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ORIGINAL ARTICLE

A study on the efficiency difference between winning and losing teams in the quarterfinals and semifinals of the EURO 2024

Heechul Hwang . *Korea Institute of Materials Science. Gyeongsangnam-do. Republic of Korea.*

ABSTRACT

Football performance is analysed by goals scored, shots, effective shots, and passes. Extant studies have examined the factors in terms of leagues and world cup, including passes, number of successful passes, shots and effective shots and so on. However, the factors that predict and directly affect winner or loser are diverse and lack consistency. This study thus investigated the factors affecting quarterfinal and semifinal in EURO 2024 and analysed them considering the efficiency of pass and shoot. The analysis confirmed that efficiency significantly affects winning and losing teams. Therefore, this efficiency could serve as a valuable reference for efficient management and strategic decision-making for football.

Keywords: Performance analysis, Football, Efficiency, EURO2024, Tournament.

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Corresponding author. *Korea Institute of Materials Science, 797, Changwon-daero, Seongsan-gu, Changwon-si,, Gyeongsangnam-do, Republic of Korea.*
E-mail: sumvete@gmail.com
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INTRODUCTION

UEFA Euro 2024 is the most famous and popular football match in the world. A total of 24 countries in 6 groups advance to the finals. The top two teams from each group will advance directly to the round of 16, and the top four teams among the third-place teams will advance to the round of 16. Each team will compete in a tournament to determine the final winner. Therefore, it is important for champion team to manage the game efficiently throughout the tournament to the final.

Football involves assessing both individual player and team performance, with numerous studies examining the elements that contribute to success in football match. Research on attacking indicators often concentrates on shots, successful attempts, and passes, while defensive is evaluated through indicators such as tackles and clearances. Despite this, relying solely on indicators like shots, possession, and pass count to evaluate team performance has its limitations.

In the 2018 Russian World Cup, Germany lost 2:0 in the match against Korea, despite having 16 more shots and 476 more passes, and was eliminated from the World Cup round of 16. In the 2022 Qatar World Cup, Japan defeated Spain 2:1 despite having 8 fewer shots and 846 fewer passes and advanced to the round of 16 as first place in the group.

In this study, we explore the potential of evaluating matches by analyzing efficiency for teams from UEFA nations and compare these factors with the progression to the next round.

The organization of this paper is outlined as follows: the next section provides a review of relevant literature and the theoretical framework. Subsequently, the research methods used for efficiency analysis are detailed. The results section presents the descriptive statistics and findings from the efficiency analysis. Finally, the discussion and conclusion sections address the implications of the study.

Literature review

This paper conducted an efficiency analysis targeting the teams that advanced to the EURO finals, and the current status of various previous studies is as follows. There are many factors that affect winning and losing in football games.

There is a variety of research on factors affecting matches in terms of leagues, but less research on tournament matches.

Many researchers have studied shooting indicators. Oberstone (2009) argued that a lower number of shots required to score is a significant predictor of success. Similarly, Lago-Ballesteros and Lago-Peñas (2010) observed that leading teams typically had higher numbers of goals, shots, and shots on target. Further, Lago-Peñas, Lago-Ballesteros, and Rey (2011) indicated the quantity of shots as a crucial factor distinguishing winning teams from losing ones, with victorious football teams generally demonstrating higher statistics in both total shots and shots on target. HONGYOU LIU(2015) found that Shot, Shot on Target is positive effects on the probability of winning in the 2014 FIFA world cup. Also, Danilo L(2019) conclude that Winners also had a tendency towards greater passing success, shots and shots on target in the 2018 FIFA world cup.

In the view of pass indicator, there is below researchers. Regarding pass indicators, several researchers have made significant contributions. Collet (2013) examined team success through the efficiency of passes that lead to goals. Harrop and Nevill (2014) founded that a lower number of passes and those made in the

opponent's half were key factors in winning matches. Rossi (2019) highlighted that effective passing is more crucial than simply maintaining possession of the ball.

In terms of efficiency indicators, notable research includes Broich et al. (2014), who emphasized the importance of goal efficiency for team success in the German top division. Hwang (2022) found that overall game efficiency positively impacts a team's seasonal performance in Korean football league. Additionally, Hwang (2024) observed that both pass and shooting efficiency contribute to improved seasonal performance in Serie A league.

Existing research has limitations in identifying factors that affect match results due to the variety of performance indicators. So, this study divided performance indicators into efficiency categories and focused on verifying whether these factors affect winning and losing teams. This study distinguishes itself by analyzing the efficiency of teams in the context of EURO 2024 matches.

This study distinguishes itself from existing research in several ways. Firstly, it focuses on analyzing factors that influence teams advancing to specific stages of the tournament, such as the quarter-finals and semi-finals. Secondly, the efficiency metrics for quarter-final teams are derived from their performance up to the Round of 16, while those for semi-final teams are based on their performance up to the quarter-finals. Football has traditionally lagged in the development and application of such efficiency indicators. By further developing the various efficiency metrics explored in this study, there is potential to enhance team performance and deepen the understanding of the sport.

