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REVIEW ARTICLE

How to be Successful in Football: A Systematic Review

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Abstract:

Background:

Despite the popularity of football, the analysis of success factors in football remains a challenge. While reviews on performance indicators in football are available, none focuses solely on the identification of success factors and addresses the large and growing body of recent research up until 2016.

Objective:

To find out what determines success in football and to organize the body of literature, a systematic literature review analyzing existing studies with regard to success factors in football was undertaken.

Methods:

The studies included in this review had to deal with performance indicators related to success in football. The studies were published in 2016 or before. The initial search revealed 19,161 articles. Finally, sixty-eight articles were included in this review. The studies were clustered with regard to comparative analyses, predictive analyses and analyses of home advantage.

Results:

In total, 76 different variables were investigated in the reviewed papers. It appeared that the most significant variables are efficiency (number of goals divided by the number of shots), shots on goal, ball possession, pass accuracy/successful passes as well as the quality of opponent and match location. Moreover, new statistical methods were used to reveal interactions among these variables such as discriminant analysis, factor analysis and regression analysis. The studies showed methodological deficits such as clear operational definitions of investigated variables and small sample sizes.

Conclusion:

The review allows a comprehensive identification of critical success factors in football and sheds light on utilized methodological approaches. Future research should consider precise operational definitions of the investigated variables, adequate sample sizes and the involvement of situational variables as well as their interaction.

Keywords: Match analysis, Soccer, Success, Performance, Indicator, Football.

1. INTRODUCTION

Football or soccer (in this paper the term 'football' is used) is the most popular sports in the world. According to the "Big Count" study of FIFA [1] there are 270 million people involved in the match (players and referees). Moreover, football attracts millions of spectators around the world. For example, the global TV audience that followed the 2015 UEFA Champion's League final between FC Barcelona and Juventus Turin was estimated to be 180 million people from more than 200 territories [2]. Due to its high popularity, football stands out among sports and games. In contrast

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to games such as basketball or handball, football is a low scoring game, and scoring a goal is usually a rare event. For this reason, the final match score does not provide a clear picture of the teams' technical and physical performances. To understand success factors in football, various other performance indicators next to goals scored have to be considered. Football is also a sport which has elements of chance but nevertheless, this does not mean successful teams are just luckier than others [3, 4].

To identify the factors which lead to success in football it is necessary to find performance indicators which significantly discriminate winners and losers. However, the identification of critical factors for successful performance poses a major challenge [5]. In 1912, Fullerton did the first work in this area of performance analysis for baseball [6]. In football, Reilly and Thomas [7] performed one of the first systematic notational analyses. They used hand notation and audio tapes to analyze in detail the movements of English First Division football players [8], and found out, inter alia, that a player is usually in touch with the ball for only two percent of the time. In another early performance analysis, Reep and Benjamin [9] developed a new approach to study 3,213 matches in England between 1953 and 1968 using frequency distributions. Their analysis revealed that about 80 percent of all goals are scored after three or fewer passes and about 10 shots are needed for one goal.

A milestone for science and football was the first World Congress of Science and Football which was held in Liverpool in 1987 [5]. Various themes were discussed such as team management, computer-aided performance analysis and decision-making by referees [10]. In the following years, the numbers of research papers concerning football and performance analysis increased steadily [11 - 15]. Hughes and Bartlett [16] reviewed and analyzed research on performance indicators in sports and defined a performance indicator as "… a selection, or combination of action variables that aims to define some or all aspects of a performance. Clearly, to be useful, performance indicators should relate to successful performance or outcome" (p. 739). Researchers also monitored match structures, summarized some performance indicators and utilized them (*e.g.*, numbers of shots, passes, dribbles or ball possession) in various subsequent papers which provided more insight into possible success factors in football [6, 17].

In the context of this paper, two review studies regarding performance analysis in football are noteworthy. Mackenzie and Cushion [18] critically reviewed 60 articles (articles published up to 2010) with a focus on methodological approaches and concluded that there is an overemphasis of research on predictive and performance controlling variables (*e.g.*, location, shots). They suggested an alternative approach that focuses on research that investigates athlete and coach learning to enhance our understanding of football performance. However, these factors cannot readily be operationalized as success factors. Sarmento, Marcelino, Anguera, Campanico, Matos and Leitao [19] systematically reviewed 53 articles (articles published up to 2011) with a focus on major research topics and methodologies. They concluded that most studies used a comparative analysis to analyze differences between players or teams. Unlike Mackenzie and Cushion, they identified a lack of predictive studies. While it was not the main focus of their research, they also identified some success factors for a team such as the number of shots and shots on goal. They concluded that match location, quality of the opposition, match status and match half seem to have a greater importance for success due to a large number of studies that focused on these aspects.

Both aforementioned reviews comprised a wide variety of possible outcomes in the included articles, such as physical conditions or contextual variables. In this study, we focus solely on predictive or comparative studies that considered success as an outcome (win/loss, league ranking, *etc.*). This allows a clear identification of the critical factors for success. Moreover, this review also considers studies published after 2011, addressing a large and growing body of recent research that has not been covered in previous reviews, and enables an assessment of the current state of the art.[1] Not only has the amount of the articles related to performance analysis in football grown substantially since 2011, also various new methodological approaches have been utilized. For example, Grund [20] introduced network analysis into the research about success factors and Collet [21] revealed new insights into the effect of ball possession using an ordered-logit regression. Liu, Gomez, Lago-Penas and Sampaio [22] used a k-means cluster analysis and a cumulative logistic regression to reveal the factors that differentiate the between winning and losing teams. Overall, the aim of this study is to provide a systematic review of the available literature on performance analysis in elite male football concerning methodologies and results to find out critical factors for success in football and to provide guidance for future research[2].

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[1] The body of research on this topic has grown significantly in the last years. For example, in the three years between this review and the review of Sarmento et al. [19] the number of predictive studies, which are the most promising studies to deliver new insights to the of success in football, has grown by more than 40 percent (see also tables 6 to 8).

[2]Actual results of the selected articles are found in the discussion section

2. MATERIALS AND METHODS

The systematic review of performance indicators in elite men's football was done in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) statement [23]. The last search was conducted on June 24th, 2017.

To search for relevant publications and ensure the quality of the articles, the following databases were utilized: Web of Science (the modules "Core" and "Medline"), Scopus and PubMed. Articles that were published in 2016 or before and in English were considered. The search strategy comprised search terms that combined one of two primary keywords (soccer OR football) with a second keyword (*e.g.*, success, win, loss) using the Boolean operator and all utilized search terms are presented in Table **1**.

Table 1. Search terms.

| Keyword 1	OR Keyword 1	AND Keyword 2
soccer	football	possession
soccer	football	goal
soccer	football	pass
soccer	football	success
soccer	football	shot
soccer	football	sprint
soccer	football	duel
soccer	football	corner
soccer	football	win
soccer	football	lose
soccer	football	loss
soccer	football	performance indicator
soccer	football	match performance
soccer	football	indicator
soccer	football	distance
soccer	football	home advantage

For inclusion, the articles had to meet the following criteria:

- The data had to deal with performance analysis in football.
- The variables of interest were linked to success (win/loss, goals, continuance in league/tournament, league ranking and points won).
- Adult elite football was investigated.
- The study was written in English.
- The study was published in an academic journal.
- The study design was comparative or predictive or focused on home advantage in football.

It should be noted that we included studies on home advantage in this review as a separate category besides comparative and predictive studies utilizing inferential statistics. Although most of the studies on home advantage used a descriptive approach to reveal the influence of home advantage, we considered these non-inferential studies because home advantage is one of the most investigated variables regarding success factors [18].

