

The relationship between game success indicators in the FIFA World Cup – Qatar 2022: An elastic-net regularization approach

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Abstract

Background and Study Aim The significance of analyzing statistical indicators is paramount, as they provide valuable insights into the distinguishing performance factors of teams. The purpose of this study: 1) to identify statistically significant differences between relevant performance factors among winning, drawing, and losing teams in the 2022 Football World Cup in Qatar; 2) explore indicators that are most strongly associated with the game results in this tournament.

Material and Methods A total of 64 matches and 32 participating teams were analyzed. The variables included in the research were: total shots, shots on target, shots off target, effectiveness, passes, passes completed, crosses, crosses against, offsides committed, offsides received, fouls received, ball possession, fouls committed, corners, corners against, yellow cards and red cards. The results are extracted from the official FIFA website. The Analysis of Variance (ANOVA) and the ordinal logistic regression with elastic net were used for data calculation.

Results The results indicate that winning teams have statistically significantly higher mean values of variables related to goals scored: total shots ($p < 0.05$), shots on target ($p < 0.01$), and effectiveness ($p < 0.01$). According to the information-based model selection criteria AIC (Akaike information criterion) and BIC (Bayesian information criterion) effectiveness and shots on target are the most important variables regarding game results. They, along with corners, are best associated with successful teams. In contrast, crosses, ball possession, corners against, and yellow cards are associated with less successful teams. Results suggest that teams with high ball possession and large number of crosses, but fewer shots on target, have weaker results than teams with more shots on target and less ball possession.

Conclusions The study underscores the significance of certain performance indicators, such as total shots, shots on target, and effectiveness, in predicting a team's success. These findings provide valuable insights for coaches and teams to focus on specific aspects of their game to enhance their chances of winning. Additionally, understanding the impact of variables like ball possession, crosses, corners, and yellow cards emphasizes the importance of a well-rounded strategy for achieving success in international football tournaments.

Keywords: game performance, game analysis, soccer, winner, loser.

Introduction

Performance in high-level football is closely linked to the collection and findings of statistical data, which appropriately assist in the success of the winning teams, and at the same time differentiate them from the losing teams. The identification of these factors can be an important step toward objective predictive analysis. The goal of performance analysis is to provide coaches with information about the player and the team in order to plan subsequent training sessions to improve mistakes made or to better prepare for the next match [1]. However, other important issues related to weak competencies and contemporary research methodology that should be paid attention to in future research may include different factors, such as developing a theoretical framework, examining contested and game situations,

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and incorporating dynamics space and time [2]. This is probably the reason for the growing research trend in performance analysis in football, especially in Europe [3]. Player performance analyses related to match results can be highly valuable in explaining the effects of the team's performance [4, 5]. There are a considerable number of game indicators that can influence the results of matches [6, 7, 8].

A longitudinal study analyzing 288 matches from the UEFA Champion League during 2007-2008, 2008-2009, and 2009-2010 seasons showed that the variables differentiating the winning, drawing, and losing teams were: total shots, shots on target, passes, passes completed, venue and opponent's quality based on table ranking [9].

In the analysis of the FIFA 2014 World Cup in Brazil, 9 variables were identified having a positive effect on the probability of winning the game: total shots, shots on target, shots from counterattacks,

shots inside the penalty area, ball possession, short passes, the average of passes, aerial advantage and tackles; 4 variables having a negative effect: shots blocked, crosses, dribbles, and red cards; and 12 other variables with no clear influence for the group they belong to [10].

Another research [11] conducted during the same FIFA 2014 World Cup in Brazil presents impressive data in favor of the winning teams for the following variables: total goals, goals from standard situations, total shots on target, shots accuracy, and on the other hand, statistically lower values are presented with the yellow cards received.

Furthermore, a statistical analysis of 38 matches in the African Cup of Nations – AFCON 2019 demonstrates the statistical and significantly better performance of the winning teams in: total shots, shots on target, and shots from counterattacks, while total shots, shots on target, fouls, total passes, and yellow cards present the highest discrimination factor between the winning, drawing and losing teams [12].

In addition to World and Continental Cups, there are also studies in prestigious European leagues in finding relevant factors that may have an impact on the success of the game.

