THE ATTACKING PROCESS IN FOOTBALL: A TAXONOMY FOR CLASSIFYING HOW TEAMS CREATE GOAL SCORING OPPORTUNITIES

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LONDON SPORT INSTITUTE,
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THE ATTACKING PROCESS IN FOOTBALL: A TAXONOMY FOR CLASSIFYING HOW TEAMS CREATE GOAL SCORING OPPORTUNITIES

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ABSTRACT

The majority of existing Performance Analysis (PA) research has adopted a reductionist approach which considers only selected events such as the number of shots, passes or pass success rates in isolation for analysis (Mackenzie & Cushion, 2013). James (2009) also suggested the obvious problem associated with previous types of research is that simply analysing outcome measures cannot provide meaningful information for improvement without an understanding of the processes undertaken to achieve these outcomes. Understanding the patterns of play exhibited within a game can help coaching be more specific and objective to facilitate the improvement for tactical performances of teams (Tenga et al., 2015). Previous football research has traditionally measured the number of passes (Reep and Benjamin, 1968; Bate, 1988; Hughes and Frank, 2005) or duration of team possessions (Jones et al., 2004; Bloomfield et al., 2005; Lago and Martin, 2007; Lago, 2009) to determine playing styles of team. Although these methods identified different team playing styles, based on overall match statistics, the authors have typically not distinguished the "how" different attacking procedures evolved e.g. how teams initiate or develop build-up play, progress attacks and create goal scoring opportunities. Therefore, this thesis aimed to identify the attacking process to provide practically useful and objective information for applied practice.

Study 1 established operational definitions for unstable situations (potential goal scoring opportunities) in football to differentiate stable and unstable game states. Validity tests were conducted by four football coaches and two performance analysts from a professional football club in the English Premier League to create robust operational definitions. After the completion of this process, five specific situations were deemed as unstable situations, which arose due to pitch location, game situation

or a specific action i.e. 1) Penalty Box Possession (PBP), 2) Count Attack (CA), 3) Ratio of Attacking to Defending players (RAD), 4) Successful Cross (SC) and 5) Successful Shot (SS).

Study 2 produced a framework for the attacking process to describe how all unstable situations arose from the start of each possession. The attacking process was categorised into three independent situations, stable (no advantage), advantage, and unstable (potential goal scoring opportunity) situations. Possessions that did not results in advantage or unstable situations were not analysed. English Premier League football matches (n=38) played by Crystal Palace Football Club in the 2017/2018 season were analysed as an exemplar. Results showed that Crystal Palace FC created a median of 53.5 advantage situations and 23 unstable situations per match. They frequently utilised wide areas (advantage) to progress their attack, which resulted in 26.6% unstable situations i.e. penalty box possessions and successful crosses. However, this was the lowest success rate compared to the other advantage situations. This study provided a novel methodology for classifying the attacking process with a scientifically valid approach for use in the applied world.

Study 3 analysed all possessions for Crystal Palace Football Club in the 2017/2018 season, irrespective of whether advantage or unstable situations arose. This enabled the analysis of the influence of situational variables i.e. match venue, opposition quality, match status, key player's appearance on the attacking process. Appropriate categorisations for independent variables were presented with one problem associated with some previous papers i.e. only using the end of season ranking for team quality (Lago-Peñas & Lago-Ballesteros, 2011; Almeida et al., 2014; Liu et al., 2015; Aquino et al., 2016; Mendez-Dominguez et al., 2019) amended. Crystal Palace had, on average, 91.3 stable, 54 advantage and 26 unstable situations from 114.8 possessions per match which resulted in 12.5 shots. Poisson log-linear regression explained that Crystal Palace created more midfield line breaks; more zone 14, wide area and penalty box possessions and less counter attack chances for different levels of each independent variable e.g. when playing at home compared to away. This suggests that strategy changes depending on the situation would be advantageous.

Overall, this thesis aimed to provide useful information for the applied world and close the purported gap between academic and applied areas. This methodology will help teams better analyse opponent's patterns for creating advantage and unstable situations. Future research should consider using the duration of possessions and pitch area information to further develop the usefulness of the model.

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PUBLICATIONS FROM THIS THESIS

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Journal submission

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Conference abstracts

1. Jongwon Kim, Nic James, Nimai Parmar, Besim Ali & Goran Vučković. (2019). Analysing the attacking development process in football. Research paper presented at the Asia-Pacific Conference on Performance Analysis of Sports 2019 in Nagoya, Japan, Oct. Book of Abstracts of the Asia-Pacific Conference on Performance Analysis of Sports 2019, Nagoya, Japan, pp. 29.
2. Jongwon Kim, Nic James, Nimai Parmar, Besim Ali & Goran Vučković. (2019).The influence of situational variables on attacking process in football. Research paper presented at the 8th International Workshop and Conference of the

International Society of Performance Analysis of Sport (ISPAS) in Budapest, Hungary, Sep.

3. Jongwon Kim (2019). Performance analysis in football: Performance analysis from the applied and research area. The Korea Professional Football League Association in Seoul, Republic of Korea, June.
4. Jongwon Kim, Nic James, Nimai Parmar, Besim Ali & Goran Vučković. (2018). Analysing the process of creating unstable situations in football. Research paper presented at the ISPAS World Congress of Performance Analysis of Sport XII in Opatija, Croatia, Sep. Book of Abstracts of the ISPAS World Congress of Performance Analysis of Sport XII, Opatija, Croatia, pp. xx.
5. Jongwon Kim, Nic James, Nimai Parmar, D. Gethin Rees & Goran Vučković. (2018). Identifying Perturbations in Performance Analysis of Football. Research paper presented at the 2018 MDX Research Degrees Students Conference (RDSC), London, UK, Sep. Book of Abstracts of the Middlesex University Research Students' Summer Conference 2018, London, UK, pp. 30.
6. Jongwon Kim, Nic James, D. Gethin Rees & Goran Vučković. (2017). Applying the dynamic systems approach to analysing football. Research paper presented at the 2017 MDX Research Students' Summer Conference (RSSC), London, UK, June. Book of Abstracts of the 2017 MDX Research Students' Summer Conference, London, UK, pp. 73.
7. Jongwon Kim, Nic James, D. Gethin Rees & Goran Vučković. (2017). Assessing the instability of passing and shooting situations in football. Research paper presented at the 8th International Scientific Conference on Kinesiology in Opatija, Croatia, May. Book of Abstracts of the 8th International Scientific Conference on Kinesiology in Opatija, Croatia, pp. 708.

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PRACTICAL EXPERIENCES DURING PHD JOURNEY

1. PERFORMANCE ANALYST

- Crystal Palace Football Club U16-23 (Jul 2018 ~ June 2019)
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2. FOOTBALL EDITOR

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  (dissertation supervisor at MSc Sport Performance Analysis)

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Figure 0.1 Infographic showing outline of thesis and brief overview of chapters

CHAPTER 1

INTRODUCTION

CHAPTER 1: INTRODUCTION

My performance analysis journey commenced following a fourth, football related, surgery on my anterior cruciate ligament (ACL). Devastated at not being able to play football ever again, I decided to increase my scientific knowledge in performance analysis as I could not imagine my life without football. After graduating (BSc Sports Media) in my country (South Korea), I came to the UK to study the MSc Sport Performance Analysis course at Middlesex University, the starting point of serious performance analysis study.

The MSc course facilitated my becoming skilful with analysis software i.e. SportsCode, FocusX2, Dartfish and Quintic, as well as statistics programs IBM SPSS, Python, R and Microsoft Excel. These enabled me to enter the applied football field with Barnet Football Club as a performance analyst. Alongside the practical work, theoretical and scientific knowledge was gained from the academic modules i.e. biometric modelling, research methods and a dissertation. However, I realised there were still gaps between my academic knowledge and what was needed for performance analysis in the applied. The need to understand and link the demands of both football coaches and researchers led to me enrolling for a PhD (2016).

Studying for a full-time PhD whilst working part-time involved devoting specific time to each task judiciously. In the first year I worked Charlton Athletic FC but in the following two years I diversified somewhat, time was spent as an analyst with Crystal Palace FC (two seasons); a football editor for a South Korean media company (goal.com) writing match reports on all Tottenham Hotspur matches including interviewing Son Heung-Min after each match; teaching SportsCode on the MSc PA course at Middlesex University; supervising an MSc student dissertation and finally translating a football analysis book into Korean for a publishing company.

No matter how busy I was, I was also pushing hard on my research culminating in presenting abstracts of the different studies at 7 conferences, I twice received 1st place on the young researcher's award, sponsored by Routledge, at the World Congress of Performance Analysis of Sport XII, 2018 and the 8th ISPAS International Performance Analysis workshop and conference, 2019. The first two studies of my PhD have also been published in SCI journals. Whilst this PhD period has often consisted of excessive schedules for research and work, it has also been an exciting and invaluable challenge to better understand the various perspectives of performance analysis with the consistent goal of ensuring that the research questions were relevant and applicable to performance analysts working in the field.

CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2: REVIEW OF LITERATURE

2.1 INTRODUCTION OF LITERATURE

This chapter 2 critically reviewed research papers relevant to this thesis. Firstly, the previous approaches and methods to determine team playing styles in football (section 2.2) were reviewed to establish new methodologies for categorising the attacking process. Secondly, unstable situation and perturbation papers (section 2.3) were reviewed to aid the creation of appropriate definitions for each phase of the attacking process. Finally, papers discussing issues referred to in this thesis i.e. situational variables (section 2.4) and reliability (section 2.5) were reviewed to help determine methods to overcome the previously identified problems. Consequently, this chapter critically explored previous approaches, findings and limitations to design appropriate methodologies for describing the attacking process in football. The key information used in this thesis was summarised for each study for both playing styles (Table 2.4) and situational variables (Table 2.7).

2.2 PLAYING STYLES IN FOOTBALL

According to Tenga et al. (2015) understanding the patterns of play in football could help coaching be more specific and objective as well as facilitating improvement in a team's tactical performance. The identification of different playing styles, and a consequent recognition of the superiority of one method over another, has been the cause of great controversy in the history of football (Yiannakos & Armatas, 2006). To elucidate, Barcelona traditionally plays the ball out from the goal keeper using short passes to move the opponents around the pitch (possession play) and hence create space whilst Stoke City uses long passes, directly to a forward, to reach the offensive area without any other attacking processes (direct play). Whilst these two playing styles are ubiquitous in the literature Hewitt et al. (2016) further defined game (playing) style as the characteristic playing pattern used to achieve attacking and defensive objectives in specific situational contexts i.e. set piece, unorganised and organised open play. Identifying a game style could therefore aid the creation of more detailed analyses, impact training methodologies and enable coaches and sport scientists to have a clearer understanding of what teams need to do in order to win (Hewitt et al., 2016).

2.2.1 TECHNICAL VARIABLES TO DETERMINING PLAYING STYLE

Technical performance variables have typically been used for identifying styles of play in football. For example, playing patterns have been discriminated using the number of passes prior to shots or goals (Reep & Benjamin, 1968; Bate, 1988; Hughes & Frank, 2005; Redwood-Brown, 2008) as well as the duration of team possessions (James et al., 2002; Jones et al., 2004; Bloomfield et al., 2005; Lago & Martin, 2007; Lago, 2009; Lago & Dellal, 2010). This research has differentiated 'possession play' whereby a team uses short passes from the back to progress the ball up the pitch (relatively large number of passes over long duration) from 'direct play' where a team uses long pass directly to the front (relatively low number of passes over short duration).

Reep and Benjamin (1968) investigated 3213 matches played over 15 years and provided a unique way to analyse possession and goal scoring opportunities. Their findings suggested that every 10 shots created one goal and that 80% of goals were scored from possessions containing 3 passes or less. Many people (researchers, pundits and coaches) took these results to suggest that long ball play (direct play) was more effective than possession play (build-up play). The basic premise being that chance determines goals i.e. it takes ten shots, and therefore the quicker, and more often, a team shoots, the more goals will be scored. James (2006) suggested that this research had influenced football coaching for example, Charles Hughes, who was the Assistant Director of Coaching for the Football Association (Hughes, 1987); Stan Cullis, manager of Wolverhampton Wanderers and Graham Taylor, manager of Lincoln City, Watford, Aston Villa, England and Wolverhampton Wanderers all adopted playing tactics (direct play) based on these research findings. However, James also argued that better quality build up play might result in better shooting chances and therefore more goals per shot. This argument, basically in support of the build-up style of play, has become the most prevalent in current football.

Hughes and Franks (2005) analysed passes, shots and goals from 116 matches in the 1990 and 1994 FIFA World Cup to re-evaluate Reep and Benjamin's findings. The results were similar to Reep and Benjamin's finding that every 10 shots created a goal and about 80% shots were created from passing sequences of four or less (1990 World Cup = 80%, 1994 World Cup = 77%). However, Hughes and Franks realized that there were more zero pass possessions than 1 pass possessions and more 1 pass than 2 pass possessions and so on (as shown in the Reep and Benjamin (1968) paper but not explicitly discussed). Since the distribution of passing sequences was positively skewed the chance of more goals resulting from possessions with low numbers of passes was obviously higher. This inequality was thus removed in the Hughes and Franks paper by calculating the number of shots for each possession length i.e. number of passes, per 1000 possessions. This resulted in very little difference in the frequency of shots between any passing sequences. The authors suggested that short passing sequences (direct play) would be more efficient for less skillful teams whilst more skillful teams would favour long passing sequences (possession play).

Studies involving simple metrics about possession e.g. number of passes, have suggested that playing patterns could be discriminated (Fernandez-Navarro et al., 2016) e.g. possession play determined by longer possession durations or number of passes. However, this approach does not account for possessions which contain elements of different playing patterns. For example, a possession involving multiple passes between defenders in their defensive third of the pitch (generally regarded as possession play) followed by a long pass to an attacker in the attacking third (direct play) would simply be classified as possession play due to the number of passes. Thus, this methodology has the potential for failing to classify possession types fully (if multiple possession types were classified) or correctly (if one possession type deemed to supersede another).

Kempe et al. (2014) calculated an Index of Offensive Behaviour (IOB), which included 11 variables related to passing and possession parameters i.e. measures of time, distance and direction, to characterise attacking patterns of teams. Positive values of IOB indicated ‘possession play’ and negative values ‘direct play’. They analysed the 2010 FIFA World Cup and the German Bundesliga 2009/2010 season and identified Spain and Barcelona had high values for IOB i.e. ‘possession play’ whilst Honduras, Dortmund and Hannover 96 were classified as ‘direct play’. This index suggested the most successful teams (except for Dortmund) used possession play rather than direct play.

2.2.2 CLASSIFICATION OF PLAYING STYLES

Some authors provided operational definitions for different playing styles rather than measuring technical variables such as the number of passes. Playing styles were usually divided into two styles ‘counter attack’ or ‘elaborate attack’ which was usually dependent on the speed of attack (Table 2.1). These styles were then compared to assess their relative effectiveness.

Table 2.1 Classification of playing styles in football

Year	Authors	Playing styles
2006	Yiannakos & Armatas	‘counter attack’, ‘organised offense’
2010	Tenga et al.	‘counter attack’, ‘elaborate attack’
2010	Sarmento et al.	‘counter attack’, ‘fast attack’, ‘positional attack’
2012	Lago et al.	‘counter attack’, ‘direct attack’, ‘elaborate attack’
2015	Gonzalez-Rodenas et al.	‘counter attack’, ‘direct attack’, ‘combinative attack’
2017	Sgro et al.	‘direct attack’, ‘possession attack’
2019	Mitrotasios et al.	‘counter attack’, ‘fast attack’, ‘direct attack’, ‘combinative attack’
2019	Fernandez-Navarro et al.	‘counter attack’, ‘direct attack’, ‘fast tempo’, ‘build up’, ‘maintenance’, ‘sustained threat’

Yiannakos and Armatas (2006) found that teams in the Euro 2004 competition created more goals using an organised offence (44.1%) than counter attacks (20.3%) or set plays (35.6%). However, they did not present operational definitions for these playing styles rendering the results as not useful (Williams, 2012) because the data had not been collected using clearly defined operational definitions. Tenga et al. (2010) did provide definitions for playing styles which were related to the degree of offensive directness i.e. counter attacks occurred when a team regained the ball and created a penetrating pass or dribble within the first or second pass, otherwise it was classified as an elaborate attack. This rather simplistic approach e.g. no account for long balls was made, found the probability of producing score-box possessions was higher for counter attacks (36.4%) than elaborate attacks (24.4%), but only when playing against an imbalanced defence. In a further study, Tenga et al. (2010b) found the proportion of goals scored from counter attacks (52%) was higher than elaborate attacks (48%).

