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ANALYZING COLLECTIVE BEHAVIOURS IN FIFA WORLD CUP QATAR 2022

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Abstract: Performance analysis is integral to modern football, providing data-driven insights for enhancing strategies, player development, and tactical behaviour. Collective behaviours in football, akin to natural systems, have gained attention. Team coordination, passing networks, and player movement dynamics are critical for analysing performance and team cohesion. Factors such as team length and width contribute to understanding collective behaviour. This study explores factors influencing teams' performance in the FIFA World Cup Qatar 2022, including ball possession, field zones, team width, team length, distance to the goal line, and area covered by the team. This study examined 64 matches played among the 32 teams. Analysis reveals the significance of goal-scoring ability, highlighting that winning teams score significantly more goals than draws and losses. Contrary to common belief, ball possession percentages do not significantly differ among these outcomes, indicating its nuanced role. Within possession and out-of-possession phases, strategies like line height, team length, and team depth vary little across different outcomes, suggesting the effectiveness of balanced approaches. In the final third phase, winning teams employ higher defensive lines and deeper formations. In conclusion, this study illuminates the multifaceted nature of football performance. Goal-scoring ability and field zone-specific strategies play pivotal roles. Ball possession's influence is more complex than previously thought. Understanding these dynamics can inform teams and coaches for more informed and effective performance optimization, emphasizing the need for nuanced analysis and future research.

Key Words: Collective Behaviour, Performance Analysis, Team Coordination, Football

2022 QATAR FIFA DÜNYA KUPASINDAKİ KOLLEKTİF DAVRANIŞLARIN ANALİZİ

Öz: Performans analizi, modern futbolun ayrılmaz bir parçasıdır ve stratejileri, oyuncu gelişimini ve taktiksel davranışı geliştirmek için veriye dayalı içgörüler sağlamaktadır. Teknolojinin ve daha derin analiz arayışıyla birlikte genişleyen bu alan, oyuncu ve takım performansının teknik ve taktiksel yönlerini incelemeye odaklanmaktadır. Futbolda doğal sistemlere benzer kolektif davranışlar dikkat çekmektedir. Takım koordinasyonu, geçişler ve oyuncu hareket dinamikleri, performansı ve takım uyumunu analiz etmek için kritik öneme sahiptir. Takımın uzunluğu ve genişliği gibi faktörler kolektif davranışın anlaşılmasına katkıda bulunur. Bu çalışma, topa sahip olma, saha bölümleri, takım genişliği, takım uzunluğu, kale çizgisine olan mesafe ve takımın kapladığı alan dahil olmak üzere, 2022 FIFA Dünya Kupası'nda takımların performansını etkileyen faktörleri araştırmıştır. Bu çalışmada 32 takım arasında oynanan toplam 64 maç incelenmiştir. Analizler sonucunda kazanılan maçlarda, beraberlik ve mağlubiyetlerden çok daha fazla gol atıldığı sonucuna ulaşılmıştır. Yaygın inanışın aksine, topa sahip olma yüzdeleri önemli ölçüde farklılık göstememiştir.. Topa sahipken ve top rakipteyken çizgi yüksekliği, takım uzunluğu ve takım derinliği gibi stratejiler farklı sonuçlar arasında farklılık göstemiştir. Sonuçlara göre üçüncü bölgede, kazanan takımlar daha yüksek savunma hatları ve daha derin dizilişler kullanmaktadırlar. Sonuç olarak bu çalışma futbol performansının çok yönlü tarafını 2022 FIFA Dünya Kupası özelinde araştırmayı amaçlamış ve gol atma yeteneği ve saha bölgesine özgü stratejilerin çok önemli roller oynadığı sonucuna varmıştır. Bu dinamikleri anlamak, takımları ve koçları daha bilinçli ve etkili performans optimizasyonu konusunda bilgilendirebilir, analiz ve gelecekteki araştırmalara duyulan ihtiyacı vurgulayabilir.