A study of the professional Spanish Football League in the 2008-2009 season shows statistically collected data findings as follows: winning teams having significantly higher mean values in the following variables: total shots, shots on target, shot effectiveness, assists, offside positions (committed) and crosses against, while the losing teams having significantly higher mean values in the following variables: crosses, offsides (received) and red cards. Variables that make a distinction between the winning, drawing, and losing teams were total shots, shots on target, crosses, crosses against, ball possession, and venue [13].

An analysis of matches in the Turkish Super League [14] in the 2019-2020 season shows that the total number of shots, shots on target, and a number of key passes were important determinants for the success of the game. All these variables were found to be important for the success of the teams based on the league table ranking.

The researches and analysis of performance in the Qatar 2022 World Cup are necessary, among others, due to the fact that games are played for the first time in the winter season, where the majority of teams are from the European continent and need to adapt to the conditions and weather of the Asian continent, which can play a decisive role in the variability of performance indicators. However, the findings of this research, in addition to the above-mentioned factors, should be treated with special care due to the limited number of teams, and as such may not be applicable to all teams.

In football, the main goal is to defeat the opponent, to do this, is necessary to collect data

for all opponents, firstly to see the strengths and weaknesses of the team, and to determine the level of physical condition and improve this level in order to achieve this goal [15]. Since the collection of statistical data is a highly decisive task, some similar studies fail to demonstrate the reliability of the data collection system used [16]. Considering that other researchers have used different equipment for data collection, it is important to emphasize that the results from this research may be difficult to compare with other research.

Through a collection of statistical data, this research attempts to identify specific factors that can have an impact on the success of the game and can distinguish the best teams from the other teams in the Football World Cup in Qatar – FIFA 2022.

Materials and Methods

Participants

A total of 64 matches with 32 participating teams in the Football World Cup in Qatar – FIFA 2022 were analyzed. Only statistics during the regular playing time were collected, excluding extra time. Statistical data from the official FIFA website were used for the analysis of relevant factors for the success of the game.

Research Design

Participating teams were divided into three groups: winning, drawing, and losing (dependent variables). The variables included in the research were divided into three categories:

- variables related to goals scored: total shots, shots on target, shots off target, and effectiveness (shots on target x 100 / total shots);
- variables related to offense: passes, passes completed, crosses, offsides committed, fouls received, corners and ball possession;
- variables related to defence: crosses against, offsides received, fouls committed, corners against, yellow cards and red cards (independent variables).

Statistical Analysis

After verifying the homogeneity of variance through Levene's test ($p > 0.05$), one-way analysis of variance (ANOVA) was used to determine differences between the winning, drawing and losing teams. The effects on mean differences were calculated through the Post Hoc (Bonferroni) test. Ordinal logistic regression with elastic net regularization was used to find coefficients that best associated with the game results.

The offsides committed, offsides received and yellow cards variables were log+1-transformed. All variables were z-standardized for better comparability. The R function “ordinalNet” from the “ordinalNet” package was used. The following parameters were used: alpha = 0.5 and lambda values between 0.004 and 0.04.

Results

Table 1 presents the descriptive statistics data of the three groups. In the first group related to goals scored, there is a significantly bigger difference between the winning and drawing teams in the total shots variable ($< .05$). Additionally, winning teams show significantly higher mean value results in the shots on target variable ($< .01$) compared to drawing and losing teams, as well as in the effectiveness variable ($< .01$) where winning teams have statistically higher mean values than drawing and losing teams. However, there are no significant differences between the drawing and losing teams. On the other hand, winning teams in the group related to offense had

higher mean value results in the offsides committed and corners variables, as in the group related to defense where losing teams had higher mean values in the offsides received and yellow cards variables, but with no statistical significance.

Table 2 shows that shots on target and effectiveness have a greater impact on the positive game outcome. Shots on target, effectiveness, and corners ($\lambda = 0.072$) show the best predictions for successful teams (with shots on target contributing the most), while variables such as crosses, ball possession, corners against, and yellow cards show the best predictions for less successful teams (with ball possession having the largest coefficient). Additionally, if the penalty term

Table 1. Differences (mean $\pm$ SD) between winning, drawing, and losing teams in the Football World Cup – FIFA 2022.

