GRA methods. In the third part, we illustrate and discuss empirical analysis about UEFA Euro 2021 and Copa America 2021 teams; in the last part of the study, we draw conclusions by empirical analysis.

2. Methods and Data

The study applied Google to collect the data of UEFA Euro 2021 and Copa America 2021. The reliability of statistics of UEFA Euro 2021 was assessed by the UEFA official website (uefa.com) which provides game stats, and the data were compared with those provided by Google. The intraclass correlation coefficient (ICC) values were recorded from 0.932 to 0.995. For the Copa America 2021, we invited 2 football analysers who randomly reanalysed 6 knock out stage matches (30% of the total) via the official broadcasting signal to verify the results provided by Google. The ICC values were calculated to compare using the Google website, and the ICC values were recorded from 0.924 to 0.973. This study comprises seven technical variables that show the performance of football teams in the knock out stage of UEFA Euro 2021 and Copa America 2021. In the data applied, the technical variables correspond to values of the teams, not to the individual values of the players. All the seven technical variables were used as criteria including goals, total attempts, on target, possession, passes attempted, passing accuracy, and corners taken. Variables, except for goals, are all related to goals and offenses including total attempts, on target, possession, passes attempted, passing accuracy, and corners taken [6, 10, 11, 18]. Before using GRA, we used regression analysis in which goals were the dependent variable, and total attempts, on target, possession, passes attempted, passing accuracy, and corners taken were independent variables. The analysis results showed that the R-squared values were 0.623 (UEFA Euro 2021) and 0.548 (Copa America 2021). It means that the technical variables cited in this study have good explanatory power for goals.

3. Grey Relational Analysis (GRA)

In order to analyse the data, we conducted a GRA to determine each team's performance with respect to their UEFA Euro 2021 or Copa America 2021 rivals. GRA is a multistep procedure that provides a comprehensive ranking system for sets of data [4, 17, 19]. According to Chuang et al. [19], GRA is one of very popular methods to analyse various relationships among the discrete data sets and make decisions in multiple criteria situations. Thus, this study uses GRA to calculate the weight of goals impact criteria (total attempts, on target, possession, passes attempted, passing accuracy, fouls committed, off sides, and corners taken) and team of performance in the knock out stage. Steps for GRA are as follows:

Step 1. Reference and comparison sequences generation.

Find the reference sequence x_0 and comparison sequences x_1, x_2, \dots, x_n from the original matrix A . Reference sequence in this study refers to the set of goals for each criteria, while the comparison sequence is the performance index for each team.

Step 2. Original matrixes normalization.

The benefit or defect types of criteria are both applied in sports research. In this research, the criteria of benefit types

such as on target and possession are the more the better, and fouls (defect type) are as few as possible. However, the target type is used mostly in the industrial field, such as the size of the screw cap, the smaller the error value, the better, so the screw cap size will be applied the target type, but the error value will also be the defective type. In addition, the criteria used in this study are all offensive-related criteria which are benefit type adopting to normalize the sequences.

There are three different methods of normalizing the sequences including benefit type, defect type, and target type methods. In this study, only the first method is used.

The benefit type method indicates that the larger target value is better. The calculation is as follows:

$$X_{ij}^* = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \quad (1)$$

where $\max_i x_{ij}$ is the largest value in index j and $\min_i x_{ij}$ is the smallest value in index j .

Step 3. Grey relational distance Δ_{0i} calculation. Δ_{ij} measures the distance between each comparison and reference sequences after normalization and is calculated as follows:

$$\Delta_{ij} = |x_{0j}^* - x_{ij}^*|, \quad (2)$$

where x_{0j}^* is normalized reference sequence value and x_{ij}^* is the normalized comparison sequence value.

Step 4. Grey relational coefficient Y_{0ij} calculation.

The following shows the calculation for Y_{0ij} :

$$Y_{0ij} = \frac{\Delta \min + \xi \Delta \max}{\Delta_{ij} + \xi \Delta \max}, \quad (3)$$

where $\Delta \max = \max_{vi} \max_{vj} \Delta_{ij}$, $\Delta \min = \min_{vi} \min_{vj} \Delta_{ij}$, and $\xi \in [0, 1]$. ξ is the distinguishing coefficient whose purpose is to expand or compress the range of the grey relational coefficient. Generally, 0.5 is taken as a benchmark [19].

Step 5. Grey relational grad Γ_{0i} calculation.