Some studies have attempted to differentiate three playing styles ‘counter attack’, ‘direct attack’ and ‘elaborate attack’ (Sarmento et al., 2010; Lago et al., 2012; Gonzalez-Rodenas et al., 2015). These authors distinguished counter attacks from direct attacks even though both are quick attacks. Counter attacks take place when a team regains the ball and quickly progresses up the field, this takes place with the opponent’s defence out of shape i.e. one or more defensive player out of position, and the speed of the attack does not allow this defensive shape to reorganise. The direct attack, on the other hand, involves a long pass into the opponent’s half where the opponent’s defence is already in shape.

Mitrotasios et al. (2019) further added the fast attack which occurred when a team used a number of penetrative passes and short passes to progress towards the goal quickly. They analysed the 5 top Leagues in Europe and found that English Premier League (EPL) teams used more fast and direct attacks whilst Spanish La Liga teams used more combinative attacks.

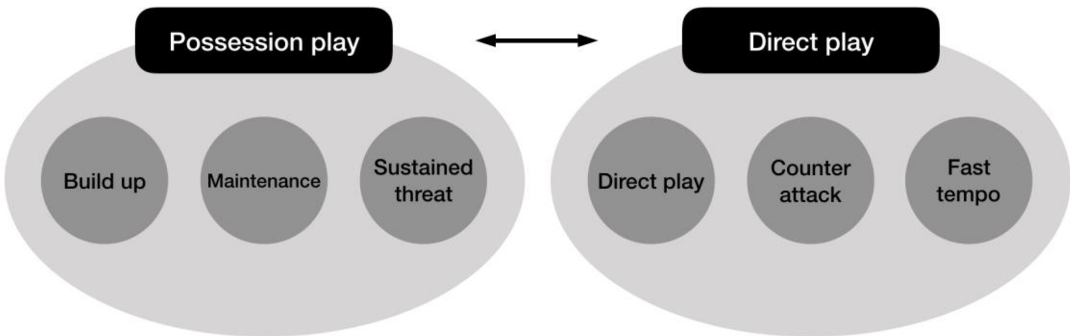

Figure 2.1 Six different playing styles defined by Fernandez-Navarro et al. (2019)

Fernandez-Navarro et al. (2019) differentiated elaborate attacks into ‘build up attack’, ‘maintenance attack’ and ‘sustained threat’ depending on the duration of the possession and pitch area (Figure 2.1). The build up attack occurred when a team had possession of the ball in the opponent's half, but outside the penalty area, for between 8 and 25 seconds. The maintenance attack occurred when a team had possession of the ball in their own half for between 10 and 30 seconds. The sustained threat occurred when a team had possession of the ball in the opponent's defensive third for between 6 and 20 seconds This methodology resulted in six attacking styles of play i.e. three direct methods (counter attack, direct play and fast attack) and three elaborate possession methods (build up, maintenance sustained threat). This study found that EPL teams (n=380 matches) from the 2015/16 season created more goals using direct attacks when a team was drawing and playing at home whilst counter attacks were more effective when winning.

2.2.3 FACTOR ANALYSIS TO DETERMINE PLAYING SYTLE

Factor analysis was used to cluster the playing styles of a team by grouping performance variables perceived to be relevant measures (Table 2.2). The values for each factor thus discriminated how much each team utilised each specific playing style.

Table 2.2 Factor analysis for playing styles in football

Year	Author	Variable	Factor	Factors description
1988	Pollard et al.	6	3	- direct/elaborate - high/low use of central area - high/low regaining possession in attack
2016	Fernandez-Navarro et al.	19	6	- direct/possession - cross/no cross - wide/narrow possession - fast/slow progression - pressure on wide/central - low/high pressure
2017	Lago et al.	20	5	- possession - set piece - counter attack - transitional play - transitional play including set piece
2018	Gomez et al.	87	8	- possession - ending action - individual challenge - counter attack - set piece - transitional play - fouling action - free kick

Pollard et al. (1988) used factor analysis to identify team playing styles for National teams in the 1982 FIFA World Cup and English first division teams in the 1984/1985 season. They found that three principle components accounted for 92.5% of the variation in playing styles depending on whether teams used 1) direct or elaborate play, 2) the wide areas and 3) regained possession in attack. The authors used 6 variables (number of long passes, long goalkeeper clearances, crosses, regains close to the opponent's goal, number of passes in defence and the average number of passes in possessions involving 3 or more passes). The results showed for example, that France used an elaborate style of play because they had high values for possession in defence and multi-pass movements but low values for long forward passes and long goalkeeper clearances. This research was quite forward thinking in terms of when it was undertaken compared to other research at the time. Some debate could be had in terms of the variables used to infer playing style. For example, the use of goalkeeper clearances in probably unique. However, current football philosophy requires goalkeepers to play as an extra defender and play short passes rather than the long clearances popular thirty years ago when this paper was published. The use of crosses for determining playing style was also interesting. Perhaps teams who adopted the long ball philosophy did not therefore play many crosses compared to teams who played up the pitch. Currently, the top teams in the EPL use wide players frequently although their options range from crossing the ball to dribbling into the box, playing a short one two to beat the defender or passing back to a midfield player to reset the offence. High pressing was not a term used thirty or more years ago although the importance of regaining the ball in the attacking third was emphasised by the work of Reep and colleagues. Hence whilst this relatively old piece of research investigated football in a different era, the variables considered valuable then are still thought useful now, even though the emphasis of play has dramatically altered.

Fernandez-Navarro et al. (2016) used 19 variables to determine playing styles which resulted in 6 factors to determine whether teams used 1) direct or possession play, 2) crosses, 3) wide or narrow possessions, 4) fast or slow progressions, 5) pressure on wide or central areas and 6) exerted low or high pressure. For example, factor 1, named possession directness, loaded on 5 variables (number of sideward passes, forward passes, average direction of passes, ball possession percentage and passes from the defensive to the attacking third). Barcelona FC was regarded as a possession play team because they had a high value for factor 1 (see Table 2.3 overleaf, taken from Fernandez-Navarro et al., 2016). Similarly, Lago et al. (2017) used 20 variables and extracted 5 factors to identify team playing styles. These authors also identified a factor related to 'possession style' play but this loaded on the duration of possession in the opposition half and final third, ball possessions, positional attacks, passes, accurate passes, forward and backward passes. Whilst both papers identified variables that related to a possession style of play no definitive set of variables related to possession style has been identified. This may not be possible given that factors are derived from the data used in the study, which will be different between studies. The determination of factors to be retained is based on the eigenvalues with Kaiser (1960) recommending 1.0 as the threshold (as used by Lago et al., 2017) whereas Fernandez-Navarro et al. (2016) used 0.7 as recommended by Jolliffe (1972). Debate on this can be found in Field (2013, p. 677) where the number of variables is suggested as the best determinant. Since both studies had less than 30 variables Field suggests 0.7 may be more appropriate although he also states that the sample size and underlying research goal may determine the most appropriate value. However, techniques for validating factors, such as using split data sets, should also be used in future to help identify the most appropriate variables. Finally, some debate on the correlation value used to select the variables associated with each factor is pertinent. The two studies quoted here used correlation values of 0.6 or more which was lower than Pollard et al. (1988) used (0.8 or more). Statisticians will suggest that the sample size, and hence the significance of the correlations, should be used as a rule for this identification. However, this leads to very low correlations being considered statistically meaningful for large data sets. Stevens (2002) suggests using the R^2 (amount of variance accounted for) as a better guide and recommends using correlation values of 0.4 (16% of variable explained) as the lowest value. This is at odds with the sports science view, as presented here, but this was because both papers were trying to identify the most important variables, rather than providing an exhaustive list of variables, associated with possession play.

Table 2.3 Attacking and defensive playing styles of teams (Fernandez-Navarro et al., 2016)

	Attacking styles of play								Defensive styles of play			
Teams (season 2006–2007)	D	P	C	NC	WP	NP	FP	SP	PW	PC	LP	HP
1. Atletico de Madrid		•	•			•	•			•		•
2. Barcelona		••		••		••	•			•		•
3. Betis	•			•	••••		••		•		•	
4. Bilbao	•			••		••		••	•			••
5. Celta		•		•	•		•			••	•	
6. Deportivo	•			•	•			•	•			•
7. Espanyol	•			•••		•		••		••		••
8. Mallorca	•			••	•		•		••			•
9. Osasuna		•			•			•	•			••••
10. Real Madrid		•		•		•	••			•	•	
11. Real Sociedad		•	•			•		•	••			••
12. Sevilla	•			•		•		•	•		•	
13. Valencia		•		•	•		•		•			••
14. Zaragoza		•		•••	•		•		•		••	
15. Arsenal		••	•			•	•			•	•	
16. Aston Villa	•		•			•		•		•••	••	
17. Bolton	••		•			•	•			••		••
18. Chelsea		•	••			•	•		•		•	
19. Everton	••			•		•	•			••	••	
20. Liverpool		•	•••			•	•		•		•	
21. Manchester City	••		••			•	•		•		••	
22. Manchester United		•	•			•		•	•		•	
23. Portsmouth	•			•		•	•			•	•	
24. Tottenham		•		•	•			•••		•	•	
25. West Ham		•	••		•			•		••		•
26. Wigan	••		•		••		••			••		•
	Attacking styles of play								Defensive styles of play			
Teams (season 2010–2011)	D	P	C	NC	WP	NP	FP	SP	PW	PC	LP	HP
27. Atletico de Madrid	•			•	•			•		•		•
28. Barcelona		••••	•		••			•		••		••
29. Bilbao	•		••			•		•		•		•
30. Getafe		•		•	•			•	••		••	
31. Levante	•			•	•••			•••	•		••	
32. Osasuna	••		••			•		•	•			•
33. Real Madrid		•	•			••	••		•		•	
34. Real Sociedad	•		••		•		•		•			••
35. Valencia		•	••		•			••	••		•	
36. Villareal		••	•		•		•		•		•	
37. Zaragoza	•			•		•••	•		••		•	

Abbreviations for attacking and defensive styles of play: Direct (D), Possession (P), Crossing (C), No Crossing (NC), Wide Possession (WP), Narrow Possession (NP), Fast Progression (FP), Slow Progression (SP), Pressure on Wide Areas (PW), Pressure on Central Areas (PC), Low Pressure (LP) and High Pressure (HP).
The number of dots indicates the degree of utilisation of the style of play by the team, more dots indicates a higher utilisation.
• Score between 0 and ±1. •• Score between ±1 and ±2. ••• Score between ±2 and ±3. •••• Score between ±3 and ±4.

Gomez et al. (2018) also used a factor analysis with many more variables (n=87) and extracted 8 different factors to identify playing styles (ball possession, counter attacks and transitional play), ending actions, individual challenges, set piece, fouling actions and free kicks. They also identified the influence of situational variables i.e. match location (playing at home or away) and team quality (ranking of team analysed not opponent) on each factor. Results suggested that teams in the Greek first division during the 2013/14 season had more possession play, ending actions and set pieces when playing at home than away and higher quality teams had more possession play, ending actions and individual challenges than lower teams.

Table 2.4 overleaf summarises the research related to playing styles with details of the reference, sample size, use of technical variables and main findings given.