Anahtar Kelimeler: Kolektif Davranış, Performans Analizi, Takım Koordinasyonu, Futbol

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INTRODUCTION

Performance analysis has become an integral part of modern football, providing teams with a data-driven approach to enhance their strategies, optimize team performance, player development and tactical behaviour. Match and performance analysis in football is a systematic process of collecting, processing, and interpreting data and/or video footage from competitions or trainings to gain insights into individual and team performance. This field has evolved significantly over the years, driven by advancements in technology and a growing demand for a deeper understanding of performance. The analysis of footballers' movements in both training sessions and matches has become highly important for elite-level football teams. Through match and performance analysis, it becomes possible to scrutinize technical aspects in football such as the tactical strategies employed by teams, their passing precision, shooting accuracy, and dribbling proficiency during the game (Ertetik, 2022; Fernandez-Navarro et al., 2016). By evaluating the performance of football players and teams, it becomes possible to identify their physical and physiological requirements. Subsequently, training sessions can be strategically designed by drawing insights from the technical and tactical analysis of matches. Moreover, teams can prepare for upcoming matches by conducting comprehensive assessments of their opponents (Carling, 2013).

There are various methods that can be used for match and performance analysis in football. Some of the primary methods include notational analysis, video analysis, tracking with optical cameras, and global positioning systems (GPS). Forcher et al. (2022) suggest that the notational analysis can provide information about key game events, but they lack insights into player interactions and team dynamics. The use of advanced technology, including algorithms and neural nets, has replaced manual analysis and offers more objective insights into the game. Tracking data has emerged as a helpful tool to elevate the analysis of sports matches as a result og convergence of technology, sports science, and the desire for improved performance. Using various measurement techniques such as GPS, multiple camera tracking systems or radio-frequency identification (RFID), sports enthusiasts and professionals can gather precise data on player and ball positions on the field (Gudmundsson & Horton, 2017). Positional data, recorded with precision, have become particularly valuable, leading to a shift from traditional to data-driven analysis methods Furthermore, the utilization of tracking data allows for a more granular evaluation of how players interact with opponents, significantly enhancing the accuracy and depth of performance indicators. While earlier research mainly centered around the physical attributes of football players through the utilization of tracking data, modern analysis has pivoted towards a more profound exploration of tactical performance. This shift towards examining interactions resembles observing a dynamic ecosystem, where players' tactical choices constantly influence position changes, leading to dynamic play patterns and unique behaviors in team sports (Ertetik, 2022; Frencken et al., 2012).

The exploration of collective behaviors within natural schemes has significantly enhanced our comprehension of how large populations of creatures co-operate and acclimate to accomplish shared purposes (Deneubourg & Goss, 1989). To illustrate, we can think of the synchronized movements of fishes (Bode et al., 2010), the collective decisions of bees (Visscher & Camazine, 1999), and the activities of ant colonies (Gordon, 2013). In accordance with these revelations, prior research has postulated that sports teams can likewise be conceptualized as open systems (Reilly et al., 2005). Within these systems, collective behaviors materialize from the intricate patterns of interpersonal coordination among each member of group (Passos et al., 2009). An advanced tactical performance and coordination among players are essential

for success in team sports. Gonçalves et al. (2017) suggests that team passing networks and player movement dynamics are important factors to consider when analyzing team coordination and performance in youth football as the authors concluded that team passing networks and player movement dynamics are closely related. In another study, its noted that the half of the match and the ball possession status influenced players' spatio-temporal relationships, in a way that significantly contributes to the collective understanding of football teams (Clemente et al., 2013).

It is known that team's performance is significantly influenced by collective behaviors in football. Researchers studying the interactions of football teams on the field have created certain classifications to determine the average positions of teams. Concepts such as team length and team width have been developed in this manner. Team length is defined as the distance between the player closest to their own goal and the player closest to the opponent's goal. Team width can be explained as the distance between the outermost players closest to the touchlines on both sides of the field (Frencken et al., 2011). These parameters used to measure teams' tactical performance and behaviors have been addressed by sports scientists in recent years through various methods and have been used to assess players' collective cohesion on the field (Folgado et al., 2014a). Castellano et al. (2017) reported that the pitch length had a significant effect on both inter- and intra-team behaviors in 7-a-side small-sided games (SSGs). In terms of intra-team behaviors, the players were more spread out on the longer pitches, with a larger effective area of play. They also showed more cooperation and coordination between players. Figueira et al. (2018) concluded that playing football with different age groups can have a positive effect on tactical behavior and physical performance in youth football players. They suggested that coaches should consider organizing mixed-age training sessions to promote the development of their players.