METHODOLOGY

Data

This study examined data from 16 countries that advanced to the quarter-finals and 8 countries that reached the semi-finals, using information registered on the official UEFA EURO website. All match data is presented in Table 1.

Table 1. EURO2024 Match Data.

Nations	Number of shots	Number of effective shots	Number of passes	Number of success passes	Goals	Match played
Spain	123	42	4088	3698	15	7
England	75	22	4289	3839	8	7
Netherlands	80	22	2869	2554	10	6
France	98	24	3235	2926	4	6
Germany	94	33	3235	2949	11	5
TÜRKIYE	71	23	2282	1975	8	5
Switzerland	58	21	2360	2072	8	5
Portugal	89	25	3643	3303	5	5
Austria	52	22	1900	1621	7	4
Italy	43	10	2359	2107	3	4
Slovakia	50	16	2836	1527	4	4
Georgia	31	8	1302	1072	5	4
Belgium	52	20	2071	1816	2	4
Romania	37	15	1214	933	4	4
Slovenia	35	9	1252	940	2	4
Denmark	52	16	2243	1943	2	4

Ukraine	42	12	1403	1230	2	3
Hungary	30	10	1116	910	2	3
Croatia	42	14	1685	1510	3	3
Serbia	26	6	1552	1356	1	3
Czechia	42	14	995	787	3	3
Albania	33	13	1085	917	3	3
Scotland	16	3	1128	917	2	3
Poland	36	13	1080	898	3	3

The efficiency analysis was conducted using the MaxDea commercial software. The optimal number of decision-making units (DMUs) can differ between studies, but it is generally advised to have more DMUs than the total number of input and output factors (Cooper et al., 2007). Since the ability to distinguish between efficiencies decreases when the number of input and output factors is high relative to the number of DMUs, it is considered appropriate to use at least four DMUs for effective analysis. So, the analysis limited to quarter-final to semi-finals teams.

Effective game strategies that maintain offensive momentum through passes into the goal opportunity can contribute to winning. From an efficiency perspective, a team that executes few passes while making numerous attacks may demonstrate high game efficiency. The shot and pass success rate data for the EURO 2024 teams are presented in Table 2. For this analysis, input factors included the total number of shots, shots on target, passes. The output factor in this study is defined by points: 3 points for a win and 1 point for a draw. The study aimed to explore whether teams with higher efficiency could win the quarter-final to semi-finals tournament.

Table 2. Shot and pass success rate.

Shot success rate (Number of shots on target / shots)	Pass success rate (Number of success passes / total passes)
32%	86%

Table 3. Quarter-final data.

Division	Average	Standard Deviation	Minimum value	Maximum value
Shooting	43.5	10.28	28	55
Effective shot	19.8	5.9	12	29
Number of passes	2059.7	393.1	1489	2478
Goal	7.5	2.9	3	11

Table 4. Semi-final data.

Division	Average	Standard Deviation	Minimum value	Maximum value
Shooting	57.7	12.2	42	68
Effective shot	22.7	8.5	15	35
Number of passes	2646	363	2170	3405
Goal	8.5	3.8	4	13

Methods

Data Envelopment Analysis (DEA) evaluates efficiency by comparing input and output factors. This method determines whether a Decision-Making Unit (DMU) is efficient or inefficient by analyzing its performance relative to others. DEA assesses the relative efficiency of each DMU by calculating their distances through linear programming techniques. Previous studies have utilized DEA to examine the efficiency of football team

(Espitia-Escuer & García-CebriAn, 2004; Espitia-Escuer & García-Cebrián, 2010; García-Sánchez, 2007; Haas et al., 2004; Haas, 2003; Hwang, 2022; Hwang, 2024; Rossi et al., 2019; Tenga et al., 2010).

Efficiency is quantified on a scale from 0 to 1, allowing for comparisons between DMUs. A DMU with a higher efficiency score indicates better performance, while inefficient DMUs can identify areas needing improvement in input or output factors. The CCR model, which assumes constant returns to scale, and the BCC model, which allows for variable returns to scale, are commonly used in DEA. This study employed the CCR model with an input-oriented approach to enhance efficiency by minimizing input while keeping output constant. Inefficient DMUs are identified based on their efficiency scores, with a score of 1 indicating optimal performance. (Charnes et al., 1978).

$$Max\ E_k = \left(\sum_{r=1}^{s} u_r y_{kr}\right)$$

$$s.t$$

$$\sum_{i=1}^{m} v_i x_{ki} = 1$$

$$\sum_{r=1}^{n} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0\ , \mathrm{j} = 1, 2, \dots, \mathrm{n}\ ,$$

$$u_r > 0, \qquad r = 1, \dots, s,$$

$$v_i > 0, \qquad i = 1, \dots, m$$

This study used as input factors the number of shots, effective shots, and passes, which were identified as determining factors for victory in existing research and integrates shooting attempts, shots on target, passes into a single metric using efficiency analysis methods.