Table 2.4 Summary of playing styles literatures in football

Reference	Sample	Measure	Main findings
Bate, R. (1988). Football chance: tactics and strategy	*Matches*: 16 *Competition*: International (including Senior, U-21, U-18 and U-16), FIFA World Cup in 1982) and domestic (Notts County FC in 1985/86 season)	Goals Shots Number of passes Pitch area Possession	• 79% of goals were scored from movements of 4 or less passes. • 50-60% of all movements leading to shots and goals originated by set plays in the attacking 3rd or regaining the ball in the attacking 3rd.
Fernendez-Navarro, J., Fradua, L., Zubilaga, A., Ford, P. R., & McRobert, A. P. (2016). Attacking and defensive styles of play in soccer: analysis of Spanish and English elite teams	*Matches*: 97 *Competition*: Spanish La Liga and English Premier League in the 2006/07 and 2010/11 seasons	Possession Direction of passes Pitch area of possession/regain and passes Crosses Shots	• Factor analysis extracted 6 factors that defined 8 different attacking playing styles (direct/possession, crossing/no crossing, wide possession/narrow possession, fast progression/slow progression) and 4 defensive styles (pressure on wide areas/pressure on central areas, low pressure/high pressure). • Barcelona showed possession play style whilst Bolton used direct play style based on possession and sideward passes.
Fernendez-Navarro, J., Fradua, L., Zubilaga, A., & McRobert, A. P. (2019). Evaluating the effectiveness of styles of play in elite soccer	*Matches*: 380 *Competition*: England Premier League in the 2015/16 season	Possession Style of play	• Presented 8 different playing styles with operational definitions. • Counterattack style was more effective when teams were winning.
Gollan, S., Ferrar, K., & Norton, K. (2018). Characterising game styles in the English Premier League using the "moments of play" framework	*Matches*: 380 *Competition*: England Premier League in the 2015/16 season	96 variables including shots, passes, touches, chances, dribbles, tackles, blocks, interceptions, offsides, lost possessions, set pieces etc.	• Success for the top-ranked teams was associated with the dominance in transition moments. • Higher ranked teams demonstrated control of established offense and set piece.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Gomez, M., Mitrotasios, M., Armatas, V., & Lago-Penas, C. (2018). Analysis of playing styles according to team quality and match location in Greek professional soccer	*Matches*: 301 *Competition*: Greek Super League in the 2013/14 season	87 variables including shots, passes, possessions, dribbles, tackles, interceptions, fouls, saves, counter attacks, recovering balls, set pieces etc.	• Factor analysis extracted 8 factors (ball possession, ending actions, individual challenges, counterattack, set piece, transitional play, fouling action, free kick). • Playing styles were different depending on match location and opposition quality.
Gonzalez-Rodenas, J., Lopez-Bondia, I., Calabuig, F., Perez-Turpin, A., & Aranda, R. (2015). The effects of playing tactics on creating scoring opportunities in random matches from US Major League Soccer	*Matches*: 30 *Competition*: Major League Soccer in the 2014 season	Field starting zone Initial penetration Type of attack Passes per possession Percentage of penetrative passes Initial defensive pressure Initial invasive zone Type of corner and free kicks	• Counterattack was more effective than combinative attack. • Set piece was the most effective type of initiation of possession for creating scoring opportunities compared to restarts and recoveries.
Hewitt, A., Greenham, G., & Norton, K. (2016). Game style in soccer: what is it and can we quantify it?	Qualitative	Review paper	• 5 specific moments needed to measure performance (established attack, defensive transition, established defence, offensive transition, set-piece).
Hughes, M., & Franks, I. (2005). Analysis of passing sequences, shots and goals in soccer	*Matches*: 52 & 64 *Competition*: FIFA World Cup (1990 and 1994)	Number of passes Shots Goals	• More shots per possession at longer passing sequences than shorter passing sequences for successful teams. • The conversion ratio of shots to goals was better for direct play than possession play.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
James, N., Mellalieu, S. D., & Hollely, C. (2002). Analysis of strategies in soccer as a function of European and domestic competition	*Matches*: 21 *Competition*: Domestic and European competitions in the 2001/02 season	Duration of possession Pitch area Passes	• Attacking play occurred more down the right side of the pitch in domestic matches compared to European games.
Jones, P. D., James, N., & Mellalieu, S. D. (2004). Possession as a performance indicator in soccer	*Matches*: 24 *Competition*: English Premier League in the 2001/02 season	Duration of possession	• Successful teams in the English Premier league typically had longer possessions than unsuccessful teams irrespective of the match status (evolving score). • Successful and unsuccessful teams kept the ball for longer periods when they were losing compared to winning.
Kempe, M., Vogelbein, M., Memmert, D., & Nopp, S. (2014). Possession vs Direct Play: Evaluating Tactical Behavior in Elite Soccer	*Matches*: 612 & 64 *Competition*: German Bundesliga between the 2009~11 seasons & FIFA World Cup in 2010	Passes per action Passing direction Target player passes Passing success rate Passing success rate in forward direction Number of passes per attack Game speed Duration of attack Gain of possession Distance per attack Relative ball	• Index Of offensive Behaviour (IOB) and Index of Game Control (IGC) presented as new approaches to evaluate tactical behaviour by combining different offensive variables. • IOB reliably distinguished the two common tactical approaches in soccer: possession and direct play. • Successful teams preferred possession play with IGC the most important variable of success irrespective of the tactical approach.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies in professional association football	*Matches*: 27 *Competition*: Spanish La Liga in the 2005/06 season	Duration of possession Pitch area of possession	• Possession strategies were influenced by match variables, either independently or interactively. • There was more play in the attacking zone when the team was playing at home than playing away. • Ball possession was less in the defensive zone and more in the attacking zone when losing compared to winning or drawing.
Lago, C., & Dellal, A. (2010). Ball Possession Strategies in Elite Soccer According to the Evolution of the Match-Score: The Influence of Situational	*Matches*: 380 *Competition*: Spanish La Liga in the 2008/09 season	Duration of possession	• The best classified teams maintained a higher percentage of ball possession and their pattern of play was more stable. • Strategies in soccer were influenced by situational variables and teams altered their playing style accordingly.
Lago, C., & Martin, R. (2007). Determinants of possession of the ball in soccer	*Matches*: 170 *Competition*: Spanish La Liga in the 2003/04 season	Duration of possession	• Duration of possession was influenced by situational variables e.g. longer possessions playing at home than away and losing than drawing and winning.
Lago-Penas, C., Gomez-Ruano, M., & Yang, G. (2017). Styles of play in professional soccer: an approach of the Chinese Soccer Super League	*Matches*: 240 *Competition*: Chinese Super League in the 2016 season	Ball possession Type of attack Passes Crosses Interceptions Lost balls Recovered balls	• Factor analysis showed 5 different styles of play (possession, counterattack, set piece, transition in attack, transition in defence). • Guangzhou Evergrande used possession play style based on ball possession and positional attacks whilst Shanghai SIPG used counterattack style based on interceptions, recovered balls and counterattacks.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Lago-Bellesteros, J., Lago-Penas, C., & Rey, E. (2012). The effect of playing tactics and situational variables on achieving score-box possessions in a professional soccer team	*Matches*: 12 *Competition*: Spanish La Liga in the 2009/10 season	Outcome of possession Duration of possession Starting zone Possession type Number of passes Players in possession Passing options Opposition player's number Defensive pressure	• Direct attacks and counterattacks were three times more effective than elaborate attacks for producing score-box possessions. • The use of a counterattack originating in the pre offensive zone showed a higher probability of producing a score-box possession compared with an elaborate attack starting in the defensive area. • Team possession originating from the offensive zone and against imbalanced defence registered a higher success than those started in the defensive zone with a balanced defence.
Mitrotasios, M., Gonzalez-Rodenas, J., Armatas, V., & Aranda, R. (2019). The creation of goal scoring opportunities in professional soccer. Tactical differences between Spanish La Liga, English Premier League, German Bundesliga and Italian Serie A	*Matches*: 80 *Competition*: Spanish La Liga, English Premier League, German Bundesliga and Italian Serie A (the season was not given)	Initial zone Initial pressure Style of play Possession length Penultimate action Final zone Type of finishing Success	• Spanish La Liga had high values for passing and offensive elaborate variables. • English Premier League had fast and direct attack (high score for offensive verticality). • German Bundesliga had high values for counter attacks and crossing play. • Italian Serie A had high values for counterattack and direct attack (lowest offensive sequences).
Pollard, R., Reep, C., & Hartley, S. (1988). The quantitative comparison of playing styles in soccer	*Matches*: 32 & 42 *Competition*: 1982 FIFA World Cup & First division of the England Football League in the 1984/85 season	Long forward passes Long goal clearances Crosses Regaining possession Possession in defence Multi-pass movements	• Factor analysis showed 3 different playing styles (elaborate/direct, high/low use of centre area, regaining possession in attack). • France used an elaborate style whilst England used the central area for attack.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Reep, C. & Benjamin, B. (1968). Skill and chance in association football	*Matches*: 3213 *Competition*: English First Division and World Cup matches between the 1953~1968	Number of successful passes in a possession Shot at goal Shooting area	• Approximately 80% of goals resulted from a sequence of three passes or less. • Goals scored every 10 shots. • Regaining possession in the opponent's half produced many goal scoring opportunities.
Redwood-Brown, A. (2008). Passing patterns before and after goal scoring in FA Premier League	*Matches*: 120 *Competition*: English Premier League in the 2004/05 season	Number of passes Ratio of Successful passes Passing frequency Ratio of passes	• In the 5mins before scoring, the scoring team played a significantly greater percentage of passes accurately while the conceding team played significantly fewer passes. • In the 5mins after scoring, the scoring team played significantly fewer passes and a lower percentage of accurate passes.
Sarmento, H., Anguera, M. T., Campaniço, J., & Leitão, J. (2010). Development and validation of a notational system to study the offensive process in football.	*Matches*: 2 *Competition*: Barcelona FC games in the 2009/10 season	Start of the offensive process Development of the offensive process End of the offensive process Way and direction of the pass Height of the pass Rhythm of the game Spatial characterization Game Centre	• Presented an analysis technique to determine hidden patterns of behaviour (T-patterns) during sequences of game play. • Suggested that large volumes of data may allow the detection of multiple temporal patterns which may help optimise sports performance.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Sarmento, H., Anguera, M. T., Pereiral, A., Marques, A., Campaniço, J., & Leitão, J. (2014). Patterns of Play in the Counterattack of Elite Football Teams - A Mixed Method Approach	*Matches*: 36 *Competition*: Barcelona FC, Internazionale Milano, Manchester United games in the 2009/10 season	Type of attack Start of the Offensive Process End of the OP Pitch area Relative numeric inferiority Absolute numeric inferiority Relative numeric superiority Absolute numeric superiority Equal numeric under pressure 8 Coaches Interviews	• Coaches determined playing patterns using their opinions of tactical-strategic, tactical-technical and player characteristics for different teams. • The potential value of a combination of these types of analysis is evident. It allows for the detection and analysis of regular behaviour structures (game patterns).
Tenga, A., Holme, I., Ronglan, L. T., & Bahr, R. (2010a). Effect of playing tactics on goal scoring in Norwegian professional soccer	*Matches*: 163 *Competition*: Norwegian League in the 2004 season	Possession type Starting area Number of passes Pass length Pass penetration Space utilization Outcome of possession	• Counterattacks were more effective than elaborate attacks when playing against an imbalanced defence but not against a balanced defence. • A random sample of all possessions showed that elaborate attacks (59%) were used more often than counterattacks (41%). • Offensive playing tactics should differ according to the degree of defensive balance to improve a team's ability to produce (and prevent) score box-possessions.

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Tenga, A., Holme, I., Ronglan, L. T., & Bahr, R. (2010b). Effect of playing tactics on achieving score-box possessions in a random series of team possessions from Norwegian professional soccer matches	*Matches*: 163 *Competition*: Norwegian League in the 2004 season	Possession type Starting area Number of passes Pass length Pass penetration Space utilization Defensive pressure Defensive backup Defensive cover	• Offensive tactics were more effective in producing score-box possessions when playing against an imbalanced defence (28.5%) than against a balanced defence (6.5%). • Counterattacks were more effective than elaborate attacks when playing against an imbalanced defence but not against a balanced defence.
Tenga, A., & Larsen, Ø (2003). Testing the validity of match analysis to describe playing styles in football	*Matches*: 1 *Competition*: Norway vs Brazil	Number of passes Number of touches Pitch area of possession Speed of attack Attack type	• Norway used more direct plays compared to Brazil. • Norway were deemed to play faster than Brazil because they had on average less passes per attack (Norway= 3.09, Brazil= 4.24) and lower maximum number of touches per ball involvement (Norway= 2.75, Brazil= 3.41).
Tenga, A., Ronglan, L. T., & Bahr, R. (2010). Measuring the effectiveness of offensive match-play in professional soccer	*Matches*: 163 *Competition*: Norwegian League in the 2004 season	Possession type Starting area Number of passes Pass penetration Outcome of possession	• The offensive tactics of counterattack, final third starting zone, long possessions (five passes or more) and playing penetrative passes were more effective in producing goals, scoring opportunities and score box possessions (shooting opportunities). • Scoring opportunities and score box possessions (shooting opportunities) can be effectively utilised as measures of playing tactics in football (occur more frequently than goals).

Table 2.4 Summary of playing styles literatures in football (contd.)

Reference	Sample	Measure	Main findings
Tenga, A., & Sigmundstad, E. (2011). Characteristics of goal-scoring possessions in open play: Comparing the top, in-between and bottom teams from professional soccer league	*Matches*: not given (997 goals) *Competition*: Norwegian top professional league in the 2008, 2009 and 2010 seasons	Possession type Passes per possession Duration of possession Possession starting zone	• Team's rank significantly influenced how goals were scored from open play possessions. • The top three and in-between teams scored significantly more goals from counterattack possessions than the bottom three teams.
Yiannakos, A., & Armatas, V. (2006). Evaluation of the goal scoring patterns in European Championship in Portugal 2004	*Matches*: 32 *Competition*: European Championship in the 2004 season	Goals Actions prior to the goal Attack type Set-piece type Pitch area	• More goals were scored in the second half of matches. • Organised offensive moves produced more goals than counterattacks. • Long passes led to goals (34.1%) more often than combination plays (29.3%) or individual actions (17.1%).

2.3 UNSTABLE SITUATIONS AND PERTURBATIONS IN SPORTS

Football is a complex sport involving many players and different situations and it is not plausible that a reduced set of action variable can consistently predict the game result, with the exception of goals scored, which is both obvious and uninformative. Mackenzie and Cushion (2013), in a critical review of PA in football, suggested that variables had been measured because of availability rather than to develop a deeper understanding of performance. McGarry et al. (2002) suggested that an alternative methodical approach to overcome this problem could be the dynamical systems perspective, referred to by Kelso (1995), which described how behaviours could deviate through a series of states from stable to unstable (perturbation) or vice versa (smooth out).

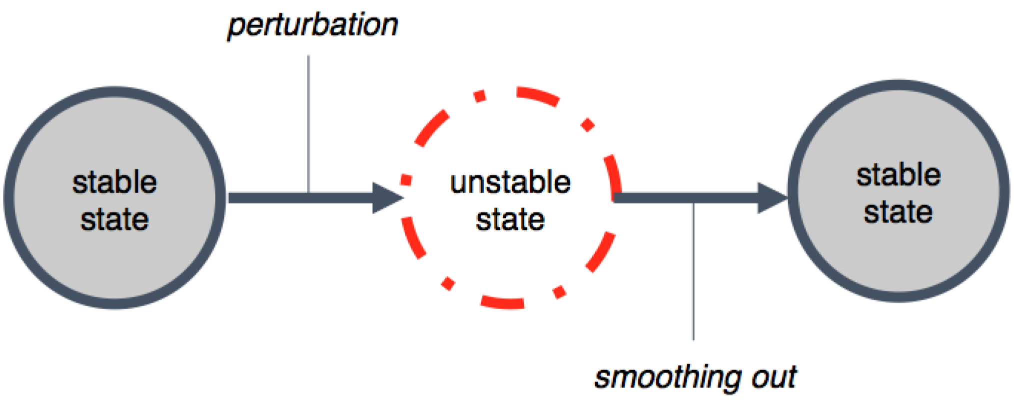

Figure 2.2 Game state changes between stable and unstable states

Intuitively, this approach seems well suited to the analysis of football, the antithesis of the reductionist approach, although squash was the first sport to be analysed. McGarry et al. (1999) showed 60 rallies from the 1988 Men's Canadian Open Squash Championship to six expert and six non-expert squash coaches and asked them to identify when rallies changed from a stable situation, defined as neither player having an advantage over the other, to an unstable one where one player had an advantage. The coaches could reliably identify the shot which occurred between these two hypothesised game states although occasionally either one of two consecutive shots were identified. The authors suggested that this transition point could contain a perturbation, described as an event which caused the change in game state, in this case 85% identified strong or weak shots as the cause.

Roddy et al. (2014) also investigated perturbations that occurred during the critical incidents in a squash rally i.e. the last three shots played in a rally that were won N.B. rallies can be replayed under some circumstances called Lets. Perturbations were deemed to have occurred if the rally loser was out of position when playing the shot immediately prior to the opponent playing a winner. In the 2135 rallies (n= 31 matches) from the 2011 Men's Australian Open Squash Championship only 238 perturbations were identified. However, this narrow definition of a perturbation meant that situations where a player was out of position but recovered sufficiently to not allow the opponent to play a winner was not deemed a perturbation. This is a different use of the term perturbation as used by McGarry et al. (1999) who suggested that perturbations could be "smoothed out" i.e. stability in the rally regained after a perturbation had caused instability.

In a more complex game such as football it may not be as obvious as to how an action by one or more individuals might affect the overall status of the system. Indeed, for a complex sport where players use off the ball positioning to gain an advantage over their opponents it may be difficult to discern periods of stability and instability and furthermore which actions are responsible for changes in the system state. Some attempts have been made to consider football within a dynamical system perspective although much of this has been to consider movements between players e.g. Siegle and Lames (2013). At a more general level some authors have referred to stable rhythms and flow within sport but do not define stability (McGarry et al., 1999;

Hughes et al., 2001: Hughes & Reed, 2005). Siegle and Lames (2013) suggested that football can be characterised as having an in-phase structure. They measured the relative phases of the team, both as a group (midfielders) and as individual players (attackers and fullbacks) to understand the complexity of football. They analysed the 2016 FIFA World Cup Final match between France and Italy and calculated the mean centre and the range of the longitudinal and lateral positions of players in order to identify the relative phases. The results showed that both teams created perturbations when they had a penalty kick, scored a goal and had situations of players being injured, and that groups and individual players created perturbations when they had goal-scoring opportunities.

James et al. (2012) analysed perturbation attempts which they described as actions whose purpose was to create instability, defined as a goal scoring opportunity. They hence defined a stable situation as when neither team had an immediate goal scoring opportunity. Consequently, an attempt to create a goal scoring opportunity e.g. a pass into the penalty box, could be successful if an attacker was in a position to score a goal (an unstable situation). However, if the attacker was unable to kick the ball e.g. a defender intercepted the ball, the situation would remain stable and therefore the attempt unsuccessful. Eight home matches involving one Coca-Cola League One team in the 2007/8 season resulted in an average of 78 perturbation attempts per match. The home team (mean=48.1 per match) had significantly more attempts than the away teams (mean=39.6). However, the home team's rate of perturbation attempts per possession (11.8% of total possessions) was significantly lower than that of the away teams (17.5%). This paper provided a definition for a perturbation in terms of the aim of the player in possession of the ball (tries to create a goal scoring opportunity i.e. an unstable situation) but allowed for the fact that this aim was not always achieved i.e. an unsuccessful perturbation attempt did not change the current stable situation.