The aim of football performance analysis is to leverage data-driven insights, advanced technology, and tactical understanding to optimize team strategieswhile also assessing collective behaviors and tactical dynamics within teams. Different competitions or tournements can give an insight of several performance indicators. Therefore, the aim of this study is to investigate whether the results achieved by the teams that competed in the FIFA World Cup Qatar 2022 are influenced by factors such as ball possession, field zones (1st, 2nd, and 3rd zone), team width, team length, distance to the team's goal line, and the area covered by the team.

METHOD

Model of the Research

This study evaluates the matches played in the 2022 FIFA World Cup held in Qatar using a scanning model.

The Universe and Sample

Matches played by the teams that qualified for the FIFA World Cup Qatar 2022 in were analysed in this study. The teams were divided into eight groups in this tournament, and a total of 48 matches were played in the group stage. After the group stage, all matches were played in a knockout format. The teams that finished in the top two positions in their groups faced each other in the round of 16, where 8 matches were played, and the winning teams advanced to the next round. The teams that advanced to the quarter-finals were determined by winning the round of 16 matches, and in this stage, 4 matches were played. The winning teams proceeded to the semi-finals. The four teams in the semi-finals faced each other,

playing 2 matches, with the winners advancing to the final, and the other two teams competing in the third-place match. A single match was played in the final and the third-place match, concluding the tournament. The research group for this study consisted of 64 matches played among the 32 teams participating in the FIFA World Cup Qatar 2022.

Data Collection

Team length, team width, distance from the team to the goal line, and the area covered by the team were selected as parameters in line with the study's objectives. Match results were also encoded in the data sets to determine if they were influenced by these parameters. Furthermore, the data was divided into two categories: when the team had possession of the ball and when the opponent had possession of the ball. Within these categories, the field was further divided into the 1st, 2nd, and 3rd zones. As a result of this grouping, data on 49 wins, 49 losses, and 30 draws were obtained. Team length refers to the distance between the two farthest players on the team (the furthest forward and furthest backward) between the two goal lines, excluding the goalkeeper. Team width refers to the distance between the two touchlines, excluding the goalkeeper, of the two players closest to the touchlines on the team. The distance of the team from the goal refers to the distance of the last player in the team, excluding the goalkeeper, to their own goal line. The area covered by the team is obtained by multiplying the team's width by its length. The data was obtained from reports publicly available on FIFA's official website. The analyses in the study were reviewed by internationally certified coaches in the field of football. All procedures in this study were carried out in compliance with the Helsinki Declaration.

Data Analysis

The data was presented as the mean and ± standard deviation, with a significance level of $p < 0.05$. Whether the match results of the teams were influenced by team width-length, distance from the goal line, and the area covered by the team parameters were tested using one-way analysis of variance (ANOVA). The homogeneity of variances in one-way ANOVA was examined using the Levene test. When a significant difference was found in any parameter, the Bonferroni (for homogeneous variances) or Dunnett T3 (for non-homogeneous variances) post-hoc test was used. All statistical analyses were performed using SPSS software version 22 (SPSS Inc., Chicago, IL, USA).

FINDINGS

The results of the one-way analysis of variance (ANOVA) that show whether the match results are influenced by the selected parameters of team width-length, distance from the goal line, and the area covered by the team, according to the study's objective, are presented in Table 1.