The initial search revealed 19,161 articles (Web of Science [Core and Medline]: 9,706; Scopus: 6,038; PubMed: 3,417). After excluding the duplicates 10,833 articles remained. The articles were screened based on an assessment of both the title and the abstract. All articles without a focus on the investigation and analysis of data on the conditions of competition results in elite adult football were excluded. In total, 185 articles were relevant for this review. These articles were read in detail and assessed for relevance and quality. Articles which did not meet the criteria were excluded. After this step, 53 articles remained. Subsequently, the literature references of these 53 articles were screened for more articles meeting the criteria. Fifteen additional articles were identified. Finally, 68 articles were included in the review (Fig. **1**).

Then, the articles that met the inclusion criteria were indexed, and each article was summarized. The summaries comprised the study purpose and design, methods of data collection and analysis, and key findings. This enables an overview and comparison of the articles and allows an assessment of the current state of research on performance indicators in football.
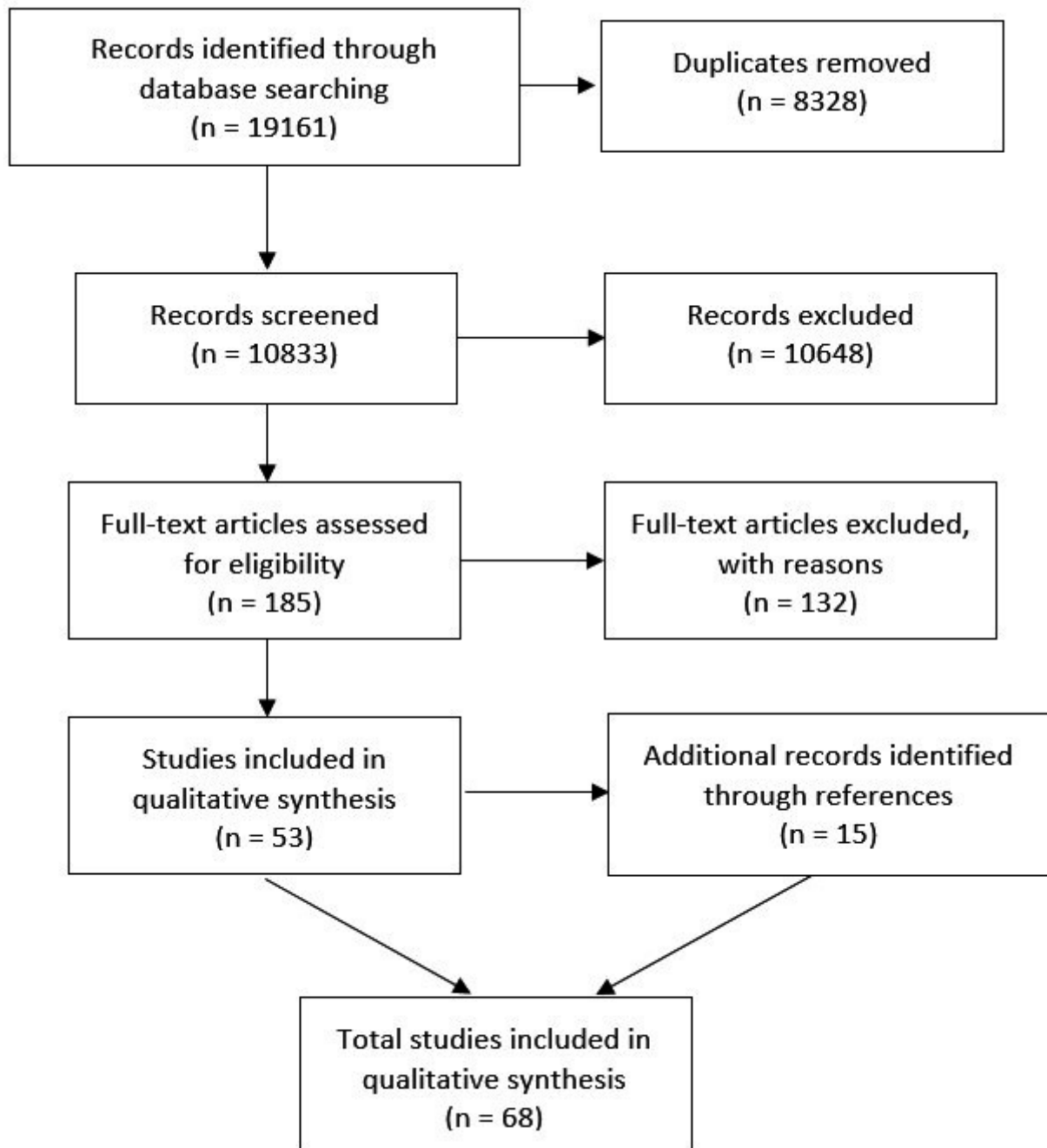
Fig. (1). Flow diagram of this systematic review [23].

3. RESULTS

The identified articles were published between 1986 and 2016, covering a time span of 31 years. More than half of the articles (exact 61.8%; 42 articles) were published within the last seven years (2010-2016) of the searched time period, indicating that this field of research has recently gained momentum.

To organize the identified analyses, the articles were categorized following a system used by Sarmento *et al*. [19] and Marcelino, Mesquita, and Sampaio [24]. In the first step, the articles were assigned to [25, 26] comparative, [27] predictive or Home Advantage (HA) analyses [28]. In the second step, articles were assigned to one of the three types of analyses from above according to the different operationalization of success (*i.e*., win/loss, goals, continuance in league/tournament, league ranking and points won) (Table **2**).

Table 2. Number of articles in each category.

–		Variables of interest					–
Design	**Win/ Loss**	**Goal Difference**	**Goals**	**League / Tournament Ranking**	**Points**	**Continuance in League/ Tournament**	**Row Total**
Comparative	7	2	1	9	1	2	22
Predictive	14	5	7	3	3	–	32
Total*³	*21*	*7*	*8*	*12*	*4*	*2*	*54*
Home advantage	20	–	–	–	–	–	20

* Multiple responses possible.

Of the articles, 30 were predictive analyses, 22 were comparative analyses, and 20 focused on the analysis of home advantage. One of the articles [15] covers both types of analyses (predictive and comparative). In total, 21 articles over all three types of analysis utilized "win/loss" as the success variable. "Goal difference" was used by seven articles, "goals" by eight, "league/tournament ranking" by 12, "points" by four and "continuance in league/tournament" by two.

4. DISCUSSION

In the following section, methods and major results of the identified articles will be presented within the three different categories of type of analysis. Finally, all findings will be summarized and the most frequent and significant variables regarding success factors in football will be discussed.

5. COMPARATIVE ANALYSES

In seven of the 21 comparative analyses, researchers compared wins and losses. In three of the seven papers draws were also included, and in one instance the percentage of wins was considered alongside wins and losses (Table **3**). In the three papers that compared only wins and losses [29 - 31] the authors tried to find variables that explain differences between winners and losers. Broich *et al*. [29] identified goal efficiency (number of goals divided by the number of shots), shots, passes and ball contacts as the most important team parameter for winning. Efficiency was also analyzed by Szwarc [31]. He showed that players of winning teams are more efficient than their opponents. As a result of the small sample (seven matches) only shots on goal ($p<0.05$) and shots defended by a goalkeeper ($p<0.01$) differed significantly between winners and losers. Kapidizic *et al*. [30] did not analyze efficiency but they also found that the numbers of shots within 16 meters ($p<0.05$) and accurate passes ($p<0.01$) are significant indicators for winning teams at the European Championship in 2008. Winners also scored more goals than losing teams in the Championship. Three more papers investigated the differences between wins, losses and draws [27, 32, 33]. These studies reported various significant differences between winning, drawing and losing teams. Winners have more entries into the penalty area ($p<0.01$) [33], more successful attacks ($p=0.003$) and passes ($p=0.015$) as well as a higher ball possession rate ($p=0.001$) [32]. Armatas *et al*. [27] revealed that 71.4 percent of teams that scored the first goal subsequently won the match ($p<0.05$). In contrast to the other studies, one study focused on the total winning percentage [34]. Another difference is the use of group cohesion as the independent variable. The authors showed a statistically significant relationship between individual attraction to the group-task and performance with a very high effect size of 1.94 ($p<0.05$). The higher the positive feelings of each group member to the group-task, that is, to play football successfully, the higher were the likelihood of winning.

