

Analysis of Goalkeepers' Shots Creating Actions Based on Gray Relational Analysis

-- An Example of the 2022/23 UEFA Champions League

Jiuqin Duan^{1,*}

¹School of Arts and Science, University of California Santa Barbara, Goleta, CA 93117, USA

*Corresponding Author's Email: jiuqin@ucsb.edu

Abstract

This research takes all the goalkeepers who had shots creating actions in the 2022/23 UEFA Champions League as the research objects. With the methods of literature review, video observation, and mathematical statistics, this study aims to determine: 1. the most related actions of shots creating for goalkeepers 2. The relation between winning rates and shots creating actions. The result shows: 1. Goalkeepers' throw attempts have the closest relation to shot creating action 2. The teams with lower winning rates tend to have better goalkeepers' shots creating behavior.

Keywords

Goalkeeper; Football; Gray relational Analysis; UEFA Champions League.

1. INTRODUCTION

Football unites people as the most popular sport in the world. From religion to science, football influences all aspects of human society. Being marked as the only position on the field that can touch the football with hands, goalkeepers are of great importance and specialness. The development of goalkeeper technology has a long history, and its birthmark is the establishment of the English Football Association in 1863 and the formulation of football competition rules. Before 1863, goalkeepers were only allowed to use their bodies to block the goal. As a result, no technical moves were needed at that time. Due to the promulgation of the rules of the game, the managers of football teams started to rebalance the tactical focus by shifting more attention from offense to defense. At this particular moment, goalkeeper skills are slowly being discovered. The new match rules in 1909 enacted by FIFA required that the color of the goalkeeper's jersey must be distinguished from other players on the field, which is a sign indicating that the keepers were treated in a different and unique role. The goalkeeper's skills have been initially developed, and new skills such as throwing, collecting ball on the ground, and the diamond catch appeared. Accompanying with the rapidly increasing popularity of modern football, the need for a good goalkeeper on the team is unprecedentedly high. Alex Welsh points out that the goalkeeper is the most important position on the football field, which could be evidenced by the rising transfer market value of goalkeepers and the increasing number of goalkeeper coaches in professional clubs[1]. Keepers' skills were also significantly influenced by the continuous optimization of formations in order to win the game. In 1996, the enactment of the return pass rule had the greatest impact on goalkeeper skills. The return pass rule requires that when a player intentionally kicks the ball to his own goalkeeper, the keeper cannot touch it with his hands, forcing the goalkeeper to use his feet to handle the returning pass. Under this stimulation, the activity area of the goalkeeper is increasing as well as the frequency of using feet to pass the ball[2]. The requirements for goalkeeper skills have become

more comprehensive. Goalkeepers in modern football are described as “the last person to stop an attack and the first person to launch an attack”[3]. Therefore, goalkeeper skills can be simply divided into defensive and offensive skills. It is worth noticing that the main research direction on goalkeepers is more attached to their defensive behaviors, such as diving, reflexes, and handling. There is less research conducted on the contribution of goalkeepers' offensive actions. When it comes to goalkeeper's attacking involvement, the previous studies generally focused on their special technical analysis, such as the choice of switching from defense to offense, whether they can echo with the movement of one's own players, whether they can understand the needs of the offensive players, etc. The prime purpose of this research is to find out the most critical data types for goalkeepers to create shooting opportunities and search for the relation between winning rate and shots creating action. Based on the results, we hope to provide a theoretical basis and practical guidance to improve the football teams' performance at an angle of goalkeeper offensive involvement.

2. RESEARCH OBJECTS & METHODS

2.1. Research Objects

The research objects are the 16 goalkeepers who had shots creating action on record in the 2022/23 UEFA Champions League. Table One below shows the basic information of these players, and Table Two indicates their offensive statistics. Shot Creating Action is an advanced statistic that tracks the two offensive actions that directly lead to a shot on goal; Pass Attempts describe the time the goalkeeper kicks the ball forward in an attempt to complete a pass to a teammate; Goal Kick Attempts are anytime the goalkeeper restarts the game in a way of kicking the ball. These three types of data only identify the pass as an attempt when the ball movement is over 40 yards.