Table 1. One-Way Anova Results

	Field Zones	Parameters	Win (N=49)	Draw (N=49)	Lose (N=49)	F	p	Win-Lose Difference	Win-Draw Difference	Lose-Draw Difference
		Goal	2,41 ± 1,32 *	0,57 ± 0,68	0,87 ± 1,04	41,68	**0,00**	1,84	1,54	-0,3
		Ball Possession (%)	43,33 ± 12,95	45,87 ± 12,07	44,57 ± 9,49	0,56	0,57	-2,54	-1,24	1,30
In Possession	**Build Up Low**	**Line Height (m)**	39,18 ± 2,20	39,16 ± 1,49	39,50 ± 1,43	0,38	0,68	0,02	-0,32	-0,34
		Team Length (m)	53,47 ± 3,24	54,47 ± 3,09	54,33 ± 3,00	1,41	0,25	-1,00	-0,86	0,14
		Team Depth (m)	19,51 ± 2,37	19,69 ± 1,97	19,47 ± 2,45	0,12	0,88	-0,18	0,04	0,23
		Surface Area (m2)	2097,35 ± 195,04	2134,10 ± 157,73	2145,77 ± 134,06	0,95	0,39	-36,76	-48,42	-11,66
	Build Up Mid	**Line Height (m)**	33,16 ± 2,09	32,84 ± 1,89	32,93 ± 2,00	0,34	0,71	0,33	0,23	-0,10
		Team Length (m)	55,02 ± 2,57	55,49 ± 2,66	55,43 ± 2,43	0,46	0,63	-0,47	-0,41	0,06
		Team Depth (m)	40,02 ± 3,54	40,43 ± 2,77	40,57 ± 2,36	0,37	0,69	-0,41	-0,55	-0,14
		Surface Area (m2)	1823,71 ± 131,70	1822,31 ± 139,64	1824,20 ± 115,12	0,00	1,00	1,41	-0,49	-1,89
	Final Third Phase	**Line Height (m)**	36,57 ± 2,31	35,84 ± 2,18	36,17 ± 2,23	1,32	0,27	0,73	0,40	-0,33
		Team Length (m)	43,33 ± 2,29	45,18 ± 2,51 #	43,53 ± 2,16	8,72	**0,00**	-1,86	-0,21	1,65
		Team Depth (m)	52,55 ± 2,47	53,71 ± 2,58 &	53,67 ± 2,09	3,36	**0,04**	-1,16	-1,12	0,05
		Surface Area (m2)	1581,73 ± 90,74	1619,16 ± 135,35	1572,50 ± 96,28	2,12	0,12	-37,43	9,23	46,66
Out of Possession	**High Block/Press**	**Line Height (m)**	36,49 ± 1,86	36,81 ± 1,93	36,77 ± 2,01	0,39	0,68	-0,33	-0,28	0,05
		Team Length (m)	40,20 ± 2,09	40,86 ± 2,13	40,90 ± 1,95	1,58	0,21	-0,65	-0,70	-0,04
		Team Defence Depth (m)	47,51 ± 1,82	48,00 ± 1,88	47,90 ± 2,12	0,87	0,42	-0,49	-0,39	0,10
		Surface Area (m2)	1467,22 ± 108,37	1503,96 ± 107,42	1504,57 ± 118,54	1,69	0,19	-36,73	-37,34	-0,61
	Mid Block	**Line Height (m)**	26,73 ± 2,53	27,16 ± 2,68	26,63 ± 2,47	0,51	0,60	-0,43	0,10	0,53
		Team Length (m)	39,86 ± 2,21	40,10 ± 2,18	40,70 ± 1,99	1,45	0,24	-0,24	-0,84	-0,60
		Team Defence Depth (m)	37,39 ± 1,46	37,90 ± 1,75	37,20 ± 1,67	2,07	0,13	-0,51	0,19	0,70
		Surface Area (m2)	1064,90 ± 112,23	1089,24 ± 123,62	1084,80 ± 122,90	0,56	0,57	-24,35	-19,90	4,44
	LowBlock	**Line Height (m)**	25,20 ± 3,67	25,53 ± 3,19	24,67 ± 3,11	0,61	0,54	-0,33	0,54	0,86
		Team Length (m)	36,00 ± 2,04	35,51 ± 2,06	35,67 ± 2,23	0,69	0,50	0,49	0,33	-0,16
		Team Defence Depth (m)	18,08 ± 2,07	17,59 ± 2,73	17,60 ± 2,47	0,60	0,55	0,49	0,48	-0,01
		Surface Area (m2)	905,65 ± 131,63	905,24 ± 116,08	878,30 ± 113,73	0,57	0,57	0,41	27,35	26,94

* Win > Lose and Draw; # Lose > Win and Draw; & Lose > Win.