Variables	Winner	Drawer	Loser
Related to goal scored			
Total shots	12.5 $\pm$ 6.1*	9.2 $\pm$ 3.5	10.2 $\pm$ 5.0
Shots on target	5.2 $\pm$ 2.7*°	3.1 $\pm$ 2.2	3.0 $\pm$ 2.0
Shots off target	4.9 $\pm$ 2.9	3.8 $\pm$ 1.9	4.9 $\pm$ 2.6
Effectiveness	42.4 $\pm$ 13.0*°	32.6 $\pm$ 17.4	28.7 $\pm$ 16.0
Related to offense			
Passes	479.3 $\pm$ 180.2	491.3 $\pm$ 113.9	498.8 $\pm$ 142.8
Passes completed	412.3 $\pm$ 182.3	419.5 $\pm$ 119.2	425.9 $\pm$ 142.1
Crosses	17.3 $\pm$ 7.9	17.6 $\pm$ 6.9	18.4 $\pm$ 7.7
Offsides committed	2.1 $\pm$ 2.0	1.8 $\pm$ 1.6	1.9 $\pm$ 1.4
Fouls received	12.0 $\pm$ 4.7	12.4 $\pm$ 3.0	11.9 $\pm$ 3.5
Corners	4.7 $\pm$ 2.9	4.1 $\pm$ 2.3	4.0 $\pm$ 2.8
Ball possession (%)	42.7 $\pm$ 13.1	44.3 $\pm$ 9.5	45.4 $\pm$ 2.2
Related to defense			
Crosses against	18.4 $\pm$ 7.7	17.6 $\pm$ 6.9	17.3 $\pm$ 7.9
Offsides received	1.9 $\pm$ 1.3	1.8 $\pm$ 1.6	2.1 $\pm$ 2.0
Fouls committed	11.9 $\pm$ 3.5	12.0 $\pm$ 3.5	12.0 $\pm$ 4.7
Corners against	4.0 $\pm$ 2.8	4.0 $\pm$ 2.3	4.7 $\pm$ 2.9
Yellow cards	1.5 $\pm$ 1.4	1.6 $\pm$ 1.4	1.9 $\pm$ 1.5
Red cards	.04 $\pm$.2	.0 $\pm$ 0	.02 $\pm$.1

*Significantly different from drawers; ° Significantly different from losers

Table 2. Model coefficients for selected parameters of ordinal logistic regression with an elastic net.

Variables	$\lambda=0.192$	$\lambda=0.072$	$\lambda=0.022$
Passes			
Passes completed			
Crosses		-0.13	-0.46
Offsides committed			
Fouls received			
Corners		0.09	0.48
Ball possession (%)		-0.23	-0.48
Crosses against			0.23
Offsides received			
Fouls committed			
Corners against		-0.08	-0.49
Yellow cards		-0.13	-0.28
Red cards			0.16
Total shots			
Shots on target	0.17	0.39	0.49
Shots off target			
Effectiveness	0.18	0.29	0.35

is shrunk to less than $\lambda = 0.022$, crosses against and red cards will have a predicted impact on the winning teams. However, the other variables included in the research are not related to the outcome of the match.

Figure 1 shows that positive coefficients are associated with a positive outcome, and negative coefficients with a negative outcome. The earlier the path of the respective variable (coming from the right) deviates from zero and the larger the

coefficient, the more important the variable is for the game result.

Figure 2 shows that shots on target describe the probability of the game result. For example, with 10 shots on target, about 63% of all games are won, 17% are lost and 20% end in a draw. With 75% effectiveness, the probability of the game outcome results in about 22% games lost and drawn and 56% games won.