Vilar et al. (2013) analysed the number of players in specific sub-areas of the pitch to identify the dynamic stability and instability of team. They hypothesised that local player numerical dominance was an important factor for analysing an attacking opportunity and defending stability. They analysed one match from the English Premier League in the 2010/2011 season and found that a team could have a relative advantage based on the number of players in a specific area. The results showed that the two teams had one more defender than attackers in the centre-back area for 47% and 44% of the game, which meant that both teams had a defensive advantage for about half of the playing time. In the centre-front area, Team A had an equal number of players for 21% of the time and one more player than defenders for 6%, which was longer than Team B (13% and 2% respectively). These findings revealed an instability in a different area, comparing the number of players between teammates and opponents, which made it possible to identify playing strategy (formation) and how the team managed offensive and defensive instability.

Link et al. (2016) used player and ball tracking data to quantitatively determine the probability of a goal being scored, named "dangerousity". Using the position of the player in possession of the ball, ball speed, defensive pressure and defensive organisation the authors effectively provided a measure which could be useful in the classification of an unstable situation. They performed a validity test using three semi-professional football coaches who rated 100 game situations in terms of danger (1 little danger to 5 very dangerous). The degree of agreement between coaches, and between coaches and the algorithm, suggested that observers could evaluate the extent to which a goal scoring event could occur and the basis of this was measurable using player and ball positions.

The relatively recent advent of player and ball tracking in football has allowed researchers to utilise a dynamical systems approach to better understand the complex relationships between players. For example, Vilar et al. (2013) assessed defensive stability and attacking opportunities in relation to ball and player location changes. Using one match played in the 2010 EPL season the net team numerical advantage was calculated frame by frame using Shannon's entropy as a measure of uncertainty. Similar studies in football have considered the positional centroid of a team as a precursor to critical events (Frencken et al., 2012), a measure of tactical behaviour (Sampaio & Maçãs, 2012) and the speed of contraction or expansion of the team surface area to measure team organisation (Moura et al., 2013).

2.4 SITUATIONAL VARIABLES IN FOOTBALL

Situational (independent) variables play an important role in the analysis and interpretation of performance variables (Gomez et al., 2013; Wright et al., 2014). It is plausible to suggest that contextual variables might affect the performance of teams and individuals as football is dominated by tactics (Lago-Peñas, 2012). For example, teams may play more aggressively when losing to score a goal or play defensively against strong teams to minimise the possibility of conceding a goal. However, the tactical analysis of football has traditionally focused on identifying the relationship between performance indicators and match outcomes without providing sufficient context for these variables (Mackenzie & Cushion, 2013) and ignored most situational variables (Rein & Memmert, 2016). Indeed, Rein and Memmert (2016) suggested that external, historical and individual variables were required to understand the complex processes of football when analysing team tactics.

2.4.1 MATCH VENUE

In last 40 years, Home Advantage (HA) has been a favourite research topic. Following the early work of Schwartz and Barsky (1977) and Edwards and Archambault (1979) possibly the most influential researcher, Richard Pollard, has devoted over 30 years trying to identify the existence of HA. Pollard (1986) investigated over 40,000 matches from 7 different sports and identified teams tended to secure over 50% of all points when playing at home (Table 2.5).

Table 2.5 Winning percentage at home in different professional team sports (Pollard, 1986).

	Baseball	US football	Ice hockey	Basket ball	US soccer	Cricket	English football
Winning percentage	53.6%	55%	59.9%	63.3%	65.2%	56.1%	63.9%

Courneya and Carron (1992) defined HA as "the consistent finding that home teams in sports competitions win over 50% of the games played under a balanced home and away schedule" and devised a conceptual framework for game location to explain this process (Figure 2.3). Their model presents the factors thought to potentially influence performance with the belief that these factors influence home teams differently from away teams. For example, travelling long distances to stay in an unfamiliar hotel might be supposed to unfavourably impact on a team's performance. Of course, this effect might be non-existent for teams that have the ability to mitigate this effect by travelling first class, staying in high level accommodation with all of the usual sports science and other support networks in place. The model presents the most likely factors that could cause a HA effect but whether or not these factors have an impact is likely due to other factors. For example, a local derby tends to be greatly anticipated, local rivalries debated, historical events shown on television etc. This heightened tension could, for example, put extra pressure on the referee. Potentially, one favourable decision for the home team, or an unfavourable one against the away team, could be enough to produce a HA effect, particularly in a low scoring game such as football.

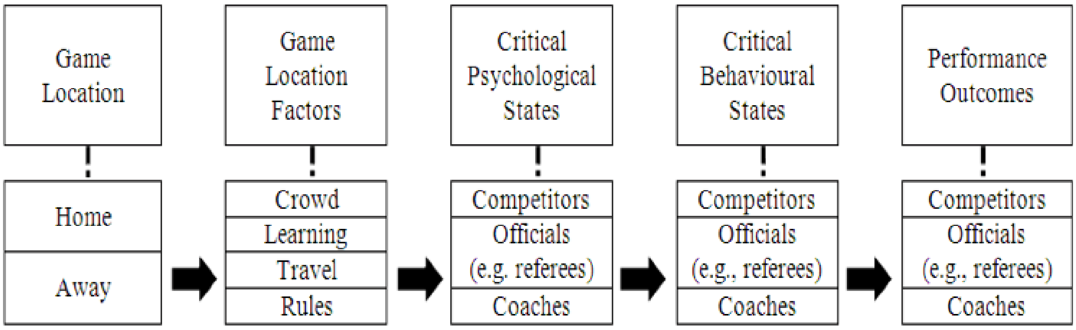

Figure 2.3 The conceptual framework for game location in Sport (Courneya & Carron, 1992)

Home winning percentages in football have regularly been found to be similar to the 63.9% found by Pollard (1986). For example, 62.1% in English football (Thomas et al., 2004), 59~64% across continents (Pollard, 2006), 61.5% in the Turkish league (Seckin & Pollard, 2008), 62% in Spanish soccer (Sànchez et al., 2009), 58% in Australian soccer (Goumas, 2014), 65% in Greek soccer (Armatas & Pollard, 2014) and 55.3-61.2% in 10 different European domestic leagues (Leite, 2017). As well as match outcome, various football studies have found that teams had longer ball possession (Lago & Martin, 2007; Lago, 2009; Bradley et al., 2014), better physical variables (Lago et al., 2010; Castellano et al., 2011; Aquino et al., 2016; Fothergill et al., 2017) and technical variables (Lago-Peñas & Lago-Ballesteros, 2011; Gomez et al., 2012; Almeida et al., 2014; Armatas & Pollard, 2014; Garcia-Rubio et al., 2015; Liu et al., 2015; Sgro et al., 2017) when they played at home compared to away.

Pollard (2008) suggested there were still difficulties for explaining the exact reasons for home advantage and presented a newer version of his model of HA factors (Figure 2.4).

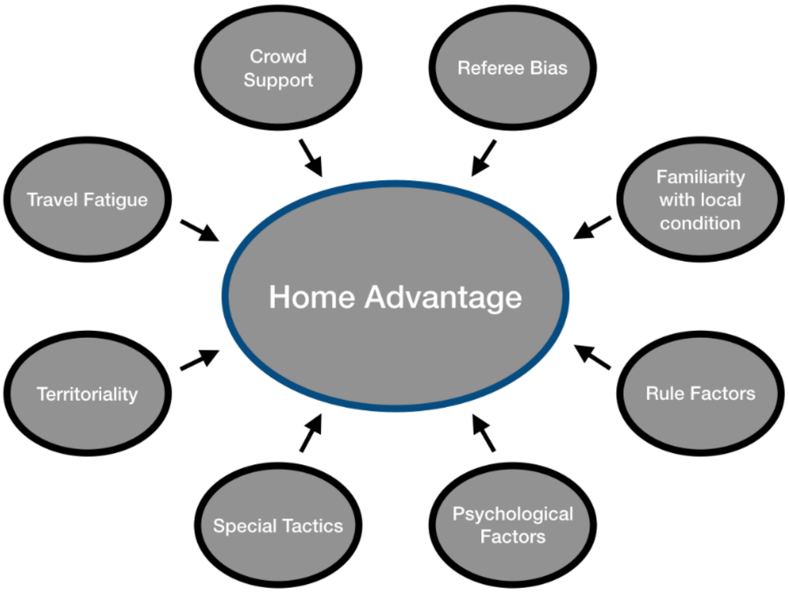

Figure 2.4 Eight potential causes of home advantage in sport (Pollard, 2008)

The main conclusion from HA research is that there are many factors which could induce a HA effect, but no one factor has a consistent influence. Indeed, it is possible, or likely, that on some occasions no HA effect is present. HA, however, is a logical situational variable of interest in football, simply based on match outcome, although the extent to which it impacts performance (tactical, technical or physical) is still largely unknown. However, anecdotal evidence such as Chelsea unbeaten in 86 matches at home (62 won, 24 drawn, 0 lost) between Feb 2004 and Oct 2008, but during the same period lost 14 times away, there remains the possibility that some teams do perform differently at home compared to away.

2.4.2 MATCH STATUS

Match status refers to the possibility that team's play differently when winning, drawing and losing (Jones et al., 2004; Lago and Martin, 2007). This would seem logical on the basis that teams might need to change strategies when the situation changes within the match, most obviously because of goals being scored. For example, if a team is losing, they may change their tactics to a more aggressive approach in order to enhance their chance of scoring a goal. Similarly, winning teams may, England supporters might recognise this, become defensively oriented to try to protect their lead. Several studies have demonstrated that teams had more ball possession when they were losing than drawing or winning (Jones et al., 2004; Lago, 2009; Lago-Penas & Dellal, 2010; Bradley et al., 2014; Kubayi & Toriola, 2019). Also, match status influenced technical variables such as shots, passes and crosses (Lago-Ballesteros et al., 2012; Almeida et al., 2014; Harrop & Nevill, 2014; Paixao et al., 2015; Sgro et al., 2017; Fernandez-Navarro et al., 2018; Praca et al., 2019) as well as physical variables (Lago et al., 2010; Castellano et al., 2011; Redwood-Brown et al., 2012; Vogelbein et al., 2014; Aquino et al., 2016).

Whilst match status has been shown to be an important factor related to performance, it has been underutilised compared to other situational variables such as match location and opposition quality perhaps because of the relative difficulty in data collection. Match location and opposition quality remain the same throughout a match whereas match status can change a number of times as the score line evolves. This means that different matches will have different periods of time in some, or all, of the different match status situations. Hence, comparing the number of shots by a team when winning, drawing and losing would be an unfair comparison if the time spent in each status was markedly different. Taylor et al. (2008) transformed variables to a standardised time period i.e. 90 minutes, using the formula: $F*(n/90)$ where F equals the observed frequency of the performance variable and n is the number of minutes played. Lago (2009) used the same formula but excluded performances over periods of less than 10 minutes in duration because they could easily over- or under-state performance if they took place in extreme circumstances i.e. the data may not reflect the strategic intention of the team. For example, if a team was winning for 10 minutes and had no shots this would be calculated as 0 shots for 90 minutes, a relatively rare event, and perhaps not representative of the team in general. A further issue for researchers interested in match status is the fact that many data providers only produce end of match statistics and hence exclude match status information. This is not true for all providers but the reality for data collection processes to include match status means that time consuming event data needs to be collected. A criticism of the literature that includes match status is the lack of transparency for how data was collected and whether any transformation was used for the calculations.

2.4.3 TEAM QUALITY

Team and opposition quality have been considered an important situational variable when analysing performances. Unsurprisingly, teams had longer possessions (Lago-Peñas & Dellal, 2010; Bradley et al., 2014; Kubayi & Toriola, 2019) and greater game-related statistics such as shots, passes and dribbles (Taylor et al., 2008; Liu et al., 2015) when teams played against weak teams compared to strong teams. James et al. (2002) suggested a team's performance is to some extent a response to the opposition's pattern of play and tactics which are, to some extent, determined by the quality of opposition. This is similar to O'Donoghue's (2009) interacting performances theory which suggests that performance is influenced by an opponent, the outcome and process of a performance is influenced by the quality and type of an opponent and these influences may be different on different occasions. Whilst team quality is a variable which may have more effect than any other situational variable the classification and ranking of a team is not always clear. For example, end of league position may be used to classify the strength of a team, but this may be insensitive to fluctuations in form during a season. Football research has used different criteria to classify team quality, usually on the basis of end of season rankings (Table 2.6).

Table 2.6 Categories of team quality in football research since 2010

Year	Authors	Categories
2011	Castellano et al.	Top / Middle / Bottom
2011	Lago-Peñas & Lago-Ballesteros	Group1 / Group2 / Group3 / Group4
2012	Pratas et al.	High / Low
2013	Adams et al.	Successful / Unsuccessful
2013	Castellano et al.	Stronger / Weaker
2014	Almeida et al.	Better / Similar / Worse
2014	Bradley et al.	Strong / Weak
2014	Vogelbein et al.	Top / In-between / Bottom
2015	Liu et al.	High / Intermediate / Low
2016	Aquino et al.	Strong / Weak
2017	Santos et al.	Top / Similar
2017	Sgro et al.	Level1 / Level2 / Level3
2017	Mao et al.	Upper / Lower
2019	Mendez-Dominguez et al.	Best / Worst
2019	Kubayi & Toriola	Stronger / Weaker

Classifying team quality into two, three or four levels, based on end of season ranking, could be deemed erroneous as 1) final rank is not an exact quality measure of a team and does not reflect within season fluctuations i.e. is not reflective of when the game was played, 2) when rank distances are used the difference between teams ranked 1 and 2 are deemed to be the same as teams ranked 11 and 12. Carling et al. (2014) suggested this method could be considered arbitrary as teams could miss out on being classified as a strong team by just a few points, despite potentially having been in the top half of the table for the majority of the season.

Table 2.7 summarises the research papers for situational variables including the reference, sample size, type of situational variables used and main findings.