When the results given in Table 1 are examined, it was found that the winning teams were statistically different according to draw and loss situations in the goal parameter (Win, 2.41 ± 1.32; Defeat, 0.57 ± 0.68; Draw, 0.87 ± 1.04; p=0.00). The team width in the 3rd zone when the losing teams have the ball is higher than in the win and loss situations (Win, 43.33 ± 2.29; Loss, 45.18 ± 2.51; Draw, 43.53 ± 2.16; p =0.00). Losing teams had higher distance from the goal in the 3rd zone than the winning teams (Win, 52.55 ± 2.47; Loss, 53.71 ± 2.58; p=0.04). Average surface area of teams according to results and field zones are given in Figure 1.

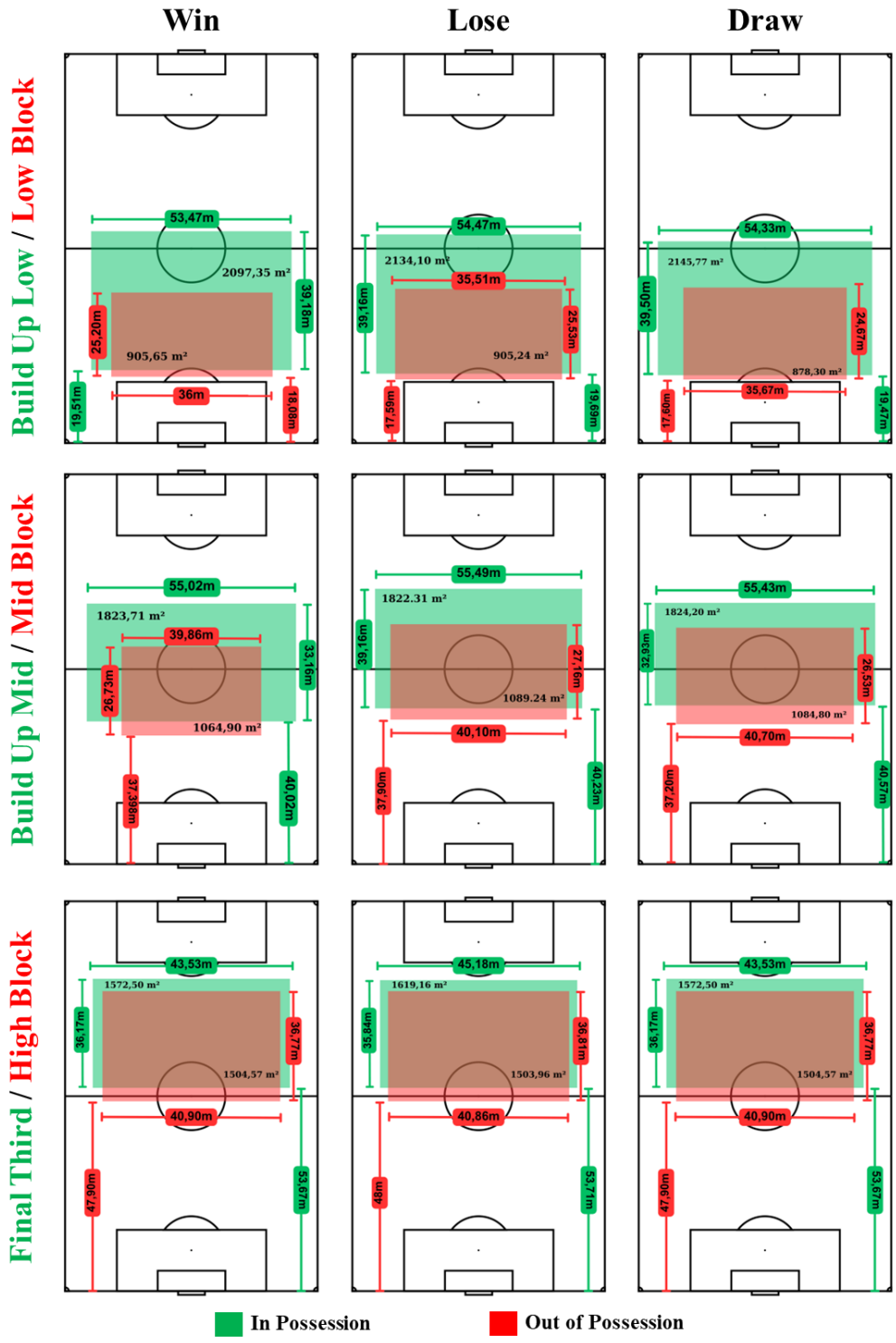

Figure 1. Average surface area by teams according to results and field zones

DISCUSSION and CONCLUSION

Match and performance analysis in football is frequently researched using different methods. Investigating the possible factors that affects performance components in different situations (tournaments, organizations, etc.) can help reveal optimal performance. This study aimed to examine the FIFA World Cup Qatar 2022 games to see if the teams' performance is influenced by factors such as ball possession, field zones (1st, 2nd, and 3rd zone), team width, team length, distance to the team's goal line, and the area covered by the team. The results obtained from the one-way ANOVA analysis provide us with valuable insights into the multifaceted nature of football performance and the intricate interplay between various field zones and match outcomes. Analysing these findings offers a deeper understanding of what separates winning, drawing, and losing teams and how different performance parameters contribute to these outcomes.

Goal Performance

It's evident that the ability to score goals plays a pivotal role in securing victories in football matches. The substantial difference in the average number of goals scored between wins, draws, and loses underscores this point. Teams that win consistently outperform their opponents, with an average of 2.41 goals per match, while drawing and losing teams struggle to reach even a goal per game on average. This stark contrast in goal-scoring ability is not just statistically significant; it's practically decisive. The ability to convert goal-scoring opportunities sets winning teams apart and highlights the importance of offensive efficiency game outcomes. In a study conducted by Gurkan et al. (2020), which involved a comparative analysis of matches resulting in victories, defeats, and draws in the UEFA Champions League