³ Oberstone [15] used comparative and predictive methods; Mechtel *et al*. [25] used win/loss and goal difference; Collet [21] used win/loss and points; Carmichael and Thomas [26] used predictive methods and home advantage; Armatas, Yiannakos, Papadopoulou and Skoufas [27] used comparative methods and home advantage; Lago-Penas, Gomez-Ruano, Megias-Navarro and Pollard [28] used predictive methods and home advantage.

Table 3. Comparative articles with regard to wins and losses.

Author(s)	Year	Sample	Data Collection	Key Findings
Carron, Bray and Eys	2002	Nine football teams in Canada	GEQ questionnaire and secondary data	Individual attraction to group-task with significant performance link ($p < 0.05$); group-integration-task not significant; both with high effect size (1.94 und 1.16)
Szwarc	2007	Seven finals European Champions League 1997-2003	Video analysis	Efficiency of shots ($p < 0.05$) and goalkeeper efficiency ($p < 0.01$) significant higher in the winners; Losers significant more efficient in general defense ($p < 0.05$) such as interrupt of action, intercepting pass with ball
Armatas, Yiannakos, Papadopoulou and Skoufas	2009	240 matches in first division of Greece 2006-2007	Video analysis	71.4% of the teams that score the first goal win the match
Kapidžić, Mejremić, Bilalić and Bečirović	2010	13 matches European Championship 2008 and 12 matches first division Bosnia and Herzegovina 2008-2009	Secondary data	European Championship: winners score more goals, and more shots on goal within penalty area First division: winners perform more successful passes, shots on goal, goals, throw-in and offensive actions
Janković, Leontijević, Pašić and Jelušić	2011	60 matches World Cup 2010	Secondary data	Winning teams perform more successful attacks (ending with a shot) and passes than losing team and in draws; winners have more ball possession and pass accuracy compared to losers
Ruiz-Ruiz, Fradua, Fernandez-Garcia and Zubillaga	2013	64 matches Word Cup 2006	Video analysis	Winners perform more entries into penalty area as teams in draws and losing teams
Broich, Mester, Seifriz and Yue	2014	118 matches first division Germany 2013-2014	Secondary data	Goal efficiency, shots, passes and ball contacts (in this order) are the most important team parameters for wins

In nine of the articles, the authors compared teams with different positions in the league/tournament ranking (Table **4**). Luhtanen, Belinskij, Häyrinen and Vänttinen [35] investigated the influence of offensive and defensive variables on the final ranking of the European Championships in 1996 and 2000. In 1996, interceptions and the success rate of all defensive actions showed a significant correlation ($p < 0.05$) with the final ranking. In 2000, significant correlations with the ranking were found for success rate in passes ($p < 0.05$) and attempts ($p < 0.05$) on goal. In the other papers, different football leagues were investigated and it was shown that better-ranked teams (top-teams) need less shots for a goal than worse ranked teams [15, 36, 37]. This parameter corresponds to Broich *et al.*'s [29] 'goal efficiency'. It was also found that top teams have more successful attacks, complete their offensive attacks more frequently between zero and 11 meters in front of the goal [38], have more successful passes [15, 38, 39], score more goals [36, 37, 40], perform more crosses [15, 40], have more ball possession [37, 39], shoot more often on the goal [37, 39], have more assists [36, 37, 39] and take more shots [15, 37, 39, 40]. The best teams in the league also perform fewer fouls [15] and allow fewer shots and crosses [40]. The worst ranked teams have fewer counter attacks, have less possession with zero to four passes and have less possession longer than 12 seconds [41]. Worse teams also have more very high-intensity running, high-intensity running and total distance covered [39]. Better teams cover more total distance with the ball and very high-intensity running with the ball [39]. Furthermore, the top teams show a faster recovering (recapture is 1.3 to 1.7 seconds faster than mean times) of ball possession [42]. Obviously, top teams score more goals per match [15, 36, 37, 40]. The cited studies showed that a lot of factors influence success (operationalized as league ranking) in football. Overall, it appears that goal efficiency, passes and shots are the most important factors in this research area.

Table 4. Comparative articles with regard to league / tournament ranking.

Author(s)	Date	Sample	Data Collection	Key Findings
Luhtanen, Belinskij, Häyrinen and Vänttinen	2001	31 matches European Championship 1996 – 2000	Video analysis	Interceptions and success rate interceptions and defensive actions have highest correlation with final ranking (1996). % Successful passes and % successful goals attempts (2000)
Armatas, Yiannakos, Zaggelidis, Skoufas, Papadopoulou and Fragkos	2009	10 seasons second division in Greece	Secondary data	Top ranked less shot per goal, more goals, more shots in penalty area and more assists
Oberstone	2009	380 matches in first division England 2007-2008	Secondary data	Goals per match, number of shots, short passes, total passes, pass completion are higher for better teams; goals conceded per match and fouls are lower for better teams

(Table 4) contd.....

Author(s)	Date	Sample	Data Collection	Key Findings
Rampinini, Impellizzeri, Castagna, Coutts and Wisloff	2009	416 matches in first division Italy 2004-2005	Video analysis	Worse teams more total distance, high-intensity running (>14km/h) and very high intensity running (>19km/h); Top teams more total distance with ball and high intensity running with ball, more short passes, tackles, dribbles, shots and shots on goal
Lago-Ballesteros and Lago-Peñas	2010	380 matches in first division Spain 2008-2009	Secondary data	Top teams more goals, shots and shots on goal; worse teams need more shots per goal
Janković, Leontijević, Jelušić, Pašić and Mićović	2011	228 matches in first division Serbia 2009-2010	Video analysis	Successful attacks (end up with a shot) and pass rate higher for top teams; top teams kick the ball more often form 0-11m to the goal
Tenga and Sigmundstad	2011	997 goals from 1922 matches in first division in Norway 2008-2010	Video analysis	Worst teams less goals through counterattack, less possession with 0-4 passes, less possession for 12 seconds or more and less possession started in the midfield
Bekris, Mylonis, Sarakinos, Gissis, Gioldasis and Sotiropoulos	2013	240 matches in first division Greece	Secondary data	Goals per match, shots, shots in penalty area, crosses and assists are higher for top teams; they conceded less shots, shots in penalty area and crosses
Vogelbein, Nopp and Hoekelmann	2014	306 matches in first division Germany	Video analysis	Top teams have a faster recovering of ball possession after losing it (defensive reaction time)

Six more studies used a comparative approach to investigate success factors operationalized differently to the articles discussed previously (Table **5**). Two papers focused on goal difference [43, 44]. Bekris *et al.* [43] compared matches with one-goal differences (short range results) as well as matches with three-goal differences or more (wide range results). Their analysis showed that winners in wide range results have more ball possession, perform more passes, win more duels (overall and aerial), and have more shots, shots on target and a higher shot accuracy. In the short range results these differences were not found. A winner-winner comparison showed that wide range winners perform more passes, have a higher pass accuracy, more short distance shots and shots on-target. Yue *et al.* [44] used a similar approach. They analyzed matches with a difference of two or more goals and matches with a difference of three or more goals. Goal efficiency, shots, passes and ball contacts were found to be the most important factors for scoring a goal (in this order). Clemente [45] and Delgado-Bordonau, Domenech-Monforte, Guzmán & Mendez-Villanueva [46] operationalized success as a continuance in a tournament. They compared teams with a different number of matches respectively teams that got to the semifinal. Both analyzed matches of the World Cup 2010. Clemente [45] revealed that teams with more matches in a tournament (the successful ones) score more goals through open play, have more shots inside the penalty area and perform more passes. Delgado-Bordonau *et al.* [46] showed that successful teams perform more shots-on-target, have a higher efficiency and concede fewer shots. They also revealed that the first goal in the match leads to a victory for 66.7 percent in the group stage and for 81.3 percent in the knockout stage. Hughes and Franks [17] used a new and different approach to analyze football. They normalized the data into "goals/shots per 1000 possessions" to analyze the relative importance of ball possession. The authors used this parameter to compare successful teams (getting to the quarterfinals) and unsuccessful teams (first round losers) in the 1990 World Cup. Accordingly, successful teams show a strong trend to be better in converting possession into shots on goal (no significant difference). For ball possessions with more than eight passes, there is a significantly higher chance for successful teams to create a shooting opportunity ($p<0.05$). In contrast, the necessary shots for a goal increase with more passes per possession [17]. Hoppe, Slomka, Baumgart, Weber & Freiwald [47] used the final points accumulated by each team during one season in the German Bundesliga. They analyzed the running performance with and without ball possession of the teams. Only total distance with ball possession was a significant predictor for final points ($p<0.01$). They concluded that not only running performance is important for success, but rather the relation to technical/tactical skill regarding ball possession [47].