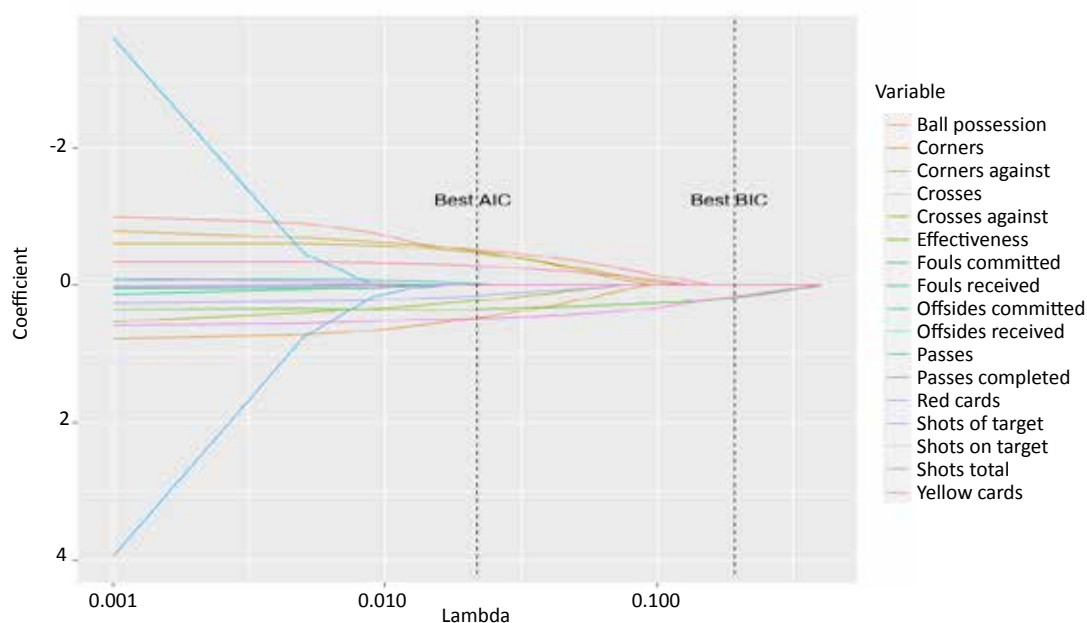


Figure 1. Graph of coefficients as a function of lambda.

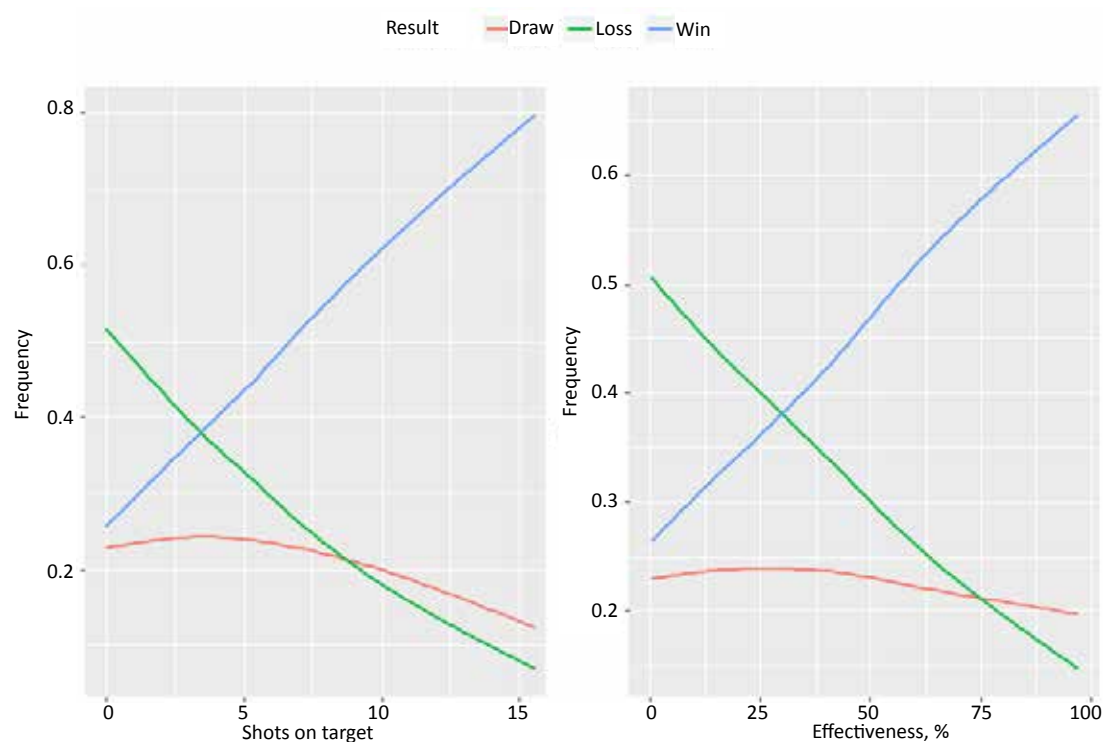


Figure 2. Graph created using Monte Carlo simulation (based on the regression model) describing the relationship between shots on target, effectiveness, and game result.

Discussion

The possibility of determining the key factors that play a decisive role in matches' final results requires specific analysis focused on determining the differentiating variables. In this context, the objective was the study of the relationship among game statistics related to the success of the game and the identification of variables that make the difference between the winning, drawing, and losing teams.