Table 1. Basic information about players

Player	Nation	Squad	Age	Born	MP	Save%	CS%	Win%
André Onana	CMR	Inter	26	1996	13	80.7	61.5	53.8
Alex Meret	ITA	Napoli	25	1997	10	76.7	40.0	70.0
Odisseas Vlachodimos	GRE	Benfica	28	1994	10	67.7	20.0	60.0
Alisson	BRA	Liverpool	29	1992	8	60.7	37.5	58.0
Diogo Costa	POR	Porto	22	1999	8	81.6	50.0	50.0
Dominik Livaković	CRO	Dinamo Zagreb	27	1995	6	77.1	16.7	33.3
Pau López	ESP	Marseille	27	1994	6	60.0	16.7	60.0
Anatolii Trubin	UKR	Shakhtar	20	2001	6	73.7	0.0	16.7
Jan Oblak	SVN	Atlético Madrid	29	1993	5	72.7	20.0	20.0
Jindřich Staněk	CZE	Viktoria Plzeň	26	1996	5	54.8	0.0	0.0
Marc-André ter Stegen	GER	Barcelona	30	1992	5	54.5	0.0	25.0
Yann Sommer	SUI	Bayern Munich	33	1988	4	76.5	50.0	75.0
Wojciech Szczęsny	POL	Juventus	32	1990	4	57.9	0.0	25.0
Péter Gulácsi	HUN	RB Leipzig	32	1990	3	25.0	0.0	33.3
Manuel Neuer	GER	Bayern Munich	36	1986	3	100.0	100.0	75.0
Marko Dmitrović	SRB	Sevilla	30	1992	2	100.0	100.0	50.0

Table 2. Player Offensive Statistics

Player	Shots Creating Actions	Pass Attempts	Throw Attempts	Goal Kick Attempts
Marko Dmitrovic	0.50	32.00	3.00	4.50
Peter Gulacsi	0.47	24.80	4.76	5.71
Jan Oblak	0.40	15.60	4.40	6.80
Alisson	0.37	29.40	4.50	4.63
Manueal Neuer	0.33	32.70	4.67	7.33
Anatolii Trubin	0.33	34.20	4.17	9.00
Andrea Onana	0.31	33.60	4.85	6.77
Diogo Costa	0.25	41.30	5.50	6.00
Yann Sommer	0.25	33.50	4.25	4.50
Wojciech Szczesny	0.25	21.40	4.00	4.75
Jindrich Stanek	0.20	20.20	3.40	8.00
Marc-Andre ter Stegen	0.20	26.80	4.40	5.60
Dominik Livakovic	0.17	29.50	4.50	12.70
Pau Lopez	0.17	25.20	3.33	4.17
Alex Meret	0.10	24.50	4.80	7.00
Odisseas Vlachodimos	0.10	19.90	4.20	6.40

Notes: 1. In Table One, MP stands for match played; Save% stands for save rate; CS% stands for clean sheets rate; Win% stands for win rate 2. The data shown in Table Two is a per-90 value 3. The data of Table One and Table Two is from fbref.com powered by Opta.

2.2. Research Methods

The research methods which is employed in this study include a literature review, video observation, and statistics. Concerning the keyword “goalkeeper”, we review a large variety of articles from the Web of Science and China CNKI. 56 matches of 16 goalkeepers are also carefully reviewed and analyzed. IBM SPSS 25 is utilized to pre-process the data, gain sum and average value, manipulate the u-test, and generate visual data. Matlab is utilized to run Gray Relational Analysis(GRA) of the collected data. GRA was proposed by Professor Deng in the 1980s. White systems represent sufficient information and black systems represent systems which is unclear, while Gray is somewhere in between, meaning we only have a partial understanding of the system. “We assume a certain indicator may be related to several other factors, and we want to know which other factor of this indicator has a relatively greater relationship with, and which factor has a relatively weak relationship. After sorting and getting an analysis result, we can know

which of the factors we care about is more related to the indicator[4].” The Gray Relational Coefficient formula:

$$\zeta_i(k) = \frac{\min_i \min_k |x_0(k) - x_i(k)| + \rho \cdot \max_i \max_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \rho \cdot \max_i \max_k |x_0(k) - x_i(k)|} \quad (1)$$

The data sequence that can reflect the behavior characteristics of the system, similar to the dependent variable Y, is called a generating sequence and denoted as x_0 here; The data sequence composed of factors that affect system behavior, similar to the dependent variable X, is called a subsequence and denoted as x_1, x_2, x_3 , and so on. While, ρ is a coefficient that controls the discrimination of the coefficient. ρ ranges from 0 to 1. The smaller the ρ , the greater the discrimination. Generally, a value of 0.5 is relatively appropriate. The result $\zeta(k)$ represents a gray relational coefficient. A greater $\zeta(k)$ indicates a closer relation. When gray

relational coefficients are obtained, the gray relational grade could be further calculated. The gray relational grade formula:

$$r_i = \frac{1}{m} \sum_{k=1}^m w_k \cdot \zeta_i(k) \quad (2)$$

k is a constant ranging from 1 to m , and w_k represents the weight of each indicator. The result of this equation r_i is called “gray relational grade”. The greater gray relational grade suggests a closer relation between the two indicators. Its value is ranging from 0 to 1. When r_i is greater than 0.6, a relatively distinct relation could be described.