Table 5. Comparative articles with regard to other operationalization of success.

Author(s)	Date	Sample	Data Collection	Key Findings
Hughes and Franks	2005	52 matches World Cup 1990	Secondary data	Variable of interest is goal scored; successful teams are better in converting possession into shots on goal; for possession with more than 8 passes there is a significant ($p<0.05$) better chance for successful teams to create a shooting opportunity; shots necessary for a goal increased with more passes per possession
Clemente	2012	208 matches World Cup 2010	Secondary data	Variable of interest is continuance in tournament; teams with more matches score more goals per match, through open play, from within the penalty area, and play more passes

(Table 5) contd.....

Author(s)	Date	Sample	Data Collection	Key Findings
Delgado-Bordonau, Domenech-Monforte, Guzmán and Mendez-Villanueva	2013	56 matches World Cup 2010	Secondary data	Variable of interest is continuance in tournament; successful teams score more goals, perform more shots, have better efficiency, conceded less goals per match, conceded less shots; during group stage, teams scoring the first goal had a 66.7% chance to win (81.3% for knockout stage)
Bekris, Gioldasis, Gissis, Komsis and Alipasali	2014	64 matches European Leagues 2013-2014	Video analysis	Variable of interest is goal difference; wide range results: winners have better performance in duels (aerial and overall), ball possession, passes, shots, shot accuracy, shots on goal; comparison of wide range with short range winners: wide range winners perform more passes, shots, and have a higher passing accuracy and more shots on goal
Yue, Broich and Mester	2014	74 matches in first division Germany 2011	Secondary data	Variable of interest is goal difference; in matches with a goal difference of 2 and more or with 3 and more the most important factors are efficiency, shots, passes and ball contacts (in this order); correlation of this four factors with number of goals shows the same result
Hoppe, Slomka, Baumgart, Weber and Freiwald	2015	306 matches in first division Germany 2012/13	Secondary data	Variable of interest is points accumulated; total distance with ball possession only significant predictor for final points accumulated (p<0.01)

6. PREDICTIVE ANALYSES

Fourteen of the predictive analyses focused on differences between wins, draws and losses (two of these papers considered two groups: winners and non-winners) (Table **6**). Four of these papers used a discriminant analysis to reveal the most discriminating factors [48 - 51]. Shots on goal was a discriminant factor in all four studies. Crosses, match location and ball possession [48, 49] as well as the quality of the opponent (similar to strength or team ability) [49] were other identified factors. Collet [21] and Harrop and Nevill [52] used a regression analysis/model and showed that higher pass accuracy is a good predictor for success. More shots, fewer passes, fewer dribbling and match location are further predictors [52]. Collet [21] investigated the influence of possession on success and showed that possession is not as relevant as assumed. If the strength of a team is controlled, the influence of possession on success will range from -5.7% (in German Bundesliga; significant (p<0.05)) to +1.8% (all national teams; not significant). The fact that possession has a potential negative link to success may be worth further examination. Efficiency measures seem to be better predictors for success [21, 29, 31, 44, 46]. Liu, Gomez, Lago-Penas and Sampaio [22], Liu, Hopkins and Gomez [53] and Mao, Peng, Liu and Gomez [54] used cumulative logistic-regression in a generalized linear model. They also divided the sample into close matches and unbalanced matches (a cluster analysis based on the goal difference was used) with a cluster analysis and cut-off values. In past research it appeared to be more likely in close matches that both teams play at their best [22, 55]. They showed that shots on goal, shot accuracy, tackles and aerial advantage have positive effects on winning [22, 54]. Liu *et al*. [53] also investigated the within-team effects (changes in team values between matches) and between-team effects (differences between average team values over all matches). Shots on target and total shots have positive within-team effects on winning. Game location showed a small positive within-team effect. Ball possession showed a small negative within-team effect but also a small positive between-team effect. Within-team effects varied depending on strength of team and opponent [53].

Table 6. Predictive analyses with regard to wins and losses.

Author(s)	Date	Sample	Data Collection	Key Findings
Torgler	2004	63 matches World Cup 2002	Secondary data	Higher number of shots on goal higher probability to win than not to win; dismissal has strong negative effect; hosting the tournament is a strong advantage
Bar-Eli, Tenenbaum and Geister	2006	743 matches in first division Germany 1963-2004	Secondary data	Chance of winning decreases after a red card dependent on match status and match location
Lago-Penas, Lago-Ballesteros, Dellal and Gomez	2010	380 matches in first division Spain 2008-2009	Secondary data	Shots, shots on goal, effectiveness, assists, crosses, conceded crosses, possession and match location discriminate best between win, draw and lose
Lago-Penas, Lago-Ballesteros and Rey	2011	288 matches European Champions' League group-stage 2007-2010	Secondary data	Winners perform more shots, better effectiveness, more passes, higher possession and receive less cards; shots on goal, crosses, possession, match location and quality of opponent discriminate best

(Table 6) contd.....

Author(s)	Date	Sample	Data Collection	Key Findings
Mechtel, Baker, Brandle and Vetter	2011	2962 matches in first division Germany 1999-2009	Secondary data	Players dismissal increase chance of winning for opponent; team strength (overall and at home) increase chance of winning
Castellano, Casamichana and Lago	2012	177 matches World Cup 2002-2010	Secondary data	Shots, shots on goal, shots received and shots on goal received discriminate best
Gómez, Gómez-Lopez, Lago and Sampaio	2012	1900 matches in first division Spain 2003-2008	Secondary data	Field subdivided in 19 zones; 7 variables recorded; factor analysis revealed four factors (First: Turnovers in Zone 5.2 and Crosses in zone 4; Second: Goals in zone 5.1, Shots in zone 5.1, Turnovers in zone 4 and Ball recover in zone 1; Third: Goals in zone 5.2, Shots in zone 5.2 and Ball recover in zone 1; Fourth: Turnovers in zone 5.1), factors highest for winners; draw data closer to lose
Collet	2013	6172 matches from several leagues and tournaments	Secondary data	More time with ball leads to more points and goals; passes and pass accuracy correlate with points and goals; more points on smaller pass to shots on goal relation; if team strength is controlled negative effect for possession; pass and shot accuracy are better predictors
Harrop and Nevill	2014	46 matches in second division England 2012-2013	Secondary data	Less passes (p=0.006), more successful passes (p=0.042), more shots (p=0.027), less dribbles (p=0.018) and the match location (p=0.044) are significant in prediction of success; passes (p=0.000), successful passes (p=0.001), and passes in opposition half (p=0.005) are different between wins, draws and losses
Moura, Martins and Cunha	2014	96 matches in group stage World Cup 2006	Secondary data	Cluster analysis to generate two groups of data; 70.3% of the winning team were classified into the same group; shots, shots on goal and possession discriminate best the winning teams
Hanau, Wicker and Soebbing	2015	306 matches in first division Germany 2010-2011	Secondary data	Actual winning is influenced by difference in ranking last year and home match
Liu, Gomez, Lago-Penas and Sampaio	2015	48 matches World Cup 2014	Secondary data	Shots, Shots on goal, Shots from Counter Attack, Shot from Inside Area, Ball Possession, Short Pass, Average Pass Streak, Aerial Advantage and Tackle clear positive effects on winning, Shots Blocked, Cross, Dribble and Red Card negative relationship to winning
Liu, Hopkins and Gomez	2016	320 matches in first division Spain 2012/13	Secondary data	Shots on target and total shots have positive within team effect to winning; ball possession: small negative within-team effect but a small positive between-team effect; Game location showed a small positive within-team effect; Within-team effects varied depending on the strength of team and opposition.
Mao, Peng, Liu and Gomez	2016	480 matches in first division China 2014-2015	Secondary data	Shots on goal (positive), shot accuracy (positive), cross accuracy (trivial), tackle (trivial) and yellow cards (trivial) have effects on winning