Table 2.7 Summary of situational variables literature in football

Reference	Sample	Reliability and Statistic	Main Findings
Almeida, C. H., Ferreira, A. P., & Volossovitch, A. (2014). Effects of match location, match status and quality of opposition on regaining possession in UEFA Champions League	*Matches*: 125 *Competition*: UEFA Champions League in the 2011/12 season	Match location Opposition quality Match status	• Teams regained the ball in more advanced area when they played at home than away and when they were losing than drawing and winning. • Teams were better able to dispossess an attacker when playing against lower compared to similar or better ranked opponents.
Aquino, R., Martins G. H. M., Viera, L. H. P., & Menezes, R. P. (2016). Influence of match location, quality of opponents, and match status on movement patterns in Brazilian professional football players	*Matches*: 16 *Competition*: Brazilian Championship Fourth division in the 2015 season	Match location Opposition quality Match status	• Movement variables (maximum speed, average speed and high intensity activities) were higher when playing at home than away and against strong teams than weak teams. • Opposition quality had the highest contribution for high intensity activities (19%) compared to match location (4%) or match status (16%).
Armatas, V., Papadopoulou, S., & Skoufas, D. K. (2009). Evaluation of goals scored in top ranking soccer matches: Greek "Super League" 2006-07	*Matches*: 240 *Competition*: Greek Super League in the 2006/07 season	Match location Time period First goal	• Teams had better outcomes when playing at home (47.3%-win, 26.3% draw and 26.4% lose). • Teams created more goals in the 2nd half (59%) than the first (41%). • When a team scored first, they won 71.4% of matches (16.2% draw and 12.4% lose).
Armatas, V., & Pollard, R. (2014). Home advantage in Greek football	*Matches*: 2160 *Competition*: Greek Super League in the between the 1994/95 ~ 2010/11 seasons	Match location	• Home teams had greater performances for technical variables than away teams. • The only match variable with a correlation over 0.25 with goal difference was shots from inside penalty area.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Barros, R. M. L., Misuta, M. S., Menezes, R. P., Figueroa, P. J., Moura, F. A., Cunha, S. A., Anido, R., & Leite, N. N. (2007). Analysis of the distance covered by first division Brazilian soccer players obtained with an automatic tracking method	*Matches*: 4 *Competition*: Brazilian First division Championship between the 2001~2004 seasons	Time period	• The median distance covered in the first half was significantly higher than in the second half.
Bradley, P. S., Lago-Penas, C., Rey, E., & Sampaio, J. (2014). The influence of situational variables on ball possession in the English Premier League	*Matches*: 54 *Competition*: English Premier League (the season was not given)	Match location Opposition quality Match status	• Possession decreased 1% (winning) and 0.5% (drawing) every 11 minutes. • Possession was influenced by match location and quality of opposition determined by season ranking.
Castellano, J., Alvarez, D., Figueira, B., Coutinho, D., & Sampaio, J. (2013). Identifying the effects from the quality of opposition in a football team positioning strategy	*Matches*: 6 *Competition*: Spanish La Liga in the 2005/06 season	Opposition quality	• Teams covered more distance against weak teams in the offensive area and in the defensive area against strong teams. • Higher defensive length, width and surface area were found against stronger teams.
Castellano, J., Blanco-Villasenor, A., & Alvarez, D. (2011). Contextual variables and time-motion analysis in soccer	*Matches*: not given (434 players) *Competition*: Spanish La Liga in the 2005/06 season	Match location Opposition quality Match status Time period	• Total distance was greater when playing at home than away. • When a team was losing, they covered more distance than winning and drawing. • The stronger opponent, the longer distance covered.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Courneya, K. S., & Carron, A. V. (1992). The home advantage in sport competitions: a literature review	Review paper	Match location	• Home advantage exists in major team sports. • Definition of home advantage given as "the consistent finding that home teams in sports competitions win over 50% of the games played under balanced home and away schedule".
Fernandez-Navarro, J., Fradua, L., Zubillaga, A., & McRober, A. P. (2018). Influence of contextual variables on styles of play in soccer	*Matches*: 380 *Competition*: English Premier League in the 2015/16 season	Match location Opposition quality Match status	• Teams had an increase in build-up play and a decrease in direct play when losing compared to drawing. • Teams used more build-up play at home than away. • Teams used more direct play and less build-up play against stronger teams.
Garcia-Rubio, J., Gomez, M. A., Lago-Penas, C., & Ibanez, S. (2015). Effect of match venue scoring first and quality of opposition on match outcome in the UEFA Champions League	*Matches*: 475 *Competition*: UEFA Champions League in the 2009/10, 2010/11, 2011/12 & 2012/13 seasons	Match location Opposition quality First goal	• Home teams won 76.6% when scoring first compared to 12.7% when they did not score first. • Away teams won over 60% when scoring first compared to 9.8% when they did not score first.
Gomez, M. A., Gomez, M., Lago-Penas, C., & Sampaio, J. (2012). Effects of game location and final outcome on game-related statistics in each zone of the pitch in professional football	*Matches*:1900 *Competition*: Spanish La Liga between the 2003~2008 seasons	Match location	• Teams had a greater number of goals, shots, crosses, committed fouls, turnovers and ball recovers when playing at home than away.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	**Sample**	**Reliability and Statistic**	**Main Findings**
Goumas, C. (2014). Home advantage in Australian soccer	*Matches*: 765 *Competition*: Australia Major soccer league between 2005/06 ~ 2011/12 seasons	Match location	• Home teams won 58% of matches in the long term. • Home advantage appeared to increase with crowd size.
Harrop, K., & Nevill, A. (2014). Performance indicators that predict success in an English professional League One soccer team	*Matches*: 6 *Competition*: English League One in the 2012/13 season	Match location	• Teams had better match outcome at home than away. • Teams had more dribbles away than at home.
Jones, P. D., James, N., & Mellalieu, S. D. (2004). Possession as a performance indicator in soccer	*Matches*: 24 *Competition*: English Premier League in the 2001/02 season	Match status	• Successful team had longer possessions than unsuccessful teams irrespective of match status. • Teams had longer possession when losing than winning for both successful and unsuccessful teams.
Kubayi, A., & Toriola, A. (2019). The influence of situational variables on ball possession in the South African Premier Soccer League	*Matches*: 32 *Competition*: South African Premier Soccer League in the 2016/17 season	Match location Opposition quality	• Teams had longer ball possessions at home (50.8%) than away (49.2%). • Stronger teams had longer ball possessions (50.4%) than weaker teams (49.6%).
Lago, C. (2009). The influence of match location, quality of opposition, and match status on possession strategies association football	*Matches*: 27 *Competition*: Spanish La Liga in the 2005/06 season	Match location Opposition quality Match status	• Possession was 11% and 3% lower when winning and drawing (respectively) compared to losing. • Possession increased 10.3% and 3% when they were winning and drawing in the defensive area compared to losing.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Lago, C., & Martin, R. (2007). Determinants of possession of the ball in soccer	<u>*Matches*</u>: 170 <u>*Competition*</u>: Spanish La Liga in the 2003/04 season	Match location Match status	• Teams had longer ball possessions when losing than drawing or winning. • Possession was 5.7% higher when playing home compared to away.
Lago-Peñas, C. (2012). The Role of Situational Variables in Analysing Physical Performance in Soccer	Qualitative	Match location Opposition quality Match status	• Early studies identified that teams had greater technical variables such as the number of shots, passes and possessions etc. 1) at home than away, 2) against weak teams than strong teams and 3) when losing than drawing or winning.
Lago-Peñas, C & Dellal, A. (2010). Ball Possession Strategies in Elite Soccer According to the Evolution of the Match-Score the Influence of Situational Variables	<u>*Matches*</u>: 380 <u>*Competition*</u>: Spanish La Liga in the 2008/09 season	Match location Opposition quality Match status	• Possession reduces by 0.04% and 0.09% every minute when drawing and winning compared to losing. • Possession is 2.43% lower when playing away than home.
Lago-Peñas, C., & Gomez-Lopez, M. (2014). How important is it to score a goal? The influence of the scoreline on match performance in elite soccer	<u>*Matches*</u>: 380 <u>*Competition*</u>: Spanish La Liga in the 2012/13 season	Score-line Team quality	• Possession decreased when a team went one goal up. • The probability of reaching the final third was 5% lower when winning and 3% lower when drawing compared to losing.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Lago-Peñas, C., Gomez-Ruano, M., Megias-Navarro, D., Pollard, R. (2017). Home advantage in football Examining the effect of scoring first on match outcome in the five major European leagues	*Matches*: 1826 *Competition*: English Premier League, Spanish La Liga, French Ligue 1, Italian Serie A and German Bundesliga in the 2014/15 season	Match location Opposition quality First goal	• Home teams won 84.9% of matches when they scored first whilst away teams won 76.3% when they scored first.
Lago-Peñas, C., & Lago-Ballesteros, J. (2011). Game location and team quality effects on performance profiles in professional soccer	*Matches*: 380 *Competition*: Spanish La Liga in 2008/09 season	Match location Team quality	• Home teams had a greater percentage of wins (62%) than away teams (38.1%). Draws were excluded. • Home teams and strong teams had greater game-related statistics e.g. goals, shots, passes, crosses, dribbles than away teams and weak teams.
Leite, W. S. S. (2017). Home advantage: Comparison between the Major European Football League	*Matches*: 3223 *Competition*: Belgium, England, Netherland Spain, France Italia, German, Portugal, Turkey and Russia Domestic League in the 2014/15 season	Match location	• Spain La Liga had highest home winning percentage (61.2%) whilst the Russia Premier League was lowest (55.3%).
Liu, H., Gomez, M., Lago-Penas, C., & Sampaio, J. (2015). Match statistics related to winning in the group stage of 2014 Brazil FIFA World Cup.	*Matches*: 496 *Competition*: UEFA Champions League in the 2009/10, 2010/11, 2011/12 & 2012/13 seasons	Match location Opposition quality	• Game related statistics e.g. shots, passes, crosses, corners, possessions were significantly influenced by match location (greater when playing at home than away), team quality (high level team was greater than low level), quality of opposition (greater when playing against low level team than high level team), match status (greater when losing than drawing or winning).

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	**Sample**	**Reliability and Statistic**	**Main Findings**
Mao, L., Peng, Z., Liu, H., & Gomez, M. (2016). Identifying keys to win in the Chinese professional soccer league.	*Matches*: 480 *Competition*: Chinese Super League in the 2014 and 2015 seasons	Match location Opposition quality	• Home teams had 14.5% higher winning percentage than away teams. • Teams created more shots, passes, crosses, corners and possessions against lower ranked teams than upper ranked teams.
Mendez-Dominguez, C., Gomez-Ruano, M. A., Ruiz-Perez, L. M., & Travassos, B. (2019). Goals scored and received in 5vs4 GK game strategy are constrained by critical moment and situational variables in elite futsal.	*Matches*: 1325 *Competition*: Spanish Futsal League between the 2010~2015 seasons	Competition Match location Opposition quality Match status Time period	• Teams created more goals when playing at home than away. • Teams created more goals when losing than drawing and winning.
Page, L., & Page, K. (2007). The second leg home advantage: Evidence from European football cup competition	*Matches*: 12364 *Competition*: UEFA Champions League in the 1955-2006, UEFA Cup in the 1971-2006, Inter-cities Fairs Cup in the 1955-1971 and Winner Cup in the 1960-1999 seasons	Match location Competition	• All competitions exhibited a home advantage. • Home teams had a higher winning percentage in the second leg compared to the first.
Paixao, P., Sampaio, J., Almeida, C. H., & Duarte, R. (2015). How does match status affects the passing sequences of top-level European soccer teams?	*Matches*: 20 *Competition*: UEFA Champions League in the 2008/09 season	Match status	• Teams used more long passing sequences when losing or drawing than winning but more short passing sequences when winning than drawing or losing.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Pratas, J. M., Volossovitch, A., & Carita, A. I. (2016). The effect of performance indicators on the time the first goal is scored in football matches	*Matches*: 240 *Competition*: Portuguese Premier League in the 2009/10 season	Opposition quality Time period	• When teams scored first, teams won 70% of matches. • Home teams scored first in 57.5% of matches, resulting in a 75% winning percentage whilst away teams scored first 42.5% of the time, resulting in a 62% winning percentage.
Pollard, R. (1986). Home advantage in soccer A retrospective analysis	*Matches*: not given *Competition*: MLB, NFL, NHL, NBA, NASL, FL, County Championship	Match location	• Home teams had more than a 50% winning percentage (baseball: 53.6%, US football: 55%, ice hockety:59.9%, basketball: 63.3%, US soccer: 65.2%, cricket: 56.1%, England soccer: 64.9%). • Derby matches had a greater home winning percentage than normal matches (between 63.2~67.9%). • Low division matches had greater home winning percentage than high division matches (division1:63.3%, division2: 64.1%, division 3: 64.8%, division 4: 65.5%).
Pollard, R. (2006). Worldwide regional variations in home advantage in association football	*Matches*: not given *Competition*: not given	Match location	• Home teams had a greater than 50% winning percentage from 72 domestic leagues all over the world (except one league: Andorra 48.87%).
Pollard, R. (2008). Home advantage in football: A current review of an unsolved puzzle	Qualitative	Match location	• Presented 8 causes for home advantage (crowd, travel, familiarity, referee bias, territoriality, special tactics, rule, psychological factors).

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Pollard, R., & Armatas, V. (2017). Factors affecting home advantage in football World Cup qualification	*Matches*: 2040 *Competition*: Continental qualification games for the 2006, 2010, 2014 FIFA World Cups	Match location	• Africa teams had the greatest home winning percentage (69.6%) with European teams the lowest (56%). • Teams earned an average of 15 points more at home than away.
Rampinini, E., Coutts, J., Castagna, C., Sasso, R., & Impellizzeri, F. M. (2007). Variation in top level soccer match performance	*Matches*: 34 *Competition*: UEFA European Champions League, National Cop, National League	Time period	• Players covered more distance, high intensity running distance and very high intensity running distance in the first half than second half.
Redwood-Brown, A., O'Donoghue, P., Robinson, G., & Neilson, P. (2012). The effect of score-line on work-rate in English FA Premier League soccer	*Matches*: 5 *Competition*: English Premier League in the 2007/08 season	Score-line Time period	• There were no differences for work-rate when teams were drawing, losing and winning.
Rein, R., & Memmert, D. (2016). Big data and tactical analysis in elite soccer: future challenges and opportunities for sports science	Qualitative	Match location Opposition quality Match status Competition Weather	• Notational analysis traditionally ignored contextual variables (historical data, external and individual parameters). • Big data technologies will be the potential solution to combine various date sources.
Sarmento, H., Marcelino, R., Anguera, M. T., CampaniCo, J., Matos, N., & LeitAo, J. C. (2014). Match analysis in football: a systematic review	Qualitative	Match location Opposition quality Match status Time period Competition	• Majority of papers considered situational variables e.g. match location, opposition quality and match status. • Lack of operational definitions for situational variables.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Sánchez, P. A., Garcia-Calvo, T., & Leo, F. M. (2009). An analysis of home advantage in the top two Spanish professional Football Leagues	*Matches*: 20912 *Competition*: Spanish two top divisions between the1980/81 ~ 2006/07 seasons	Match location Competition	• There were no differences between the first and second divisions. • Home advantage decreased after the 3-point system introduced.
Santos, P., Lago-Peñas, C., & Garcia-Garcia, O. (2017). The influence of situational variables on defensive positioning in professional soccer,	*Matches*: 13 *Competition*: not given	Match location Opposition quality Match status	• Teams recovered the ball more when playing at home than away. • Teams recovered the ball more when playing against similar teams than top teams. • Teams recovered the ball more when drawing than winning and losing.
Seckin, A., & Pollard, R. (2008). Home advantage in Turkish professional soccer	*Matches*: not given *Competition*: Turkish Super League between the 1994/95 ~ 2005/06 seasons	Match location	• Home teams won 61.5% of matches. • Home teams had more shots, shots on targets, passes, tackles, fouls and less yellow and red cards compared to away teams.
Sgro, F., Aiello, F., Casella, A., & Lipoma, M. (2017). The effects of match-playing aspects and situational variables on achieving score-box possessions in Euro 2012 Football Championship	*Matches*: 31 *Competition*: European Championship in the 2012	Match location Opposition quality Match status Time period Competition	• Teams had more score-box entries during the second half (31%) than the first half (26.7%). • Teams had more score-box entries when losing (30.6%) than winning (28.8%) or drawing (28%). • Teams had more score-box entries in the group stages (29%) than the knockout stages (28.2%).

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	Sample	Reliability and Statistic	Main Findings
Taylor, J. B., Mellalieu, S. D., James, N., & Shearer, D. A. (2008). The influence of match location quality of opposition and match status on technical performance	*Matches*: 40 *Competition*: Domestic League in the 2002/03 & 2003/04 seasons	Match location Opposition quality Match status	• Teams had more shots and crosses and less tackles and interceptions when playing at home than away. • Interaction of match location and match status influenced the frequency of tackles and losses of control.
Taylor, J. B., Mellalieu, S. D., James, N., & Barter, P. (2010). Situation variable effects and tactical performance in professional association football	*Matches*: 47 *Competition*: Domestic League	Match location Match status	• Teams had more passes when losing than winning or drawing.
Thomas, S., Reeves,C., & Davies, S. (2004). An analysis of home advantage in the English football Premiership	*Matches*: not given *Competition*: First division between the 1984~1992 seasons and English Football Premiership between the 1992~2003 seasons	Match location	• Home teams won 62.1% of matches in the 1984-1992 seasons in the first division of the football league and 60.7% in the English Premier League between 1992-2003 seasons.
Tucker, W., Mellalieu, D. S., James, N., & Taylor, B. J. (2005). Game location effects in professional soccer: A case study	*Matches*: 30 *Competition*: English Premier League in the 2004/05 season	Match location	• Home teams won 60.2 to 64% of matches. • Teams had more corner kicks, successful aerial challenges, crosses and dribbles when playing at home than away. • Teams had more interceptions, aerial challenges, clearances and goal kicks in the defensive area when playing away than home.