This research conducted the possibility that teams with high efficiency could advance to the quarter-finals and semi-finals by developing existing research.

RESULTS

Efficiency results

The efficiency analysis results for the teams that advanced to the quarter-finals and semi-finals are shown in Table 5/6. Among the four teams that reached the semi-finals, three winner team had higher efficiency scores compared to their opponents. Additionally, two winner teams that progressed to the final had efficiency scores exceeding those of their opponents.

The evaluation of efficiency scores suggests that these scores can be a significant factor in determining progression to subsequent rounds. Additionally, the loser team showed lower efficiency scores in the analysis.

Data comparison

The team statistics for the quarter-finals are presented in Table 5, and the results for the semi-finals are shown in Table 6. The efficiency scores derived from the five matches leading up to the Round of 16 revealed that England, Spain, and France had relatively high efficiency scores, which contributed to their advancement

to the semi-finals. Conversely, although Türkiye had a higher efficiency score than the Netherlands, it did not progress to the semi-finals.

In the semi-finals, the teams that advanced to the final were those with higher efficiency scores calculated from their performance up to the quarter-finals. Spain and England had high efficiency score than France and Nethlands.

DEA analysis of the final round was not performed due to the limitation of the number of DMUs. The data for the EURO 2024 finalist teams are shown in Table 7. In the final round, Spain exhibited lower numbers of passes and effective shots, but achieved a higher success rate. This aligns with the findings of Alves and Danilo L (2019), who noted that World Cup winners tend to exhibit greater passing success, along with higher numbers of shots and shots on target.

Factors such as the number of shots and passes are significant indicators of a team's success. However, in tournament matches, the teams that won tended to have higher efficiency scores compared to their opponents. The analysis of efficiency scores from the tournament results suggests that efficiency are important factors in determining the tournament match result.

Table 5. Quarter-final result.

	Nation	Input Variable			Output Variable	Efficiency	Result
		Number of Shots	Number of Effective Shots	Number of Passes	Points		
1	England	32	12	2419	8	1.37	Semi final
1	Switzerland	28	18	1489	8	1.17	
2	Spain	55	29	2242	12	0.99	Semi final
2	Germany	43	28	2415	10	0.81	
3	France	53	16	2080	8	0.92	Semi final
3	Portugal	53	21	2478	9	0.82	
4	Netherlands	47	16	1690	7	0.87	Semi final
4	Türkiye	37	19	1665	9	1.04	

Table 6. Semi-final result.

	Nation	Input Variable			Output Variable	Efficiency	Result
		Number of Shots	Number of Effective Shots	Number of Passes	Points		
1	Spain	67	35	2746	15	1.2	Final
1	France	68	21	2623	11	0.97	
2	England	42	15	3045	11	1.45	Final
2	Netherlands	54	20	2170	10	1	

Table 7. Final result.

Nation	Shot success rate (Number of shots on target / shots)	Pass success rate (Number of success passes / total passes)
Spain	34.10% (42/123)	90.50% (3698/4088)
England	29.30% (22/75)	89.50% (3839/3698)

CONCLUSIONS

In this study, the research examines how efficiency scores impact wining or losing in EURO tournaments. The primary findings are outlined as follows. Firstly, teams advancing in the tournament demonstrate the highest levels of efficiency. This efficiency score is derived from selected indicators such as total shots, shots on target, and number of passes. Secondly, except for one team among the quarter-finalists, all teams reaching the semi-finals exhibited high efficiency score. Similarly, all teams advancing to the finals demonstrated notable efficiency. Thirdly, from a statistical perspective, while a high number of shots and passes generally influence game outcomes positively, this correlation does not significantly affect the final round. From the results, efficient game management becomes paramount in the final rounds.

In summary, to achieve winning in tournament matches, teams must strategically manage matches in terms of efficiency. It contributes significantly by demonstrating the potential of efficiency analysis methods to assess team performance in tournament matches. This metric could serve as a valuable reference for efficient management and strategic decision-making across football.

Future research should aim to expand and refine this study further. Firstly, by incorporating offensive-oriented variables like assists, crosses, and goals scored, as well as defensive-oriented factors such as interceptions, clearances, and tackles, beyond the input factors considered in this study. Secondly, by extending the analysis beyond EURO 2024 to include other tournaments such as the World Cup and Champions League, subsequent studies could yield additional insights. Thirdly, continuous development of meaningful game analysis metrics in football could have a profound impact on the entire football industry in the future.

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No potential conflict of interest was reported by the author.

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