Gómez, Gómez-Lopez, Lago and Sampaio [56] used a factor analysis with several factors and the zone of the pitch. For the zone of the pitch they divided the field into five zones from goal to goal and into three to five subzones in each of these zones. They identified four factors. All factors are highest for winners. The best discrimination is given for ball recovery in zone two (2.1, 2.2 and 2.3) (penalty zone to center circle) and offensive actions with long passing sequences in zone 5.1 (six-yard box) and 5.2 (within penalty zone). Bar-Eli, Tenenbaum and Geister [57] and Mechtel *et al*. [25] investigated the impact of a player's dismissal. Both found out that a sending-off decreases (sanctioned team) respectively increases (opponent) the chance of winning. Mechtel *et al*. [25] also identified strength (points earned in the last three seasons) and home advantage as success factors. Torgler [58] applied an economic win function to determine the influences on winning or not winning during the FIFA World Cup 2002. He showed that a higher number of shots on goal leads to a higher probability to win. He also revealed the negative effect of a player's dismissal. Hosting the tournament was a strong advantage as well. It increases the chance of winning by 45 percentage points [58]. Hanau, Wicker and Soebbing [59] investigated the difference between the expected outcome of a football match and the actual outcome. They found out that the actual outcome is determined by the standing in the last season and home advantage.

The second most frequent kind of predictive analyses are studies that used goal scoring as the indicator of success (Table **7**). Pollard and Reep [12] developed a quantitative variable, called the 'yield', defined as the probability of a goal being scored minus the probability of one being conceded. The yield for the penalty area as starting zone of ball possession and open play is 78.3 (per 1000 possessions you can expect 78.3 more goals scored than goals conceded).

They also found that open play always has a higher yield than set play [12]. Carmichael and Thomas [26] established a match-based production function. They found that shots on goal, shots that hit woodwork, tackles, own goals and free kicks are significant predictive factors (p<0.05) for the home teams. Kapidžić, Bećirović and Imamović [60] also identified shots on goal as a significant predictor for goal scoring (p=0.027). Wright, Atkins, Polman, Jones and Sargeson [61] postulated position of attempt, goal keepers' position and type of shot as the three predictors for goal scoring. Tenga, Holme, Ronglan and Bahr [62] and Tenga, Ronglan and Bahr [63] used the same data set with different methods for their analysis. Both papers showed that counter attacks are more effective than elaborated attacks in producing goals. Grund [20] used a network analysis to identify success factors. He revealed that networks with high intensity and low centralization have a better performance. An increased passing rate lead to a better performance in this study [20].

Table 7. Predictive analyses with regard to goal scoring.

Author(s)	Date	Sample	Data Collection	Key Findings
Pollard and Reep	1997	22 matches World Cup 1986	Video analysis	Calculation of "yield" (probability of a goal being scored, minus the probability of one being concede); starting zone of ball possession, open/set play and playing strategy as factors for the yield calculation; open play higher yield as set play; the closer it gets to the opponent goal the higher the yield
Carmichael and Thomas	2005	380 matches in fist division England 1997-1998	Secondary data	Attacking play seems more important for home team and defensive play for away teams; shots on goal, tackles, free kicks and cards given are important factors
Kapidžić, Bećirović and Imamović	2009	31 matches European Championship 2008	Secondary data	Shots within penalty area are the only significant single predictor (p=0.003),; shots on goal, shots off goal, shots blocked, pass completion, long, middle and short passes and completion explained 36% of the variance
Tenga, Holme, Ronglan and Bahr	2010	163 matches in first division Norway 2004	Video analysis	More goals during counter attacks; counter attacks better than elaborate attacks; attacks starting in the last third better as first third; long possession is better than short possession
Tenga, Ronglan and Bahr	2010	163 matches in first division Norway 2004	Video analysis	Counter attacks better than elaborate attacks; scoring opportunities and score box possessions (shooting opportunities) can be used as a proxy for goals scored under certain circumstances
Wright, Atkins, Polman, Jones and Sargeson	2011	167 goals in first division England 2010-2011	Video analysis	Three factors are significant predictors of goal success (p<0.05),: position of attempt, goal keepers' position and type of shoot
Grund	2012	76 matches in first division England 2006-2008; 283,259 passes to create network	Secondary data	A clear network intensity effect is found. Increases in the passing rate lead to increased team performance. a clear network centralization effect is present; Increases in the centralization of team play lead to decreased performance

In the last group of predictive analyses three variables of interest were collected (Table **8**). The most frequent variable is goal difference as utilized in five papers [13, 25, 64, 65]. In all articles match location is positively linked to goal difference. Quality of the opponent was also identified as a significant predictor (p<0.05) [25, 64, 65]. Moreover, Carmichael *et al.* [13] showed that passes, tackles, interceptions, clearances, blocks, interceptions, free kicks and ball caught by goalkeeper are significant predictors for a positive goal difference(p<0.05). A red card was associated with a negative goal difference [13, 25, 64]. Garcia-Rubio *et al.* [65] showed that scoring first is the strongest predictor for a positive goal difference. Lago-Penas, Gomez-Ruano, Megias-Navarro and Pollard [28] used a tree analysis to determine the effects of scoring first on the outcome of a match. They showed that the first scoring team scored 1.88 goals more than their opponent on average. This is influenced by the quality of the teams and the match period in which the first goal was scored [28]. Oberstone [15], Hall, Szymanski and Zimbalist [66], and Kringstad and Olsen [67] investigated relevant factors for the league ranking in a predictive design. Hall *et al.* [66] focused on the relationship between payroll and performance. They found that there is a higher winning probability of 0.614 for 50% more spending in payroll. The top level is more sensitive to spending. Oberstone [15] developed a regression model to predict the league ranking. He revealed six variables which are sufficient for predicting the league ranking (in terms of points earned). These six variables are the percentage of goals to shot (goals divided by shots), the percentage of goals outside penalty area (goals from outside penalty area divided by goals within penalty area), ratio of short to long passes, total crosses, average goals conceded per match and yellow cards. Kringstad and Olsen [67] studied budgeted revenue and success. They showed that budgeted revenues are a significant factor (p<0.05) but only for the bottom-half of the teams and not for the top-half of the teams. The remaining three papers focused on points as the variable of interest. Lago [68] defined

performance as shots performed minus shots conceded, and found that this is a predictor for more points. Furthermore, he showed that the higher the FIFA ranking is, the higher the chance to win. Collet [21] focused on ball possession. His result was that more time with the ball leads to more points and goals, but if it is controlled by team strength a negative effect for possession can be observed. Passes and shot accuracy turned out to be better predictors for points. Coates, Frick and Jewell [69] investigated the relationship between salary structure and success. They revealed that salary inequality has a negative effect on success but the wage bill of a team has a positive relationship with success by a similar amount. This results support the cohesion theory [69].