during the 2014/2015 and 2019/2020 seasons, it was concluded that teams winning matches had higher average goals per match. Schulze et al. (2022) investigated the relationship between running behaviour preceding goal-scoring opportunities (GSOs) in football. According to results, offensive running behaviour in the minute leading up to GSOs was a significant predictor of success and greater defensive distances covered by attackers were positively correlated with attacking effectiveness, emphasizing the importance of attackers creating space ahead of them, forcing defenders to cover more ground.

Ball Possession

While the commonly held belief is that higher ball possession leads to better results, the results of our study challenge this notion. There were no significant differences in ball possession percentages among the three match outcomes. The data suggests that ball possession alone may not be a determining factor in match outcomes in FIFA World Cup Qatar 2022. The minimal difference in possession percentages among wins, draws, and losses indicates that ball maintenance might not be as crucial as previously thought. There is numerous of studies examined the effects of ball possession on game outcomes. Collet (2013) analysed the ball retention and team success in several competitions over the period of 2007 and 2010. Study has very similar results with our study, suggests that in national team tournaments, possession did not have a significant impact when offensive factors were considered. The effect of greater possession was consistently negative in league play and had little impact in the Champions League. The study also found that while possession time and passing could predict aggregated team success in domestic league play, they were poor predictors at the individual match level. In a study analyzing the matches resulting in victories, defeats, and draws in the 2021/2022 season of the Turkish Football Super League (Gurkan, 2023), it was found that there was no statistically significant difference among the three groups in terms of ball possession variable ($p>0.05$). Maneiro et al. (2020) aimed to

investigate the impact of situational match status on ball possession during the FIFA Women's World Cup 2015. Study resulted that unsuccessful teams tended to have fewer ball possessions when they were winning. Most of their possessions occurred when they were losing. Successful teams, on the other hand, had more possessions when they were winning, and they spent more time maintaining ball possession in their offensive zone.