The findings of this research show that winning teams have more shots in total, more shots on target, and are eventually more effective compared to drawing or losing teams. Based on the lambda parameter selected according to the BIC criterion, Graph 1 shows that shots on target and effectiveness are classified as the most important variables for the result of the game. It has been proven both in national leagues [17, 18, 19] as well as in important championships [20, 21] where winning teams have significantly higher numbers of total shots and shots on target than losing teams.

Graph 2 shows the probability of game results related to shots on target and their effectiveness. The higher the coefficients, the higher the possibility of the teams to win the match.

Research also states that the effectiveness of shots is expressed with 45.6% for the winning teams, 37.1% for the drawing teams, and 34.6% for the losing teams [13].

Contrary to researchers [22] who argue that successful teams with high ball possession manage to convert it to more shots on target, losing teams in the FIFA World Cup – Qatar 2022 had higher mean values of ball possession and crosses compared to winning teams. Referring to Table 2, although the penalty term is low ($\lambda = 0.072$), it can be noted that teams with high ball possession ($r = -0.23$) and a lot of crosses ($r = -0.13$), but which failed to convert them to shots on target, had worse results compared to teams with more shots on target ($r = 0.39$) and less ball possession.

During the analysis of the European Football Championship – UEFA 2016 (group stage), the research found that the key factors having an impact on the final result of the game are the total number of shots on target and the effectiveness of those shots, whereas when a team plays to overturn an unfavorable result (during a loss or a draw), then the most important factors are the frequency of numerous passes and a high percentage of ball possession [18]. Researchers also argue that ball possession cannot be considered a success factor in winning a match because a high percentage of ball possession does not necessarily imply a larger number of shots on target, but it is exactly the effectiveness of shots that makes the difference [23, 24, 25].

In addition to the above-mentioned shots on target and effectiveness variables, corners are also associated with positive match results, whereas with the shrinking of the penalty term to ($\lambda = 0.022$), the number of variables associated with positive match results such as crosses against and red cards increases even more.

The ineffectiveness of crosses against a team is seen as a counterattack possibility by the opposing team, which can create a numerical advantage in the opponent's half-field and successfully finalize the action. Although with a lower coefficient ($r = 0.16$), red cards are associated with the winning teams, a well-known phenomenon where teams with a numerical disadvantage try to mobilize additional forces to preserve the result, or sometimes even turn it in their favor.

On the contrary, indicators associated with losing teams had a negative coefficient in the corners against, crosses and yellow cards variables. The higher their coefficient, the lower the likelihood of positive results.

Since previous studies have confirmed that the venue (home or away) plays an important role in the final result in favor of home teams [13, 19, 26, 27] as well as in the review of research [5] reporting that home teams had higher mean values of key variables (goals scored, accurate shots, successful passes, successful dribbles, and corners), this cannot be taken for granted even for the teams in the World Cup because there was only one home team, and this time the host did not have better statistics than its opponents in none of the matches regarding the above-mentioned variables.

Furthermore, according to the authors [28, 29] when comparing winning and losing teams, the reduction of information on significant factors may result from different playing styles, leading to different performance profiles of teams, which cannot be excluded even from this World Cup. However, it should be taken into account that differences in terms of mathematical probability are considered only as part of the analysis of the results.

It is yet to be determined whether the trend of this World Cup, which is undoubtedly heavily influenced by the teams' playing style, will also be reflected in other championships.

Conclusions

The analysis of matches in the Football World Cup – Qatar 2022 revealed that shots on target and their effectiveness were the most important determinants for the success of the games. This World Cup highlighted that the variables related to offense and defense across the three groups (winning, drawing, and losing teams) exhibit very narrow and statistically insignificant differences among them, indicating that their performance regarding various indicators was very balanced

and therefore could not contribute to significant differences.

The results suggest that teams with high ball possession and a large number of crosses, but fewer shots on target, have weaker results than teams with more shots on target and less ball possession. Corners tend to have a positive impact on the success of the game.

The association of crosses against and red card indicators with winning teams can be explained as a need for additional mobilization to either preserve

or even stage a comeback victory. These criteria help to identify the best combination of predictors selected by the research model which can be used to modify the training process in the right direction, as well as to create a playing style that can lead to success.

Conflict of interest

There is not declared conflict of interest by the authors.

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