For each scenario, multiply the grey relational coefficient with the weights of each criterion and the weighted average obtained is the grey relational grade that indicated the degree of similarity between the comparison and reference sequence. The higher grey relational grade is better.

$$\Gamma_{0i} = \sum_{j=1}^n w_j \times Y_{0ij}, \quad (4)$$

where w_j is weight and $\sum_{j=1}^n w_j = 1$ denotes the normalized weight.

Step 6. Grey relational sequencing

Weights of criteria impact goals are ranked by the grey relational grade. The greater grey relational grade Γ_{0i} indicates its greater weight. Furthermore, in terms of team performance, the greater grey relational grade Γ_{0i} indicates the better team performance.

4. Result

4.1. Weights of Criteria and Team Performance in Knock Out Stage. In this study, we used the data from UEFA Euro 2021 and Copa America 2021. In UEFA Euro 2021, there were 24 teams divided into 6 groups in the knock out stage in which each team had played three games to qualify for the round of 16. Likewise, in the Copa America 2021, there were 10 teams divided into 2 groups and each team had played 4 games to qualify for the quarter-finals in the knock out stage. In order to find out how the technical variables affect the goal, we dealt with every single game's goals as reference series and criteria (6 technical variables) as comparative series. By using GRA, weights of these goals impact were calculated. Results are as in Table 1.

Table 1 shows that teams' criteria weights affect the goals in UEFA Euro 2021 and Copa America 2021. On target was the highest weight affected the goals in two tournaments, that has slight gap with values of 0.189 and 0.194, respectively. In UEFA Euro 2021, the weight of the other criteria affected the goals were passes attempted, corners taken, total attempts, possession, and passing accuracy. However, in Copa America 2021, the weight of the other criteria affected the goals were total attempts, corners taken, passes attempted, possession, and passing accuracy. In addition, the most influential criteria for scoring are 0.189 and 0.194 on target, respectively, in UEFA Euro 2021 and Copa America 2021. The stats of on target are correlated with scoring performance. In other words, the more attempt and on target a team has, the better its chances of scoring.

Next, in order to understand the ranking of the teams' performance in knock out stage, we used the average performance of each team as the basis of calculation by GRA. In order to find out how the performance of each team, we took the best performing team in every single technical variable as reference series and the other teams' as comparative series.

Table 2 shows team's performance and ranking in knock out stage in UEFA Euro 2021. According to the data presented in Table 2, only 3 of the top 16 teams did not advance in knock out stage.

Table 3 shows that team's performance and ranking in knock out stage in Copa America 2021. According to the information presented in Table 3, all of the top 8 teams advance in knock.

4.2. Predicting Accuracy in the Knockout Stage. All teams in knockout stage must win the game if they want to advance to the next round. In this stage, all games attracted the attention of fans, especially the match outcome. Therefore, the accuracy of the predicting model is very important. Table 4 shows the results of the knockout stage including the total of matches, the prediction by this study, the prediction by world ranking, and the accuracy rate in UEFA Euro 2021 and Copa America 2021. According to the data presented in Table 4, there were 16 of 23 match outcomes by the proposed model of this study and the accuracy rate is 69.6%. The accuracy rate of match outcome for the prediction by world ranking is 65.2%. In the results of UEFA Euro 2021, there

TABLE 1: Results of criteria weights.

Reference series	Comparative series	Criteria weights	
		UEFA Euro 2021	Copa America 2021
Goals	Total attempts	0.167 (4)	0.182 (2)
	On target	0.189 (1)	0.194 (1)
	Possession	0.166 (5)	0.154 (5)
	Passes attempted	0.173 (2)	0.162 (4)
	Passing accuracy	0.134 (6)	0.140 (6)
	Corners taken	0.171 (3)	0.169 (3)

(n) is ranking.

TABLE 2: Team's performance and ranking in knock out stage in UEFA Euro 2021.

Team	<i>P</i>	R	A	Team	<i>P</i>	R	A
Spain (6)	0.868	1	X	Scotland (44)	0.501	13	
Denmark (10)	0.751	2	X	England (4)	0.497	14	X
Italy (7)	0.739	3	X	Poland (21)	0.494	15	
Switzerland (13)	0.671	4	X	Ukraine (24)	0.490	16	X
Germany (12)	0.667	5	X	Czech Republic (40)	0.450	17	X
Netherlands (16)	0.620	6	X	North Macedonia (62)	0.441	18	
Belgium (1)	0.609	7	X	Slovakia (36)	0.429	19	
Turkey (29)	0.564	8		Wales (17)	0.426	20	X
Portugal (5)	0.552	9	X	Russia (38)	0.409	21	
Austria (23)	0.549	10	X	Sweden (18)	0.404	22	X
France (2)	0.524	11	X	Hungary (37)	0.379	23	
Croatia (14)	0.502	12	X	Finland (54)	0.373	24	

(n): world ranking; *P*: performance; R: ranking; A: advance; X: advance knockout phase.