Table 8. Predictive analyses with regard to other operationalization of success.

Author(s)	Date	Sample	Data Collection	Key Findings
Carmichael, Thomas and Ward	2000	380 matches in first division England 1997-1998	Secondary data	Variable of interest is goal difference; fixed effects for relative performance of teams; match location, differences in successful passes, passes in penalty area, tackles, clearances, blocks, interceptions, free kicks, red card and ball caught by goalkeeper are significant predictors (p<0.05)
Hall, Szymanski and Zimbalist	2002	39 teams in the first four divisions England 1974-1999	Secondary data	Variable of interest is league ranking; 50% more spending in payroll leads to 0,614 higher winning probability; Granger causality from higher payrolls to better performance cannot be rejected
Lago-Penas	2007	64 matches World Cup 2006 Germany	Secondary data	Variable of interest is points earned; performance (shots minus shots conceded) is a predictor for more points; the higher the FIFA-Ranking, the higher the chance to win
Papahristodoulou	2008	806 matches European Champions League 2001-2007	Secondary data	Variable of interest is goal difference; goals are an effect of shooting; red cars are negative for winning probability; match location important for winning probability
Oberstone	2009	380 matches in first division England 2007-2008	Secondary data	Variable of interest is league ranking; % goals to shot, % goals outside penalty area, proportion (ratio) short/long passes, total crosses, average goals conceded per match and yellow cards are sufficient to predict league ranking/point earned
Mechtel, Baker, Brandle, and Vetter	2011	2962 matches in first division Germany 1999-2009	Secondary data	Variable of interest is goal difference; players' dismissal increase chance of winning for opponent; team strength (overall and at home) increase chance of winning
Collet	2013	6172 matches from several leagues and tournaments	Secondary data	Variable of interest is points earned; higher ball possession leads to more points and goals; passes and pass accuracy correlate with points and goals; more points with lower pass-to-shots-on-goal-ratio (how many passes before a shot); if team strength is controlled there is a negative effect for possession; pass and shot accuracy are better predictors
Garcia-Rubio, Gomez, Lago-Penas and Ibanez	2015	475 matches European Champions League 2009-2013	Secondary data	Variable of interest is points earned; Positive influence of match location, scoring first and quality of opposition in match outcome, scoring first strongest predictor then match location, then quality of opposition, Structural coefficient significant underlines that teams that score first achieve more shots on goal in both stages of competition (p<0.01)
Coates, Frick and Jewell	2016	138 team year observations in first division USA 2005-2013	Secondary data	Variable of interest is points earned; Negative relationship between salary inequality and team success; the best-fit model suggests that increasing salary inequality and the team wage bill work in opposite directions by similar magnitudes
Kringstad and Olsen	2016	720 matches in first division Norway 2011-2013	Secondary data	Variable of interest is league ranking; Budgeted revenues are a significant factor of success for the bottom-half teams but not for the top-half teams (p<0.05); money could be a significant driver of success, but only to a certain extent
Lago-Penas, Gomez-Ruano, Megias-Navarro and Pollard	2016	1826 matches in France, Italy, Spain, England and Germany 2014/15	Secondary data	Three independent variables were significant factors on the final outcome: the quality of the opposition (p<0.001), the minute in which the first goal is scored (p<0.01) and the team scoring first (p<0.001); teams that scored first scored 1.88 goals more than the opponent

7. ANALYSES OF HOME ADVANTAGE

The review of predictive analyses already showed that match location (home advantage) is an important factor in explaining success in football [25, 26, 48, 49, 53, 58, 57, 64]. Seventeen papers that focused mainly on match locations specifically home advantage were identified in this the review (see Table **9**). In one of these papers [26] further factors related to success, besides home advantage, were also investigated. The first analysis of home advantage in football was done by Pollard [70]. He investigated different team sports including the first four football divisions in England from

1888 to 1984. There was very little variation between 85 seasons (between 1939 and 1945 there were no official seasons due to World War II). The points won by the home team differed between 62.5 percent and 67.9 percent. Clarke and Norman [11] provided an approach to quantify team ability and home advantage at a team level due to the influence of the quality of opponent (team ability or strength). This approach was also used by other authors to define home advantage for a team [25, 49, 64]. Clarke and Norman [11] stated that it is necessary to consider difference in ability to calculate home advantage. In their research the home advantage relating to goals differed from year to year and between teams. The average home advantage between 1981 and 1990 in England resulted in 0.528 goals per match. Another result is that team ability is more important than home advantage [11]. Overall, home advantage explains around 60 percent with some variations [71 - 86] (Table **9**). Before the 1980s, the explaining percentage of home advantage was moderately higher [71]. Saavedra Garcia, Aguilar, Fernández Romero and Sa Marques [72] investigated home advantage in the first division in Spain between 1928 and 2011. Home teams won 70.8 percent of the points for the period when 2 points were awarded for a victory and 56.7 percent when three points were awarded for a victory. Lago-Pens *et al.* [28] showed a consistent home advantage for all five major leagues in Europe (France, Italy, Spain, England and Germany) for the season 2014/15. Home teams won between 56.47 percent (Italy) and 61.84 (Germany) of the awarded points for a victory.

Table 9. Analyses of home advantage.

Author(s)	Date	Sample	Key Findings
Pollard	1986	58,123 matches in England 1888-1984	Little variation between the centuries and divisions; no difference between two- and three-point system; home advantage in percent of obtained point is around 64%; local derbies show significant lower home advantage (p<0.01)
Clarke and Norman	1995	20,306 matches in England 1981-1991	Home advantage in terms of goals per match; team ability included; home advantage 0.528 goals per match in average
Thomas, Reeves, and Davies	2004	7834 matches in England 1985-2003	Slightly lower home advantage in recent years (2%-5% lower); home advantage still stable phenomenon
Carmichael and Thomas	2005	380 matches in England 1997-1998	57% of the points obtained at home; home teams won 48% of the matches
Pollard and Pollard	2005	Over 70,000 matches in England 1888-2003	Home advantage was highest in the early years of each league; home advantage seems stable around 60% of the point obtained at home
Pollard	2006	89813 matches around the world 1997-2003	Home advantage is found in all big leagues in the world; in the Balkan countries and in the Andean region home advantage is much higher; home advantage varies from 48.87 (Andorra) to 78.95 (Bosnia) around the world
Pollard, Silva, and Medeiros	2008	2326 matches in Brazil 2003-2007	Average home advantage 65%, calculated by the points obtained at home; north and south teams have a higher advantage
Seckin and Pollard	2008	3672 matches in Turkey 1994-2006	61.5% average home advantage; calculated by the points obtained at home; local derbies (matches in Istanbul) show lower home advantage
Armatas, Yiannakos, Papadopoulou, and Skoufas	2009	240 matches in Greece 2006-2007	47.3% of the matches are won by home team, 26.3% draws and 26.4% won by away team
Pollard and Gomez	2009	81,185 matches in France, Italy, Spain and Portugal 1928 (or beginning) -2007	About 66% average home advantage of the points obtained at home; recent general decline in home advantage since the 1980s; home advantage in Spain highest with an average of 69%; increased home advantage for teams from islands; lower home advantage in capital cities
Poulter	2009	808 matches in European Champions League 2001-2007	Home teams won 67.7% of the matches; home team is 1.98 times more likely to score in match than the away team; home teams perform more shots, shots on goal and corners; away teams have more fouls committed, offside and cards
Sanchez, Garcia-Calvo, Leo, Pollard, and Gomez	2009	20,992 matches in Spain 1980-2007	About 66% average home advantage calculated by the points obtained at home; slightly significant decrease of home advantage after introduction of the 3-point system (p=002)
Lago-Penas and Lago-Ballesteros	2011	380 matches in Spain 2008-2009	61.95% victories for home and 38.05% victories for guests (draws excluded); 4 groups according to league ranking; inferior teams benefit less from home advantage than superior teams
Armatas and Pollard	2014	2160 matches in Greece 1994-2011	About 65% average home advantage calculated by the points obtained at home; shots, clearances, headed shots, corners and saves have highest effect size for match variables between home and away teams
Goumas	2014a	765 matches in Australia 2005-2012	57.7% average home advantage of the points obtained at home and 56.5% home advantage in terms of goals scored; home advantage increases with increasing time zones crossed by away teams

(Table 9) contd.....