Table 2.7 Summary of situational variables literature in football (contd.)

Reference	**Sample**	**Reliability and Statistic**	**Main Findings**
Vogelbein, M., Sopp, S., & Hokelmann, A. (2014). Defensive transition in soccer – are prompt possession regains a measure of success? A quantitative analysis of German Futball-Bundesliga 2010/2011	*Match number*: 306 *Competition*: German Bundesliga in the 2010/11 season	Opposition quality Match status	• Teams had more time to recover ball possession when winning than drawing or losing. • Top teams recovered ball possession quicker than bottom or in between teams.

2.5 RELIABILITY IN PERFORMANCE ANALYSIS IN SPORT

Operational definitions are precise rules to determine how an event is categorised. For example, a "short" pass can easily be mistaken for a "long" pass if strict rules to differentiate the two types of pass are not used. James (2006) suggested that some notational analysis studies lacked precise operational definitions which meant it likely that some event codes were incorrect. If this was the case, then any statistical analyses would be based on incorrect data and therefore, to some extent, erroneous. Williams (2012) examined 278 PA papers to explore problems associated with operational definitions and found that 22.1% of papers did not provide operational definitions and 16.8% provided unclear or vague definitions. This finding confirms the problem identified by James (2006) but it might be the case that publishing rules exacerbate the situation whereby operational definitions were not included in manuscripts due to word count limits rather than not being explicitly used. Mackenzie and Cushion (2013) also found that 79% of football PA papers did not fully define variables and 31% provided no operational definitions. As Williams (2012) stated, data is not useful unless it has been collected using clearly defined operational definitions. However, even with robust data collection methods, mistakes are still likely to be made, and therefore error checking methods are required prior to analysis.

The possibility that data collection errors can occur is primarily due to the reliance of human input although automated processes are now more commonplace e.g. computer vision techniques (e.g. Perš, Kristan, Perše, & Kovačič, 2008). James et al. (2002) suggested that three types of error (operational, observational and definitional) could happen during data collection. James (2006) also suggested that any systematic mistake reduces the validity of the analysis with this kind of error typically a consequence of misinterpreting the operational definitions. He further suggested that poor or vague definitions contribute to the analyst coding events incorrectly. O'Donoghue (2004) suggested that operational definitions have to be understandable as well as adhering to a 'gold standard' which means they are precise and contain no ambiguity so that any event can only be coded in one category. James et al. (2007) suggested that a 'gold standard' coding of an event would be achieved if a match had been analysed using freeze frame and replay functions to discuss events between analysts and experts and would thus be deemed to be as correct as possible. In practice this would occur at least once to compare the normal coding procedures against and thus have an idea of how accurate normal practice was.

The extent to which events are coded accurately for both applied and academic practice are routinely assessed through some form of reliability measurement (Bartlett, 2001). Reliability has been defined as the consistency of measurements made using an analysis system over time and is considered synonymous with repeatability (Wilson & Batterham, 1999). However, whilst a majority of researchers have used reliability tests there has been some debate regarding the appropriateness of tests used. In a special edition of the Journal of Performance Analysis of Sport (2007) papers were presented on different reliability tests with debate on the appropriateness of each. The consensus opinion was that the data type fundamentally determined the correct test with the agreement of the recommendation that the reliability assessment should be at the same level as the subsequent data analysis (Hughes, Cooper & Nevill, 2002).

2.6 RATIONALE FOR THESIS

This chapter has identified the achievements and limitations of the relevant previous research to establish new methodologies for classifying the attacking process of football teams. Previous literature attempted to distinguish different playing styles usually describing two distinct methods ‘possession play’ and ‘direct play’. These were based on match statistics such as the number of long passes made. However, the weakness in this research was that the authors did not distinguish “how” the different attacking procedures evolved i.e. how the process of goal scoring manifests itself. James et al. (2012) analysed the goal scoring process in terms of how teams attempted to create goal scoring opportunities. This research considered the game state to change from a stable (no advantage to either team) to unstable (one team had a goal scoring opportunity). Since this research did not consider the different types of unstable situation that arise in football the first study attempted to define reliable and valid mutually exclusive unstable situations. These were defined as situations where one team had a potential goal scoring opportunity (as used by James et al., 2012). Operational definitions for each unstable situation were written, modified and finalised through exhaustive testing before validation by expert coaches and reliability testing.

In order to fully encapsulate the attacking process, the second study considered possession from the stable situation, where no team had an advantage, through to the defined unstable situations developed in study 1. This study identified how a team can gain possession, how the game state transitions between stable, advantage and unstable situations which enabled the identification of how teams develop their attack.

In the final study, a case study of all Crystal Palace possessions over a full season were categorised and analysed, taking into account the situational variables, match venue, opposition quality, match status and key player appearance. The interactional effect of these situational variables was assessed to provide an ecologically valid assessment of this team’s attacking process.

2.7 AIMS AND OBJECTIVE OF THESIS

The aim of this thesis were:

1. **Determine unstable game states to aid the identification of perturbations in football**

   Related objectives:

   - Establish reliable operational definitions for unstable situations
   - Assess validity of the unstable situations using professional coaches and analysts
   - Analyse unstable situations for three different quality teams

2. **Create a taxonomy of the attacking process in football**

   Related objectives:

   - Determine the ways in which a team transitions from the start to end of a possession
   - Categorise the attacking process into stable, advantage and unstable situations

3. **Describe the attacking process for one football team over a whole season considering the influence of situational variables**

   Related objectives:

   - Analyse all possessions to enable a comprehensive evaluation of the attacking process
   - Use Poisson log-linear regression to examine the influence of situational variables on the attacking process
   - Analyse the interactional effects of situational variables on the attacking process

CHAPTER 3

STUDY 1. DETERMINING UNSTABLE GAME STATES TO AID THE IDENTIFICATION OF PERTURBATIONS IN FOOTBALL

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3.1 INTRODUCTION

Mackenzie and Cushion (2013) suggested that numerous research papers have contributed to the development of sport's performance analysis although many have been criticised for both methodical and conceptual concerns (see also Hewitt et al., 2016). For example, James (2006) suggested that some notational analysis studies lacked precise operational definitions which are likely to make some event codes incorrect. Mackenzie and Cushion (2013) found that 79% of papers did not fully define variables and 31% provided no operational definitions, the majority of performance analysis research had adopted a reductionist approach which considers only selected events such as number of shots or pass success rates for analysis and that variables had been measured because of availability rather than to develop a deeper understanding of performance. Football is a complex sport involving many players and different situations and it is not plausible that a reduced set of action variable can consistently predict the game result with the exception of goals scored, which is both obvious and uninformative. However, common findings such as winning teams created significantly more shots, higher pass accuracy or ball possession compared to losing teams are pervasive in the extant literature (e.g. Hook & Hughes, 2001; Stanhope, 2001; Jones et al., 2004; Hughes & Churchill, 2005; Hughes and Franks, 2005; Lago et al., 2010; Lago et al., 2011). James (2009) suggested the obvious problem associated with this type of study was that simply analysing outcome measures (performance indicators, Hughes & Bartlett, 2002) cannot provide meaningful information for improvement of performance without an understanding of the processes undertaken to achieve these outcomes. Furthermore, the way in which these processes take place are likely to depend on the moment of the match i.e. established attack, offensive transition or set pieces (Hewitt et al., 2016).

The dynamical systems perspective has been suggested as a different methodological approach to analysing sports performance where the whole performance is considered. This approach considers the behaviours of all participants, as opposed to selected events, and how their interactions determine game outcomes (McGarry et al., 2002). Intuitively, this approach seems well suited to the analysis of football, the anthesis of the reductionist approach, although squash was the first sport to be analysed. McGarry et al. (1999) showed 60 rallies from the 1988 Men's Canadian Open Squash Championship to six expert and six non-expert squash coaches and asked them to identify when rallies changed from a stable situation, defined as neither player having an advantage over the other, to an unstable one where one player had an advantage. The coaches could reliably identify the shot which occurred between these two hypothesised game states although occasionally either one of two consecutive shots were identified. The authors suggested that this transition point could contain a perturbation, described "as an event which caused the change in game state", in this case 85% were identified as strong or weak shots.

The idea that sporting events could display both unstable and stable situations is intuitively appealing as it seems sensible that when a team has a goal scoring opportunity the defending team would be in an unfavourable situation and hence attempt to rectify the situation i.e. goal scoring opportunities are preceded by instability in the balance of the team's behaviours (Frencken et al., 2012). The concept of these two game states is therefore pretty simple to understand and logically valid.

However, the term perturbation, the theoretical precursor, or cause, of the unstable situation is less obvious. McGarry et al. (1999) did not attempt to determine what a perturbation was, or could be, rather they presented the case for stability and its antithesis, instability. Roddy et al. (2014) investigated perturbations during critical incidents in squash i.e. the last three shots played in rallies that were won. Perturbations were deemed to have occurred if the rally loser was out of position when playing the shot immediately prior to the opponent playing a winner. This is different to McGarry et al.'s (1999) view, who suggested that perturbations could be "smoothed out" i.e. stability in the rally maybe regained after a perturbation had caused instability.

The relatively recent advent of player and ball tracking in football has allowed researchers to utilise a dynamical systems approach to better understand the complex relationships between players. For example, Vilar et al. (2013) assessed defensive stability and attacking opportunities in relation to ball and player location changes. Using one match played in the 2010 EPL season the net team numerical advantage was calculated frame by frame using Shannon's entropy as a measure of uncertainty. Similar studies in football have considered, for example, the positional centroid of a team as (a precursor to critical events; Frencken, et al., 2012) or (a measure of tactical behaviour; Sampaio & Maçãs, 2012) and the speed of contraction or expansion of the team surface area (to measure team organisation; Moura et al. 2013). These types of study have been reviewed by Memmert et al. (2017).

James et al. (2012) analysed perturbation attempts in football, events which either caused (or were part of) a change in game state (perturbation) or didn't (not a perturbation). They described these actions as ones whose purpose was to create instability i.e. a goal scoring opportunity. They further defined a stable situation as when neither team had an imminent goal scoring opportunity. An attempt to create a goal scoring opportunity e.g. a pass into the penalty box, would be successful if an attacker was then in a position to score a goal (an unstable situation). This could be described as a perturbation although the explanation for the perturbation would not be simply the pass, it would also include the ball receiver as well as potentially other factors such as defenders out of position etc. Using the same example, if the attacker was unable to kick the ball e.g. a defender intercepted the ball, the situation would remain stable and therefore the perturbation attempt deemed unsuccessful i.e. there was no perturbation. Eight matches resulted in an average of 78 perturbation attempts per match with passes accounting for the highest frequency (home = 63.4%, away = 56.15%) with the home team attempting to create perturbations more frequently when drawing (1 attempt every 1.71 minutes) than winning (2.08 minutes) or losing (2.20 minutes).

Link et al. (2016) used player and ball tracking data to quantitively determined the probability of a goal being scored, named “dangerousity”. Using the position of the player in possession of the ball, ball speed, defensive pressure and defensive organisation the authors effectively provided a measure which could be useful in the classification of an unstable situation. They performed a validity test using three semi-professional football coaches who rated 100 game situations in terms of danger (1 little danger to 5 very dangerous). The degree of agreement between coaches, and between coaches and the algorithm, suggested that observers can evaluate the extent to which a goal scoring event could occur and the basis of this is measurable using player and ball positions.

The aim of this paper was, therefore, to define unstable game states to aid the future identification of perturbations in football. Whilst previous papers have attempted to identify perturbations, there were no operational definitions for stability, instability or perturbations, with consequent subjectivity for determining these events. If unstable, and therefore stable situations, can be reliably differentiated, then the identification of perturbations is more likely since match data can be reduced to only include relevant periods. This methodology may also aid future quantitative studies using player and ball positions to determine goal scoring threat.

3.2 METHODS

3.2.1 SAMPLE

Three English Premier League teams were selected by opportunity sampling from commercially broadcast footage of the 2015-16 season. The first 14, and final 5 weeks of the season were excluded because league positions can be unrepresentative of playing standard at the start of the season and potentially affect match performance at the end of the season. Each selected team played 6 different opponents, balanced for quality based on league position at the time the match was played (1-6=top, 7-14=middle, 15-20=bottom) and venue (home and away).

3.2.2 CREATING VALID OPERATIONAL DEFINITIONS FOR UNSTABLE SITUATIONS

James et al. (2012) defined an unstable situation as where one team had a potential goal scoring opportunity. This was used as a basis for operationally defining different situations that the researchers felt fulfilled this criterion. Subsequently, after watching many goal scoring situations and opportunities from the start of possession, five mutually exclusive situations were identified that were relevant to creating a goal scoring opportunity i.e. unstable situation. Whilst more than one of these situations could occur in a single possession only the first one that occurred was used to classify the situation. Operational definitions were then created for each situation and their validity assessed in the following test.

Thirty video clips were edited such that some contained situations deemed unstable by the researchers (3 examples of each of the 5 situations) and some not deemed unstable (n=15). The clips were shown to 4 professional football coaches and 2 performance analysts. All coaches and analysts had more than 5 years coaching experience and were currently employed at an English Premier League club. They were briefly instructed as to what the researchers considered to be an unstable situation i.e. a potential goal scoring opportunity and then independently viewed each clip, with the opportunity to watch on more than one occasion, before deciding whether the situation was stable, unstable or they were not able to decide. They were also asked to explain the reasons for their decisions. At the completion of this process, a discussion between the first researcher and the coach/analyst was undertaken with a view to clarifying differences of opinion such that the five operational definitions of different 'unstable situations' could be modified if necessary so that all definitions met the approval of all coaches, analysts and researchers. The final definitions were:-

- Penalty Box Possession **(PBP)**

> "Having possession of the ball inside the penalty area with the possibility to shoot, pass or dribble"

This category of unstable situation was a consequence of the ball location, namely that the close proximity of the goal meant that a goal threat was highly likely. This situation arose when a played dribbled into the box, received a pass or regained the ball from an opponent. Whilst this situation could vary in terms of goal threat, a scoring opportunity was either immediate or imminent unless the defending team were in position to prevent the player in possession of the ball from doing anything. This definition was modified to include the caveat that opposition defenders could prevent a goal scoring opportunity when a player had possession inside the penalty box after all coaches disagreed that one of the PBP video clips was unstable because the defenders had prevented the player in possession any opportunity to do anything with the ball. All agreed that the other two PBP clips were unstable situations.

- Counter Attack **(CA)**

> "When a team regained possession and quickly moved the ball forwards, resulting in the opponent's defenders having to quickly reorganise from an un-organised position"

This category of unstable situation was a consequence of the situation, namely that a sudden change in circumstances has put the defending team in a critical moment. Counter attacks are a well-known feature of football although a precise definition is less available (sometimes referred to as transitions; Hewitt, Greenham, & Norton, 2016). This definition did not specify where on the pitch the ball was regained as different areas including both halves were often considered in this category. The consistent aspects in counter attacks were the speed at which the ball was played forwards toward goal and the need for defenders to run fast to try to get into good positions (reorganise). On the three video clips shown to coaches and analysts there were 17 agreements (out of the 18 responses).