Basically, it is a robust but simple, and straightforward multi-criteria decision-making technique. It is able to handle both incomplete and small sample-sized information, especially in situations where there is not enough data and the sample distribution pattern is unknown [5]. The data in Table Two is considered as the sample. The second line of Table Two, named “Shots Creating Actions” is selected as a generating sequence; The third, fourth, and fifth lines of Table Two, named “Pass Attempts”, “Throw Attempts”, and “Goalkick Attempts” is selected as three subsequences. The sample size of the data collected is relatively small, and three subsequences have potential connections to the generating sequence. Thus, GRA is an appropriate method to conduct the research. The shots creating action of the 16 goalkeepers is depicted as a gray system, and the purpose of the study is to explore its strength in relation to other three types of data: pass attempts, throw attempts, and goal kick attempts. As a general case, $\rho = 0.5$ is adapted.

2.3. Procedure

The data collected from fbref.com was preprocessed by the Mann-Whitney U test and then input into the GRA model on Matlab, to obtain the gray relational coefficients and weight of each data type. Based on these, the gray relational grades are further calculated. The gray relational grades are considered as a comprehensive evaluation that values the goalkeepers’ shots creating performance in matches. Next, we compare the comprehensive evaluation with the win rate of the club to which the keepers belong and obtain an r^2 , searching for the statistical strength of the correlation. Ultimately, we analyze the correlational results with the assistance of match videos.

3. RESULTS & ANALYSIS

3.1. Goalkeepers’ throw attempts have the closest relation to shot creating action

Table 3. Gray Relational Grade

Types of Stats	Gray Relational Grade(r_i)	Weight(w)	Ranking
Pass Attempts	0.488	0.2377	3
Throw Attempts	0.939	0.4574	1
Goal Kick Attempts	0.626	0.3049	2

Notes: Table Three is generated by Matlab.

According to Table Three, among three of the subsequences, throw attempts earn the highest gray relational grade, whose value r is significantly close to 1. Goal kick attempts are at the second place. Although the relation is not as strong as the first one, it is still statistically relational ($r = 0.626 > 0.5$). While pass attempts receive the lowest gray relational grade. The data suggests that pass attempts are not closely related to shot creating actions.

Two possible features of goalkeepers' throwing might make it the most significantly related factor to shots creating action. In order to analyze the possible reason behind the data, it is important to first understand what is a restart of the game. According to the official law of FIFA, after control of the ball is established by the goalkeeper, he then puts the ball back into play with a throw or kick. When kicking, keepers could choose punt or drop-kick and these two options are taken into account in "pass attempts"; when throwing(counted in throw attempts), keepers are able to use the baseball or straight arm methods. To begin with, throwing is more accurate than drop or punt kicks[6]. When the distribution of the ball is more accurate, the receivers have a relatively high chance to stop the ball in a more appropriate direction which better benefits the next movement of the players, shooting for instance. In addition, throwing requires less time to complete, which means starting a new wave of attack faster. When preparing for the long throwing, keepers' run-up distance is generally shorter than a goal kick or long pass with feet. The sudden shifting from defending to attacking could threaten the opponents' goal effectively, possibly leading to the creation of shots. Because of these advantages of throwing, goalkeepers may prefer restarting the game by throwing when they want to launch an attack directly.

3.2. Goalkeepers' teams with lower winning rates tend to have better goalkeepers' shots creating behavior.

Table 4. Comprehensive Player Evaluations

Player	Comprehensive Evaluation(ζ_i)
Jan Oblak	0.794282
Wojciech Szczesny	0.753299
Peter Gulacsi	0.751431
Marc-Andre ter Stegen	0.743828
Marko Dmitrovic	0.740959
Dominik Livakovic	0.735616
Yann Sommer	0.721878
Jindrich Stanek	0.716401
Diogo Costa	0.709509
Alisson	0.703271
Odisseas Vlachodimos	0.701977
Pau Lopez	0.696707
Alex Meret	0.689303
Andrea Onana	0.683459
Manueal Neuer	0.679170
Anatolii Trubin	0.673864

Notes: 1. The data of Manueal Neuer and Yann Sommer are combined by their mean value because they are on the same squad. 2. The sample of Anatolii Trubin is considered an outlier and, thus, not taken into consideration. 3. Table Four is generated by Matlab.

Scatter Plot Linear Fitting Function: $WiningRate = 3.968 - 4.833 \cdot \zeta_i$, $r^2 = 0.725$.