Author(s)	Date	Sample	Key Findings
Goumas	2014b	1384 matches in European Champions League and Europa League	58.8% (CL) and 58.0 (EL) home advantage in terms of goals scored; in terms of competition points gained in the group stage home advantage was 57.8% in the CL and 59.2% in the EL; crowd density is important in influencing referee bias; more yellow cards against away teams
Goumas	2014c	3277 matches in Europe, Asia, South America and Africa 2007-2013	59% (Europe), 60% (Asia), 63% (South America) and 70% (Africa) home advantage in terms of goals scored; absolute distance travelled and time zones crossed associated with poorer match performance
Saavedra García; Gutiérrez Aguilar, Fernández Romero and Sa Marques	2015	22015 matches in Spain 1928-2011	70.8% average home advantage for the period when 2 points were awarded for a victory; 56.7% average home advantage when three points were awarded for a victory
Goumas	2015	1058 matches European Champions League 2003-2013	Home advantage measured on a team level; home advantage did not vary between teams despite 58% for Inter Milan and 73% for Arsenal London; away disadvantage vary between teams significantly (p<0.05); tendency of higher home advantage and lower away disadvantage; home advantage differs significant between countries 70% English teams to 52% Turkish teams (p=0.01)
Lago-Penas, Gomez-Ruano, Megias-Navarro and Pollard	2016	1826 matches in France, Italy, Spain, England and Germany 2014/15	Results showed that home teams scored first in 57.8% of matches and went on the obtain 84.85% of points; Away team scored first, they obtained only 76.25% of subsequent points

Lago-Penas and Lago-Ballesteros [73] investigated the variables that discriminate best (discriminant value ≥|.30|) between home and away teams. Home teams score more goals, perform more crosses, more passes, have more ball possession and commit more fouls. Away teams show more losses of possession and gather more yellow cards. Armatas and Pollard [74] found shots, clearances, headed shots, corners and saves to have the highest effect size for match variables between home and away teams. Goumas [75] analyzed home advantage on a team level adjusted for team ability (operationalized by UEFA ranking points). Home advantage did not vary between teams despite a home advantage of 73% for Arsenal London and a home advantage of 58% for Inter Milan. Away disadvantage varied between teams ranging from 45% (F.C. Barcelona) to 68% (Olympiacos F.C.). There was also a tendency that teams with a higher home advantage had lower away disadvantage. Home advantage and away disadvantage differed significant between countries 70% English teams to 52% Turkish teams (p=0.01) [75]. The major causes for home advantage discussed are crowd support, travel fatigue, familiarity, territoriality, referee bias, special tactics, rule factors and psychological factors as well as the interaction of these [70, 76, 77].

8. INTEGRATIVE DISCUSSION

The aim of this study was to review performance analyses in adult male football in order to identify success factors and utilized methods. The review revealed that there is an extensive and growing body of performance analyses literature in football. In contrast to early studies that were often based on descriptive designs [9], analyses with predictive designs, explaining more and more success factors [21, 22, 49], have gained momentum in recent years. The most frequently studied variables were shots (27 times)/shots on goal (23 times) followed by passes (20 times). Overall 76 different variables were investigated in the reviewed papers. Based on the results in the papers, the most influential variables are efficiency [22, 29, 46], shots on goal [49, 54], possession [39], pass accuracy/successful passes [32, 35], quality of opponent [25, 28, 64], and match location [49, 76, 65].[4]

It became apparent that performance in football depends on a high number of variables. For example, Oberstone [15] investigated 24 different variables. Using a 6-variable regression (percentage of goals to shots, percentage of goals scored outside of box, ratio of short/long passes, total crosses, average goals conceded per match and yellow cards) he predicted the points earned by English football teams in the 2007/2008 season. The fit delivered an R^2=0.990 (p<0.0000) indicating strong evidence for his model. Similarly, Kapidžić *et al.* [30] investigated 21 variables in the first division in Bosnia and Herzegovina 2008/2009 (12 matches) and in the 2008 European Championship (13 matches). While in the first division 13 variables (*e.g.*, shots, passes, and offensive structure) significantly discriminate between winners and losers (p<0.05), in the European Championship only three variables were significant (shots on goal, number of goals scored within penalty area and number of goals scored outside penalty area) (p<0.05). Although both studies considered many variables, it were the obvious variables such as shots and goals that became significant,

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[4] The most influential variables were assessed based on specific evidences the authors provided. For example, Broich *et al.* [29] defined a parameter q (relative size of the difference) and calculated a highly significant value of 103.4 for efficiency, which is more than four times higher than the value of the second most important variable (number of shots). To quantify the importance and influence of success factors, a meta-analytical approach would be needed. However, this goes beyond the scope of this paper.

explaining only little of the underlying mechanisms of success in football. Liu *et al*. [22] and Mao *et al*. [54] studied very similar variables in two different samples. Shot on target and tackle were the only two discriminating variables in both studies. Other variables had no clear effect or the effect depended on the context [22, 54]. Based on these results, it seems that not many success factors in football are stable over different contexts and samples. It should be noted, however, that an exclusive focus on statistical data (*e.g.*, shots, possession) will probably be not sufficient to explain these mechanisms. A more sophisticated approach is needed to reveal these mechanisms. This includes more variables and the use of more complex statistical approaches such as ordered logit regressions to determine the influence of these variables. Also, the inclusion of qualitative variables *e.g.*, self-perception and social perception or the evaluation of motivation can help to reveal the nature of performance. A third area of investigation should be more player centric such as questionnaires *e.g.*, about group cohesiveness or personality traits.

Moreover, the review revealed that to date many different types of matches and settings have come into the focus of researchers, providing a more holistic view on success factors in football. Regarding comparative and predictive analyses, 34 articles focused on league matches, 13 on cup matches for national teams and six on cup matches for clubs. Especially studies that integrate different types of matches and settings provide useful insights allowing for generalizable statements. For example, Collet [21] analyzed more than 6,000 matches including league matches from England, Italy, France and Germany, matches from the European Champions League and the Europe League as well as national matches from Europe, America, Africa and Asia. In this way, he found that in the leagues pass accuracy and shot accuracy are more important for success than ball possession, in contrast to the assumptions of many scholars and professionals (for Germany one percent more possession even leads to a winning probability that is reduced by 5.7 percent). Also Lago-Penas *et al*. [28] studied over 1,800 matches in the five top leagues across Europe. They could show that scoring first is a crucial part of winning a match. In total, 27 studies chose a design that comprised an international comparison, while among the studies that focused on one nation, England showed to be the most studied country in football (11 articles), followed by Germany (7 articles) and Spain (7 articles) (Table **10**).

Table 10. Design and country of the reviewed articles.

Country of Sample	Study Design			Total
	Comparative	Predictive	Home Advantage	
Australia	–	–	1	1
Brazil	–	–	1	1
Canada	1	–	–	1
England*	1	7	5	13
Germany	4	3	–	7
Greece*	3	–	2	5
International*	9	12	7	28
Italy	1	–	–	1
Norway	1	3	–	4
Serbia	1	–	–	1
Spain	1	3	3	7
Turkey	–	–	1	1
USA	–	1	–	1
China	–	1	–	1
Total[5]	22	30	20	72

* Multiple responses.