In Possession

Possession is a crucial aspect of football that can be used strategically to control the game and create scoring opportunities. However, its effectiveness depends on how well a team uses its possession to advance its goals and adapt to the specific context of the match. Focusing on the phases of build-up play, we find that line height, team length, team depth, and surface area coverage during "Build Up Low" and "Build Up Mid" do not significantly influence match outcomes. The low F-statistics and non-significant p-values for these parameters emphasize their limited impact. However, we found that Team Length and Team Depth demonstrates significant differences in Final Third Phase. Winning teams consistently adopt higher defensive lines, longer formations, and deeper team depths during this crucial phase of attack. These findings suggest that when teams approach the opponent's goal, maintaining a strategically advantageous position can make a substantial difference in scoring and winning matches. Casal et al. (2017) analysed the pitch area in which possession occurs in football and its relationship to team success in UEFA Euro 2016 tournament. Results showed significant differences in the field zones where possession occurred between successful and unsuccessful teams. Study also reported that the successful teams tend to have longer possession times, mainly in the middle offensive zone and unsuccessful teams have shorter possession times, often in the middle defensive zone. Gómez et al. (2012) analysed data from 1,900 football games played over five seasons in the Spanish Professional Football League. They reported that the interaction between game location and final outcome was significant in between the midfield circle and offensive semi-circle (on attack) which pertained to turnovers the offensive goal area. Another study also had similar outputs, it’s noted as successful possessions were more likely to occur in the offensive zone, indicating an intention to progress toward the opponent's goal and typically involved a lower number of passes (Maneiro et al., 2021). While possession game can be an indicator of a team's control, it's not always a secure success in football. Some teams are highly effective with less possession, relying on efficient counterattacks or set pieces to score goals.

Out of Possession

Out of Possession encompasses defensive strategies, we notice that line height, team length, and team depth exhibit relatively consistent patterns across high block/press, mid-block, and low block defensive strategies. In general, these parameters do not significantly affect match outcomes in these scenarios, suggesting that a balanced approach may be equally effective across different defensive phases. Studies proved that unsuccessful teams' possessions were longer in the defensive zone when the score was tied, regardless of the start-up type. In the offensive zone, they were longer when losing and when initiating play through set-ball actions, or when winning and initiating through a transition (Casal et al., 2019). Casal Sanjurjo et al. (2021) examined various variables related to defensive transitions in FIFA World Cup 2014. They identify the loss zone, transition duration, position of defence lines and end zone of transition as key variables associated with the direct recovery of the ball during defensive transitions. One study aimed to develop an innovative network method to assess interactions between players during defensive phases of play in football. The study used a small-sided and conditioned game (SSCG) format, which involved a goalkeeper and two teams of seven players each. Results suggests that effective triangular-shaped positioning

among defensive players can help in providing cover, maintaining balance, protecting the goal, and regaining possession of the ball (Pacheco et al., 2022).
In team sports like football, statistical data often helps us understand the outcome of the game. However, sometimes, there are subtle details beyond statistics that can have a significant impact. In a football match, the positions and movements of teams on the field play a crucial role in determining the results. A winning team may be able to apply pressure or defend more effectively, perhaps on a narrower area. This depends on the team's tactical and strategic abilities. Furthermore, coordination among players can enhance the impact of per capita area. There are similarities and differences in the motion paths of players in football, providing insights into player coordination. One study found that coordinated defenders play a crucial role in football, which underscores the importance of skills like spatial awareness, often overlooked in youth development (Marcelino et al., 2020). One systematic review has examined collective behaviour in young footballers based on their age group and level of competence. According to the results, the width and length of the collective area covered by players tend to increase with age. This suggests that older and more competent players tend to utilize a larger portion of the field. The distance between dyads (pairs of players) also increases with age. This indicates that older players tend to maintain a greater spatial separation from their teammates (Nieto et al., 2022). This result may show that average team age may be effective on teams' collective behaviour.

In conclusion, this analysis of football performance parameters in different field zones and match outcomes sheds light on the intricate factors that separate winning, drawing, and losing teams. It underscores the significance of goal-scoring ability, the potential nuances of ball possession, and the importance of field zone-specific strategies. Equipped with these insights, coaches and teams can work toward more informed and effective performance optimization on the football pitch. To further refine these observations and uncover deeper insights, future research could expand the dataset, consider additional parameters, and explore the influence of tactical and strategic factors on match results. Additionally, analysing these parameters within specific playing styles and against various opponents may provide a more nuanced understanding of the intricate dynamics of football performance.

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