TABLE 3: Team's performance and ranking in knock out stage in Copa America 2021.

Team	<i>P</i>	R	A	Team	<i>P</i>	R	A
Brazil (3)	0.820	1	X	Chile (19)	0.550	6	X
Argentina (8)	0.696	2	X	Colombia (15)	0.457	7	X
Uruguay (9)	0.639	3	X	Peru (27)	0.428	8	X
Ecuador (53)	0.617	4	X	Bolivia (81)	0.356	9	
Paraguay (35)	0.585	5	X	Venezuela (30)	0.352	10	

(n): world ranking, *P*: performance, R: ranking, A: advance, X: advance knockout phase.

were 11 of 15 match outcomes by the proposed model of this study and the accuracy rate is 73.3% higher than predicting accuracy rate of 60% by the world ranking. However, the results of Copa America 2021, there were 5 of 8 games predicting accuracy by the proposed model of the study, the match outcome accuracy rate is 62.5% lower than 75.0% by world ranking.

5. Discussion

The aim of this study is to apply the GRA method to evaluate strength of football teams that advance in the knockout stage. As mentioned before, the won or lose of a football game must be judged by the number of scoring goals. Therefore, scoring has become a vital goal for the team to pursue victory, and the player must use a series of technical connections to shoot. For this perspective, the study collected the football match data recorded on the web side. The

variables related to goals and attack, including total attempts, on target, possession, passes attempted, passing accuracy, and corners taken [6, 10, 11]. By GRA, the study found the correlation between technical variables and scored goals, calculated the performance of each team in the knock out stage, and predicted the possible outcome of the knockout stage.

The results of this study indicate that the weights of the 6 technical variables we cited in the goal scored are between 1.94 and 1.34 that were similar to previous researches. For example, Lago-Ballesteros and Lago-Peñas [10] examined 2008–2009 season of the Spanish soccer league and showed results that the winner made more total attempts, on target, and ball possession than loser. Previous studies also found in Spanish soccer league that winner or drawer made more total attempts, on target, passes attempted, and passing accuracy [11]. In this line, Lago-Peñas et al. [6] also found in the UEFA Champions league that winners or drawers made

TABLE 4: Results of knockout phase in UEFA Euro 2021 and Copa America 2021.

Stage	UEFA Euro 2021			Copa America 2021		
	Total no. of matches	Prediction of this study	Prediction by world ranking	Total no. of matches	Prediction of this study	Prediction of world ranking
Round of 16	8	6	5	0	0	0
Quarter-finals	4	4	3	4	2	3
Semifinals	2	0	1	2	2	2
Final	1	1	0	2	1	1
Total	15	11	9	8	5	6
Accuracy rate		73.3%	60.0%		62.5%	75.0%
Overall	23	16	15			
Accuracy rate		69.6%	65.2%			

The appendix for details.

even more total attempt, on target, passes attempted, and possession than losers did. Bilek and Ulas [1] predicting match outcome in 2017–2018 season English premier league showed that 4 technical variables (total attempts, on target, possession, and corners taken) have impacted on results. The results of the previous studies supported the notion that winning or drawing teams were stronger in the variables related to goals and offenses than losing teams. Therefore, we applied the 6 technical variables in this study to explore the influences on the goal scored.

Most of fans judge teams' performance by FIFA world ranking and intuition. Intuitive judgment depends on personal preference. FIFA world ranking refers to the team's performance in various previous competitions, including friendly matches and the import coefficient of event types. The line-up of players will be different in each type of competition and may affect teams' performance. The most important thing is that the FIFA world ranking does not reflect the match results in time. The results indicate that intuition judgment or FIFA world ranking is one of the methods to predict the outcome of the event. However, intuition judgment lacks data basis, and FIFA world ranking cannot reflect the result of the match in time and different line-up. In order to build indicators of team performance, we proposed the GRA model to calculate teams' performance indicator base on match results as Table 2 and 3. Each team has a performance indicator that represents how the team's performance will be in the knock out stage. When the FIFA world ranking and GRA model were compared, there were differences in teams' performance in the knock out stage. For example, Belgium, the world no. 1 in FIFA world ranking, only ranked 7th in the GRA model in the knock out stage, while Italy, the world no. 7 in FIFA world ranking, ranked 2nd in the GRA model. Then, the two teams competed head-to-head in the quarter-final. Italy, ranked 2nd in the GRA model, defeated Belgium, which ranked 7th in the GRA model. If the match outcome were predicted by FIFA world ranking, it would be inaccurate.