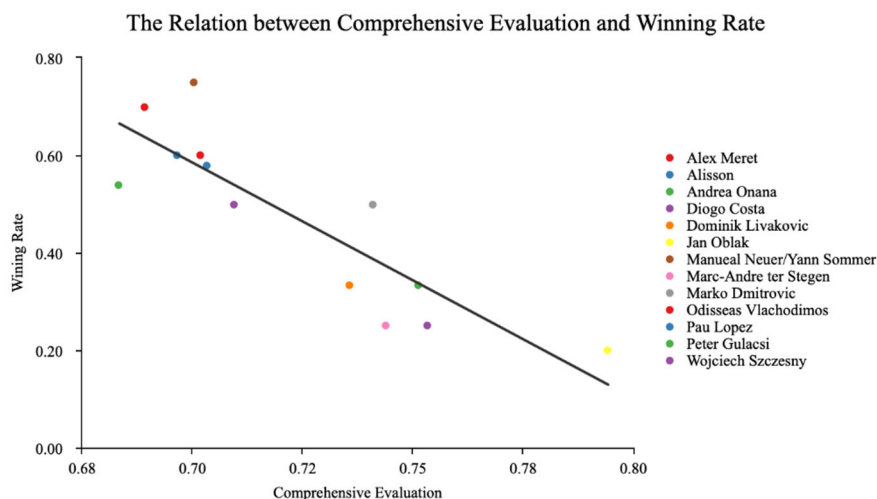


Figure 1. The Relation between Comprehensive Evaluation and Winning Rate

The shots creating action of goalkeepers is also related to the tactics that the team chooses to play. As a member of the team, the keeper's behavior could not be separated apart. Players with high comprehensive rankings generally belong to squads playing counterattack tactics. The counterattack is a fast attack that occurs at the moment of transitioning from defense to offense. It contains minimal, accurate passing, and the purpose of the attack is to create a goal-scoring opportunity before the opponent can recover their shape[7]. According to the 18 matches in the 2022/23 UEFA Champions League group stage, clubs such as RB Leipzig, Sevilla, and Dinamo Zagreb are relatively weak in overall ability to possess the ball for a long time when facing stronger teams. As a result, counterattack seems to be a more practical and effective strategy. When a team playing counterattack, goalkeepers will more frequently pass long-distance ball in order to make the attack more effective. According to Table Four, Jan Oblak is the player who receives the highest score on comprehensive evaluation and is greater than the second place distinctively. Under the instruction of Diego Simeone, Atlético Madrid adopted counterattack as their specialty. The goalkeeper would choose to directly pass the ball across the midfield, and directly connect the offense line, instead of building up the attack from the penalty area to the mid-field. Under these circumstances, the chances of shots creating action may be higher. It is also worth pointing out that, some goalkeepers of traditional strong clubs did not have shots creating behavior in games, for instance, Courtois (Real Madrid) and Ederson(Manchester City). This is possible because the team playing style requires players to take possession of the ball for most of the time. Thus, goalkeepers prefer short passes to long passes to guarantee possession. In the meantime, keepers also have fewer chances to directly get involved in attacking.

Goalkeepers' shots creating action seem to be a beneficial factor that contributes to the offense of the team. Nevertheless, its negative relation to the winning rates suggests that perhaps this is not the case. According to the scatter plot, the goalkeepers who have a higher comprehensive evaluation of shots creating action tend to have a lower winning rate in matches. Two possible reasons may be the explanation. Firstly, as the paragraph mentioned above, the clubs with disadvantages are more likely to provide more chances for their keepers to create shooting possibilities. Although counterattack is a relatively appropriate method when facing stronger opponents, the chances are still high that the team may lose the game because of their poorer overall strength. Moreover, from a technical perspective, shots creating action is not the main duty of goalkeepers. When they have more chances to launch the long passes, the possibility of losing the ball is also increased. Facing gegenpressing, the defense line is not able to move the ball smoothly to midfield or further, and passing the long ball or even clearing the

ball is the only option. If a team does so frequently, they could hardly win the match since most of the time, they are in a passive mode and handing the possession over to their opponents.

4. CONCLUSION

Conclusively, this research studied shots creating action of goalkeepers in the 2022/23 UEFA Champions League. The results suggest that goalkeepers' throw attempts have the strongest relation to shot creating action, furthermore, the teams with lower winning rates tend to have better goalkeepers' shots creating behavior. The research is carefully designed and conducted, however, some issues still remain. The sample size of the research is limited because of the actual performance of the players. Perhaps expanding the sample size, and repeating this research will earn a more convincing result. In addition, some of the analyses the author made are hypotheses that have not been verified yet. It would be better if more scholars could utilize the scientific method to verify the hypothesis made in this essay. Goalkeepers are contributing more to the offense on the team in the modern football era. Besides the traditional ways, namely long-passing and throwing, goalkeepers sometimes join the attack of corner kicks at the end of the game when the point is behind. In recent seasons, goalkeepers even get involved in disturbing the opponents' wall when earn a free kick by giving instructions to teammates to guide them to break the wall with disruptive running. This free-kick tactic is popularly adapted by goalkeepers of the Premium League. In the future, goalkeepers may have more various methods in the contribution of offense, and how it would benefit the team better is going to be a crucial problem waiting to be solved.

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