Methodologically, the review showed that in recent years new ways of statistical analyses were introduced. Lago *et al*. [48] were the first authors who used a discriminant analysis to identify differences between winners and losers. Moura *et al*. [51] combined this approach with a factor analysis. They investigated 14 variables and performed a factor analysis. Subsequently, a cluster analysis was used to classify the teams into two groups. Finally, they showed that 70.3 percent of the winning teams were classified into the same group (67.8 percent for drawing and losing teams). Shots, shots on goal, playing time with ball possession and percentage of ball possession were the most important variables to discriminate between winning teams and drawing or losing teams in this study. Liu *et al*. [22] used a cluster analysis to identify only close matches. This approach has the advantage that both teams give probably their best and do not lean

[5] Oberstone [15] used comparative and predictive methods; Carmichael and Thomas [26] used predictive methods and home advantage; Armatas *et al*. [27] used comparative methods and home advantage; Lago-Pens *et al*. [28] used predictive methods and home advantage

back because the match is already decided [22, 55]. The concept of close and unbalanced matches also improved the analysis of success factors in football [22, 29]. Close matches are defined by a small goal difference. In unbalanced matches one team dominates the other team in terms of goal difference very obviously [55, 87 - 91]. This concept was first introduced in a discrimination study about rugby in 2010 [55] and is widely used since then [22, 29, 55, 87 - 91].

However, most researchers (comparative and predictive design) used a form of regression analysis (22 studies). Discriminate analysis (six studies) and ANOVA (five studies) are the second and third most frequently used statistical methods. For example, Mechtel *et al*. [25] and Collet [21] used an ordered logit regression to identify the influence of a dismissal respective ball possession. An advantage of this method is that it controls for other variables and to investigate a goal-based and result-based approach. Liu *et al*. [22] and Mao *et al*. [54] used a generalized linear model. First they ran a cluster analysis to define cut-off values (see above). Then they applied a cumulative logistic regression to predict winning probabilities. Afterwards they employed non-clinical magnitude-based inferences to evaluate the true effect of the variable [22, 54]. This approach allows a more realistic and intuitive interpretation of effects [92]. Since much of current research is still descriptive or comparative, these two approaches are promising with regard to providing new, valuable insights to performance in football.

Finally, a crucial point that was found is sample size. Many studies, such as Kapidžić *et al*. [30] who analyzed 25 matches, rely on small sample sizes. Of the reviewed papers, the sample sizes varied from seven matches [31] to 89,813 matches [76]. In total, only 28 papers analyzed all matches of a whole or several seasons. It appears that many studies lack sample sizes that are adequate to produce generalizable results.

9. PRACTICAL IMPLICATIONS

A critical question is how the results can support football coaches and their staff. Based on the findings of this review, coaches could be advised to instruct their teams to shoot extensively while at the same time considering shot accuracy. However, advice of this kind would not do justice to the complex nature of football and the demands of coaches. Bishop [93] emphasized that only results providing performance-enhancing knowledge will be applied in practice. Hence, research has to deliver results that make it more likely to win. This also includes findings with regard to training, match preparation and coaching. Nash and Collins [94] stated that coaching is a very complex and dynamic process. The actions of coaches are based on knowledge that has been acquired over years of experience and reflection, that is, tacit knowledge [94, 95]. For coaches, the importance of shots for scoring goals is more than obvious. It is also hardly surprising that pass accuracy, the opponent's quality and home advantage have a positive impact. A benefit for football coaches would be to reveal the partial influence of these variables including their interactions (*e.g.*, by analyzing regression models).

However, there are less obvious findings that provide empirical evidence for beneficial tactical behaviors. First, possession is not as important as might be assumed [21, 22, 54]. Second, a focus on counter attacks can be very effective and can be utilized as a successful tactical strategy, especially for underdogs [41]. Ball recovery in the zone between a team's own penalty area and center circle [56] and a quick ball recovery [42] can result in significantly more successful attacks respectively goals ($p<0.001$). Coaches can build on this evidence to improve tactical concepts. For example, coaches could put more emphasis on the practice of counter attacks, as a tactical element, to overwhelm the opponent's defense and produce more good scoring opportunities. Also pressing, the attempt to recover the ball as close as possible to the opponent's penalty area seems to be a promising tactic. It shortens not only the space between the attackers and the goal, it can also cause confusion within the opposing defense. This could lead to more goals since counterattacks are more effective against an imbalanced defense [62].

CONCLUSION

The aim of this work was to review research in performance analysis relating to success factors in elite men's football. In total, 68 articles were identified and clustered based on their study design with regard to comparative, predictive or home advantage analyses. It was found that the most influential variables are efficiency, shots on goal, ball possession, pass accuracy/successful passes, as well as the quality of opponent and match location. New statistical approaches, such as discriminant analysis, factor analysis, regression analysis and magnitude-based inferences reveal interactions between these variables.

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[6] Bar-Eli *et al*. [57] focused also on a psychological factor. However, they focused on the factor that leads to a dismissal and not to a psychological factor that contributes directly to performance

Concerning study design, an increase of predictive studies was found. For future studies, we suggest considering more often one of the 'Big 3' leagues (Spain, England and Germany) or all of them to get more representative samples. Furthermore, the consideration of other influences on success such as psychological factors and/or weather conditions would be of interest. Additionally, new methodological ways of analyzing success factors in football could be beneficial. For example, Borrie, Johnson and Magnusson [96] presented a method to investigate time-based events in sports. Moreover, more advanced statistical methods should be applied to ensure a broader insight into the mechanisms of performance such as regressions and magnitude-based inferences [21, 22, 25].

Most of the studies did not consider the influence of contextual (*e.g.*, home advantage, quality of opponent) and interactional variables (*e.g.*, first goal scored by time of goal scoring). In some studies, the influence of variables is also computed without a clear definition of the investigated variables. This lack of operational definitions poses a problem and, inter alia, does not allow valid comparisons between the studies. In future research, variables should be clearly defined to enable comparable and reproducible results (see also Mackenzie & Cushion [18]; Sarmento *et al*. [19]). The consideration of interacting variables such as quality of opponent and match location should also be considered in future investigations to provide more insights. Future study designs should also make sure to take the differences between different competitions (*e.g.* leagues, cup competitions) into account, especially the differences between a league match and a knockout match.

Moreover, we found very different approaches regarding the sample size required for generalization. Sample sizes of considered matches varied between very low numbers and thousands of matches. A small sample size is clearly a limitation in some of the reviewed papers, resulting in no generalizability. Studies investigating league matches should consider at least a sample size of one season. Hence, our review supports the finding of Mackenzie and Cushion [18] with regard to small sample sizes that remains a major deficit of performance analyses in football. Additionally, future studies should use effect sizes to interpret the results properly (see also Broich *et al*. [29]). A last important aspect to consider when designing a study is the context of the analyzed sample. For example, the tactic that is used (*e.g.*, counterattacks vs. elaborate attacks) could vary regarding the opponent.

Based on the idea that performance is a consequence of prior learning, inherent skills, situational factors and influence of the opposition [97], the assumption holds that future performance is to a large extent a consequence of previous performance. Again, this underlines the aforementioned importance of considering the context of a sample as well as the operational definition of the investigated variables. Prior learning and inherent skills are two variables that were not considered in research about success factors in football as defined in this review. Both are exciting new possibilities for future research.

Finally, we would like to point to two methodological approaches that might lead to new insights in analyzing football performance. First, social network analysis provides new methods to analyze different aspects utilizing relational data, (*e.g.*, the passing network of football teams), that have the potential to contribute substantially to a better understanding of success [20, 98, 99]. Second, psychological factors could be taken into account for future research (*e.g.*, reversal theory, see Apter [100]). The investigation of psychological factors is, in fact, more difficult than the analysis of statistical data. The operationalization of cohesion found in this review [34] is a good example of the use of psychological concepts.[6]

As this review has shown, generalizable knowledge about success factors in football can be a helpful resource for coaches to gain a better understanding of the match. While significant progress in the field of performance in football was made in the last years, the review identified various deficits that future research has to address to provide more valuable information about what determines success.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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