In the tournament knockout stage, Table 4 shows that the predicting rate by the GRA model is 69.6% better than the rate of 65.2% by world ranking. Moreover, in UEFA Euro

2021, with 24 teams participated and world ranking closely, the accuracy rate of the GRA model reached 73.3%, which was better than 60.0% by FIFA world ranking. However, in Copa America 2021, there were 10 teams participated and the ranking gap was widening; the accuracy rate of the GRA model was 62.5%, which was lower than 75.0% by FIFA world ranking. The results indicated that the GRA model and FIFA world ranking are suitable methods for predicting the outcome of the football match. Nonetheless, the GRA model proposed in this study is more capable of handling complex situations when more teams participated and the ranking is close.

6. Conclusion

Football fans all over the world are very concerned about match outcome. In order to build an appropriate method of prediction, this study apply the GRA model to provide a predicting method for fans as a reference. In conclusions, first, this study presents variables related to goals scored and offense are very important on goals scored. The result shows that scoring is a series of technical cooperation more than scoring itself. Second, the performance of teams are based on teams' ability. This study proposed the GRA model to provide more useful and precise reference for the prediction of match outcome. Third, both the GRA model and FIFA world ranking are effective method for judging the match outcome. If the situation is more complicated, the GRA model will be better than FIFA world ranking when more teams participate and the FIFA world ranking are tight.

In short-term competitions such as UEFA Euro 2021 or Copa America 2021, this study has provided a method to evaluate the performance of teams by recent match data rather than relying on intuition. Football fans can apply this method to increase the accuracy of the prediction of the match outcome. Coaches use this information to adjust the line-up or the value of tactics-performance. The value of tactics-performance represents the offensive ability. The study suggests strengthening the defense and combining the long ball to attack to increasing the value of tactics-performance and possibility of winning.

Data Availability

The website data used to support the findings of this study are as follows:

- 2021 UEFA European Football Championship https://www.google.com/search?q=2021+%E6%AD%90%E6%B4%B2%E6%9D%AF%E8%B6%B3%E7%90%83%E8%B3%BD&xsrf=APq-WBui3W6A1tt3vX2RSitJVbVU2uQ_JA%3A1644811254705&ei=9tMJYrbSKo330ATNiY-gDA&oq=2021+%E6%AD%90%E6%B4%B2%E6%9D%AF&gs_lcp=Cgnd3Mtd2l6EAMYAjIFCAAQgAQyBAGAEb4yBAGAEb4yBAGAEb4yBAGAEb4yBAGAEb4yBAGAEb4yBAGAEb4yBAGAEb4yBAGAEb4yBggAEAUQHjHCC4QsAMQJzoHCAAQRxCwAZoECCMQJzoECC4QJzoFCC4QyWE6BQgAEMsBOgsIABCABBCCxAXCD AUoECEYYAEoECEYYAFCmBFi4JWCsRWGbcAF4AIABTYgB1wSSAQIxMJgBAKABAcgBCsABAQ&scient=gws-wiz#sie=lg;/m/0p3p7v6;2;/m/01110v;mt;fp;l;;
- 2021 Copa America https://www.google.com/search?q=2021+%E7%BE%8E%E6%B4%B2%E7%9B%83%E8%B6%B3%E7%90%83%E8%B3%BD+google+result&xsrf=APq-WBtrGA9JDR_sZ8e3ZPdMxdOb9K9Rfw%3A1644811504574&ei=8NQJYpzZiYGr7wPhvSV2Awved=0ahUKEwick-rqP71AhVcw4sBHQZ6BcsQ4dUDCA4uact=5oq=2021+%E7%B%E8%BE%8E%E6%B4%B2%E7%9B%83%E8%B6%B3%E7%90%83%E8%B3%BD+google+result&gs_lcp=Cgnd3Mtd2l6EAMYBQgAEKIEOgcIIxCWAXAnOgcIABHHELADOGUUIRCgAUoECEYYAEoECEYYAFC4Alj5P2CeQWgCcAF4AYAB0wKIA d4JkgEIMTMuMS4wLjGYAQCgAQHIAQRAAQE&scient=gws-wiz

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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