- Ratio of Attacking to Defending players **(RAD)**

> "The attacking team had a greater or equal number of players, compared to the defending team, between the ball and the opponent's goal line as long as the number of active defenders was less than 5"

This category of unstable situation was also a consequence of the situation i.e. a sudden change in circumstances has put the defending team in a critical moment e.g. a successful pass through a defensive line (Link et al., 2016). When classifying opposition players as defenders it is usual to only consider players behind, or in line, with the ball since the other players are effectively unable to influence the attack. These defending players are under the most pressure when their numbers are low because of the space they need to defend. Hence, we determined that in situations where less than 5 defending players were trying to defend against the same or more attackers the situation was deemed unstable. The coaches and analysts made 17 agreements (out of the 18 responses) on these video clips and verbally agreed this classification.

- Successful Cross **(SC)**

> "A long pass from a wide area into, or close to, the penalty box, where a) the first touch by a team mate had a chance of scoring a goal, b) the team mate failed to touch the ball even though the cross provided the scoring opportunity or c) the quality of the pass caused the defender to undertake a high risk defensive action playing the ball towards his own goal"

This category of unstable situation was a consequence of an action i.e. a stable situation could be changed to unstable as a consequence of a good pass even though the defensive formation sometimes remained well organised and seemingly stable. Only a successful cross could achieve instability as a cross that was headed away by a defender, saved by the goalkeeper or did not have any chance of being met by an attacker could not induce any problems for the defending team. Sometimes the receiving player did not make contact with the ball e.g. he mistimed his jump, but the cross was still deemed successful if the failure was deemed to be the receiver fault rather than the passing player. The third situation where a defender undertook a high-risk defensive action i.e. playing the ball towards his own goal, the classic own goal situation, accounted for the pressure placed on the defending team even though they could touch the ball before the attacking team. The coaches and analysts made 12 agreements (out of the 18 responses) on these video clips. Two coaches agreed with the operational definition but considered that when the defensive players were well organised they (the players) considered the situation stable. They explained that, in their opinion, some teams preferred to allow crosses, rather than other types of play, because of their strength in defending crosses. They considered this to be different for different teams but responded to the video clips shown using their logic (defensive perspective) as opposed to our logic (offensive threat). On this basis the operational definitions were unchanged as this opinion was not shared by the other participants or researchers.

- Successful Shot **(SS)**

> "When the situation was stable i.e. there was no clear goal scoring threat as the defence was well organised, a sudden shot which had the potential of scoring instantly changed the situation to unstable"

This category was a consequence of a shot i.e. a stable situation could be changed to unstable as a consequence of a good shot even though the defensive formation was well organised and seemingly stable. Occasionally, a player may decide to shoot, either when there are no other options or because he thinks there is a small chance of scoring. The coaches and analysts made 15 agreements (out of the 18 responses) on these video clips and verbally agreed this classification. Some coaches considered the defence had been successful in allowing this type of shot because of the very low chance of success.

3.2.3 PROCEDURE

Matches were viewed on SportsCode Elite v10.3.36 and Apple Movist v1.3.6 to facilitate coding using full screen, pause, replay and slow motion. Each unstable situation was notated for team, time, unstable category (PBP, CA, RAD, SC, SS), outcome (no shot, shot on target, shot off target, goal), venue (home, away) and opponent quality (against top, middle, bottom teams).

On some occasions a single team possession could include more than one unstable situation category e.g. a counter attack could result in a penalty box possession. If the unstable situation did not revert back to stability the classification of the instability was always the first one that occurred. However, if the situation did revert back to stability the two (or more) unstable situations were recorded as separate events. This methodical procedure allowed the identification of the time at which an unstable situation arose (t_u, Figure 3.1) which, in most situations would be preceded by a stable situation, during which time the literature suggested a perturbation occurred i.e. to create the unstable situation.

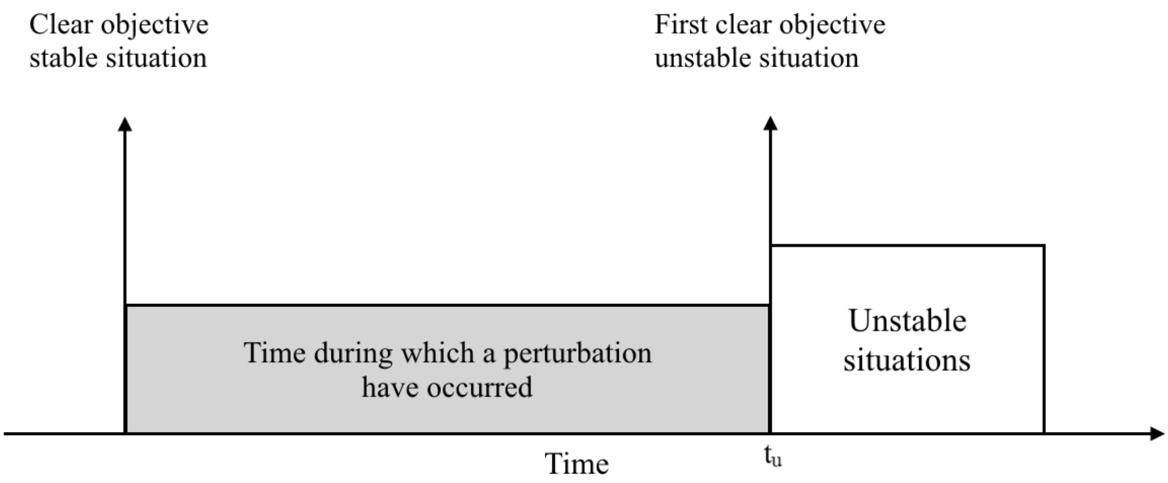

Figure 3.1 The timeline of unstable situations arising from periods of stability

3.2.4 RELIABILITY

Reliability tests were performed at the level of data analysis i.e. to determine whether unstable situations (n=5) and outcomes (n=4) were reliably categorised using intra- and inter-observer tests (James, Taylor, & Stanley, 2007). Three randomly selected matches were re-coded by the researcher (over 4 weeks after the initial coding to negate memory effects) and an independent football expert (15 years' experience) who was trained on the operational definitions but not used for the validity assessment.

Unstable situations (PBP, CA, RAD, SC, SS) had high Kappa values for intra-operator (0.98, n=161, Appendix 3.2.1) and inter- (0.93, n=162 comparisons, Appendix 3.3.1) tests. Discrepancies tended to occur when an analyst missed an event (n=7 and n=2 respectively) rather than incorrectly classifying events (n=2 and n=0 respectively). Also, outcomes (no shot, shot off target, shot on target, goal) had high Kappa values for and intra- (0.95, n=80, Appendix 3.2.2) and inter- (0.95, n=79 comparisons, Appendix 3.3.2) due to an analyst missing an event (n=2 and n=2 respectively).

3.2.5 STATISTICS

Data were analysed in IBM SPSS (v25, IBM Corp) to determine non-normality and outliers ensuing that median and interquartile range values were presented for unstable situations and outcomes. A Kruskal-Wallis H test determined differences for matches against different quality teams (top, middle, bottom) and a Mann-Whitney U for venue (home and away).

3.3 RESULTS

Teams created a median of 26.5 unstable situations (IQR=15.5) per match, resulting in 13.5 (IQR=8.0) shots and 1 goal (IQR=2.0). The three teams created unstable situations in a similar pattern (chi-square=11.6, df=8, p=0.17, Cramer's V=0.11; Figure 3.2, Appendix 3.4).

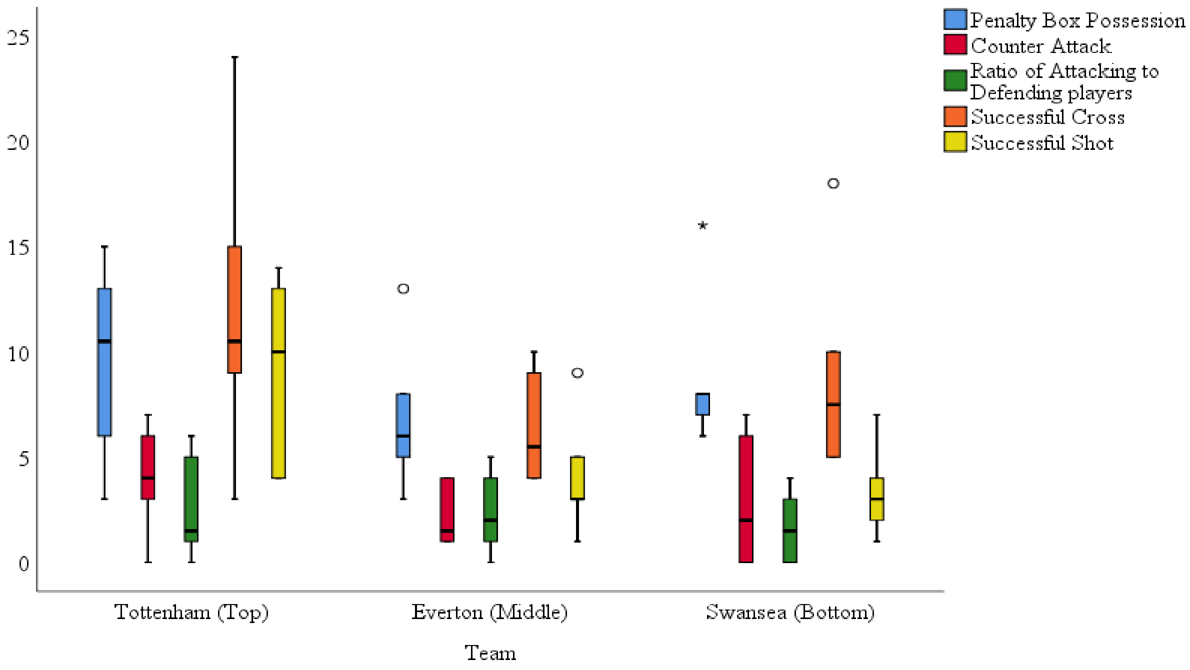

Figure 3.2 The frequency of unstable situations per match by three different quality teams

Home teams (Median=30.5, IQR=15.3) created more unstable situations (Mann-Whitney U=88.5, p<.05, Appendix 3.5) than away teams (Median=21.5, IQR=13.0; Figure 3.3). Teams also created less unstable situations (Kruskal-Wallis H=7.1, df=2, p<.05, Appendix 3.6) playing against top teams (Median=20.0, IQR=8.8) than when playing against middle teams (Median=28.5, IQR=16.0) or bottom teams (Median=30.5, IQR=8.5; Figure 3.3).

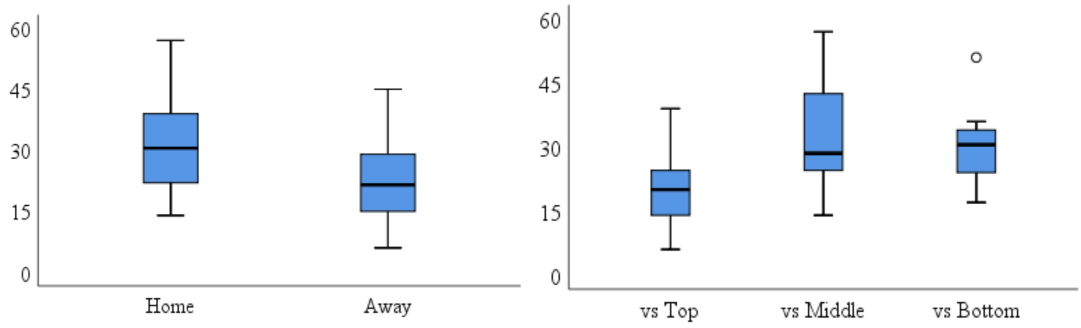

Figure 3.3 The frequency teams created unstable situations per match by venue and opponent team quality

3.4 DISCUSSION

An alternative approach to the reductionist method for analysing football has been proposed (Mackenzie & Cushion, 2013) with the dynamical systems approach favoured by some (e.g. Vilar et al., 2013). These studies have tended to focus on team formations, interpersonal distances and passing areas (Memmert et al., 2017) although recently player and ball locations have been used to quantify the likelihood of a goal being scored (Link et al., 2016) and whether team centroids relate to instability (Frencken et al., 2012). However, very small differences in player and ball positions, ball control etc. can have dramatic influences on whether an outcome is successful or not. This study attempted to classify goal scoring opportunities (James et al., 2012) according to location (penalty box possession), situation (counter attack, ratio of attacking to defending player) and action (successful cross, successful shot). These situations were identified following a rigorous process of defining, and subsequently amending following a validity test, operational definitions that distinguished the initial starting point of an unstable situation. Numerical measures of "dangerousity" were not computed but this would be an interesting next step as logically the advent of an unstable situation should correspond to a big increase in "dangerousity". Link et al. (2016) found this to be case e.g. for a successful pass through a defensive line, suggested to concur with the disruption of the balance between the defending and attacking teams Cf. perturbation, in concordance with the theory of dynamic systems (James et al., 2012).

This study provided valid definitions of unstable situations which can help researchers identify the critical periods of a match during which perturbations occur. The explanation for perturbations occurring in football is likely to be more complex than sports such as squash which only involve two players (McGarry et al., 1999). For example, whilst a successful pass through a defensive line was considered a perturbation (Link et al., 2016) the circumstances allowing the successful pass inevitably included off the ball runs by teammates and potentially incorrect positioning by some opposition players. These highly significant aspects of play tend to be overlooked by traditional on the ball analyses. The identification of unstable situations, therefore, has the potential of simplifying the analysis of football significantly, as researchers can focus on the critical moments rather than analysing the whole match. From a coaching perspective this is obvious, coaches want to know how teams create imbalances, as well as how to prevent them (personal comment by EPL coach during validity study).

The exemplar analyses of three teams of different standard (based on final league position) suggested that different teams will create unstable situations differently, due to the quality of the team, a by-product of the qualities of individual players. This, between team variability, is to be expected since differences in team tactics, to exploit the strengths of the best players, will inevitably be translated into patterns of perturbation formation, knowledge of which would logically be of great value to coaches. The frequency of unstable situations in this study also supported home advantage and opposition strength effects, hence increasing the validity of this measure as a performance indicator (Hughes & Bartlett, 2002).

3.5 CONCLUSION

Traditional analyses of football matches that consider isolated performance variables over full matches cannot reveal all the relevant factors that explain successful performance. However, the complexity involved when 22 players interact, particularly when very small differences e.g. control or lack of control of the ball, affect the outcome massively, is profound. Techniques to simplify and reduce an analysis are therefore essential if meaningful, and useful to coaches, results are to be achieved. Differentiating the moments of a match (Hewitt et al., 2016) and significant periods of play e.g. perturbations and unstable situations, are therefore paramount. This study has presented reliable and valid definitions of unstable situations in football, the significant periods of play which include or are preceded by perturbations. Future studies need to present a conceptual framework for analysing individual player, and playing position specific, actions that create instability along with objective measures of player and ball positions that substantiate the findings.

CHAPTER 4

STUDY2. THE ATTACKING PROCESS IN FOOTBALL: A TAXONOMY FOR CLASSIFYING HOW TEAMS CREATE GOAL SCORING OPPORTUNITIES USING A CASE STUDY OF CRYSTAL PALACE FC

CHAPTER 4: STUDY 2. THE ATTACKING PROCESS IN FOOTBALL: A TAXONOMY FOR CLASSIFYING HOW TEAMS CREATE GOAL SCORING OPPORTUNITIES USING A CASE STUDY CRYSTAL PALACE FC

4.1 INTRODUCTION

Football is an invasion sport with the main aim of breaking through an opponent's defence to score a goal. Since goal scoring is the key to being a successful football team (Wright et al., 2011), many previous notational analysis studies have concentrated on the measurement of scoring related indicators (Hughes and Bartlett, 2002). For example, Reep and Benjamin (1968) identified that 10 shots were needed for one goal and 80% of goals scored from less than 3 passes. Future goal scoring studies considered the impact of: the number of passes in a possession (Hughes & Franks, 2005), pitch area where goals were scored from (Yiannakos & Armatas, 2006), body part used (Muhamad et al., 2013), set-piece or open play (Muhamad et al., 2013), action prior to a goal (Michilidis et al., 2013) and time period (Armatas et al., 2009) on the number of goals scored. These studies measured the who, when and where goals were scored but neglecting, to some extent, the how but entirely the why.

Match analysis, from a coach's perspective in the applied world, will invariably focus on the why and how events occurred (Lames & McGarry, 2007) rather than the simple statistics prevalent in the research literature, the so called theory-practice gap (Mackenzie & Cushion, 2013). Mackenzie and Cushion (2013) critically reviewed performance analysis in football over five decades and suggested that a focus on key performance indicators was prevalent, based on availability rather than for developing a deeper understanding of performance. James (2009) also made the point that unless the processes undertaken to achieve outcomes are investigated then meaningful performance improvement information cannot be achieved. This academic perspective is quite different from the approach taken by coaches who plan training sessions following a comprehensive analysis of factors such as the opposition's strengths and weaknesses and attacking/defending playing patterns (Borrie et al., 2002), referred to as tactical analysis (Garganta, 2009). This process typically involves both the team being coached, and the forthcoming opponents, as it is the interaction between the two teams that coaches try to manipulate. From the theoretical perspective, Hewitt et al. (2016) suggested that identifying playing patterns (referred to as playing style), using more detailed analyses than evident in the literature, would impact training practices, and enable coaches and sport scientists to have a clearer understanding of what teams need to do in order to win. This view strongly advocates the analysis of the "developmental processes" involved prior to a team having goal scoring opportunities. This approach, therefore, requires a systematic breakdown of how teams develop ball possessions into goal scoring opportunities and goals, with the added benefit that this methodology would also enable recurrent patterns to be discerned, allowing the possibility of developing individual team profiles under different playing conditions.

Researchers have suggested that understanding playing patterns could help the development of tactical strategies to improve a team's performance (James et al., 2002; Tenga et al., 2015). Playing patterns have usually been divided into 'possession play' or 'direct play' through measuring the number of passes prior to goal (Reep & Benjamin, 1968; Bate, 1988; Hughes & Frank, 2005; Redwood-Brown, 2008) or duration of team possessions (James et al., 2002; Jones et al., 2004; Bloomfield et al., 2005; Lago & Martin, 2007; Lago, 2009; Lago-Peñas & Dellal, 2010). These studies suggested that playing patterns could be discriminated through a simple data selection process (Fernandez-Navarro et al., 2016) e.g. possession play determined for longer possession durations or number of passes. However, this approach does not allow for possessions which contain elements of different playing patterns. For example, a possession involving multiple passes between defenders in their defensive third of the pitch (generally regarded as possession play) followed by a long pass to an attacker in the attacking third (direct play) would simply be classified as possession play. Thus, this methodology has the potential for failing to classify possession types fully (if multiple possession types were nor classified) or correctly (if one possession type was deemed to supersede another).

Other studies measured multidimensional qualitative variables e.g. direction, type and distance of passes, location where possession started, speed of attack etc. to discriminate playing patterns (Tenga et al., 2010a, Sarmento et al., 2010; Tenga & Sigmundstad, 2011; Lago-Ballesteros et al., 2012; Sarmento et al., 2014). Kempe et al. (2014) calculated an index of offensive behaviours (positive values indicated possession play, negative values direct) to characterise playing patterns which included 11 parameters related to passing, direction, speed, accuracy, distance and player involvement. Recently, factor analysis was used to classify team playing style by grouping performance variables perceived to be relevant measures. For example, Fernandez-Navarro et al. (2016) clustered four possession features (direct/possession, cross/no cross, wide/narrow and fast/slow progression) that identified 8 different attacking patterns of play i.e. features that were not mutually exclusive but could present the propensity to utilise a particular attacking pattern. Similarly, Lago-Peñas et al. (2017) measured 20 variables to elicit 5 factors (possession, counter attack, set-piece, regaining ball and losing ball) where values for each factor discriminated how much each team utilised each specific playing pattern. Gomez et al. (2018) extracted 8 factors (ball possession, ending actions, individual challenges, counter attack, set-piece, transitional play, fouling actions and free-kick) and identified changes of team style according to the situational variables match location and team quality.

Although previous papers identified different team playing styles, based on overall match statistics, the authors have typically not distinguished the "how" different attacking procedures evolved e.g. how teams initiate or develop build-up play, progress attacks, create goal scoring opportunities. Some papers have tried to analyse the process of creating goal scoring opportunities by measuring pertinent performance variables such as possession start zone, penultimate action and finishing action (Mitrotasios et al., 2019; Gonzalez-Rodenas et al., 2019). However, these studies simply determined which areas or actions were most prevalent in goal scoring possessions. Kim et al. (2019a) suggested that different quality English Premier League (EPL) teams created unstable situations (defined as potential goal scoring opportunities) in different ways. Five specific potential goal scoring situations were identified according to pitch location, game situation or specific action using coach and analyst validated definitions. However, "how" these specific moments in the game arose remains unanswered.

Therefore, the aims of this paper were, 1) to establish a taxonomy of the different ways in which potential goal scoring opportunities (unstable situations) arise and 2) to provide a framework for identifying team profiles for attacking patterns of play. This will provide a rigorous methodology for players and coaches to collect information pertinent to identifying an opponent's attacking patterns. Additional information regarding individual player names (not used in this methodology) would thus generate the type of information appropriate to plan training sessions and game plans for upcoming matches.

4.2 METHODS

4.2.1 SAMPLE

All the league matches (n=38) played by Crystal Palace Football Club in the English Premier League in the 2017/2018 season were selected. All data, including video footage of the all matches, was officially provided by the football club. Ethical approval for the study was provided by the sports science sub-committee of Middlesex University’s ethics committee in accordance with the 1964 Helsinki declaration.

4.2.2 CREATING A TAXONOMY FOR THE PROCESS OF CREATING UNSTABLE SITUATIONS

This study describes the attacking process by differentiating stable, advantage and unstable situations (Figure 4.1). Each team possession could start by regaining the ball from the opponent, in any of these three situations or with a new possession i.e. a set piece (lines in Figure 4.1 indicate the start and progression of possessions).

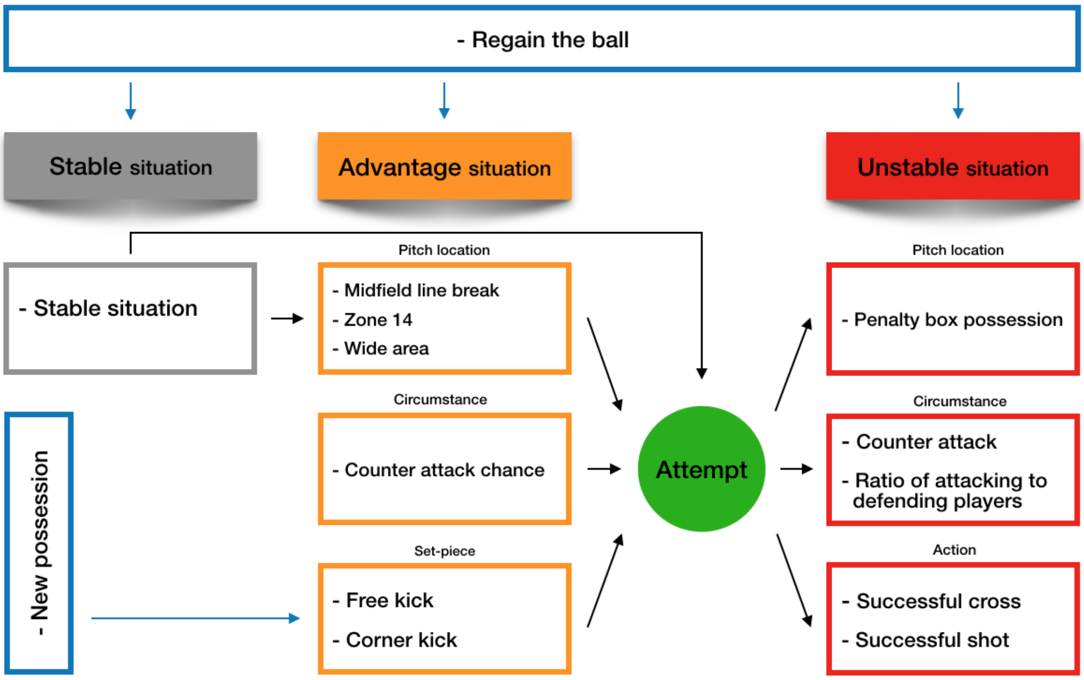

Figure 4.1 A framework for categorising the attacking process in football

Operational definitions were devised for each situation to enhance their reliability and validity. A stable situation was defined as a situation in which neither team had a clear advantage. This occurred when a team had possession of the ball in their middle or defensive third of the pitch and the opponents were in their normal positions with their midfield and defenders goal side of the ball.

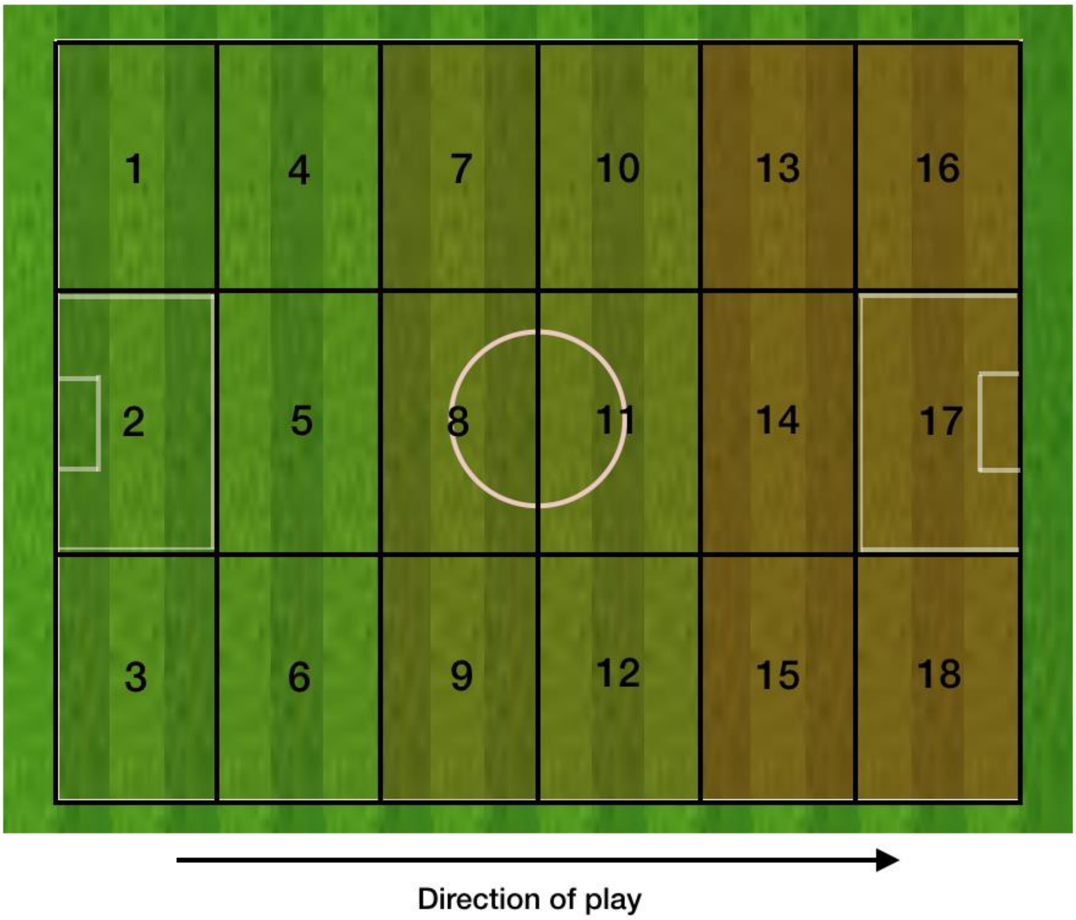

Figure 4.2 The pitch of play divided into 18 zones

The advantage situation was deemed to occur when the game state changed to one where the possibility of an unstable situation arising became clear. These situations arose when 1) a team in possession broke the opposition team's midfield line i.e. had possession between their midfield and defensive lines, 2) a team had possession in zone 14 (Figure 4.2), 3) a team had possession in a wide area of the final third of the pitch with the opportunity to pass, cross or dribble into the penalty box or shoot directly at the goal, 4) a team regained the ball and had the opportunity to counter attack, 5) free kick in position where a shot or cross was possible and 6) corner kick.

Unstable situations were previously defined by Kim et al. (2019a), who validated the five specific situations used here (Figure 4.1). Penalty kicks were excluded from both papers because penalties are the consequence of an attack and the kick deemed a new possession.

4.2.3 PROCEDURE

All matches were viewed and coded in SportsCode Elite v10.3.36, to enable time stamps for each advantage state and when unstable situations arose (see also Kim et al., 2019a). Apple Movist v1.3.6 was also used to facilitate coding due to ease of video manipulation.

On some occasions, a team in possession of the ball could be described in more than one category of advantage situation during a single possession. For example, if a team in possession in zone 14 switched the ball into a wide area, the two advantage situations were coded separately so that each specific situation was recorded. Similarly, different unstable situations could occur during a single possession. In this scenario, only the first unstable situation was coded because the aim of the study was to identify the moment the game state changed (stable to unstable) e.g. a counter attack could result in a penalty box possession situation but the latter was deemed irrelevant as there was no game state change between the counter attack and the penalty box possession. This could, however, be on interest to future analyses.

4.2.4 RELIABILITY

Intra- and inter-observer tests were performed to determine whether the advantage situations (n=6), unstable situations (n=5) and outcomes (n=3) were reliably categorised (James et al., 2007). The researcher (intra-, over four weeks after the first coding to nullify memory effects) and an independent experimenter (inter-, who was trained for each operational definition) re-coded three randomly selected matches using the same post-event coding procedure as outlined above. Advantage situations had high Kappa values for intra- (0.97, n=362 comparisons, Appendix 4.3.1) and inter-experimenter (0.86, n=372, Appendix 4.4.1). Discrepancies tended to arise when an experimenter missed an event especially wide area chances (intra=2 and inter=12). Also, Unstable situations had high Kappa values for intra- (0.94, n=138, Appendix 4.3.2) and inter- (0.87, n=146, Appendix 4.4.2). Discrepancies tended to arise when an experimenter failed to distinguish counter attacks (intra=3 and inter=8). Outcome had the same high Kappa value for both inter- and intra- (0.96, n=76, Appendix 4.3.3 and 4.4.3).

4.2.5 STATISTICAL ANALYSIS

All data were analysed in IBM SPSS 25.0. Descriptive statistics were performed to provide median and interquartile range values for advantage, unstable situations and outcomes as variables were skewed. A Kruskal-Wallis H test was used to determine statistical differences for each situation and Mann-Whitney U test used to compare playing at home and away. The level of significance set at $p<0.05$.

4.3 RESULTS

Crystal Palace football club created a median of 53.5 advantage situations (IQR=16.8), 40 attempts (IQR=11.3), 23 unstable situations (IQR=8.8), 12 shots (IQR=6.8) and 1 goal (IQR=2) per match (Figure 3). Most unstable situations developed from advantage situations (Median=20.5, IQR=7.8) with a few from possession regains in unstable situations (Median=2.5, IQR=2.8) and from stable situations which did not involve an intermediary advantage situation (Median=1, IQR=1.8) i.e. a long ball.

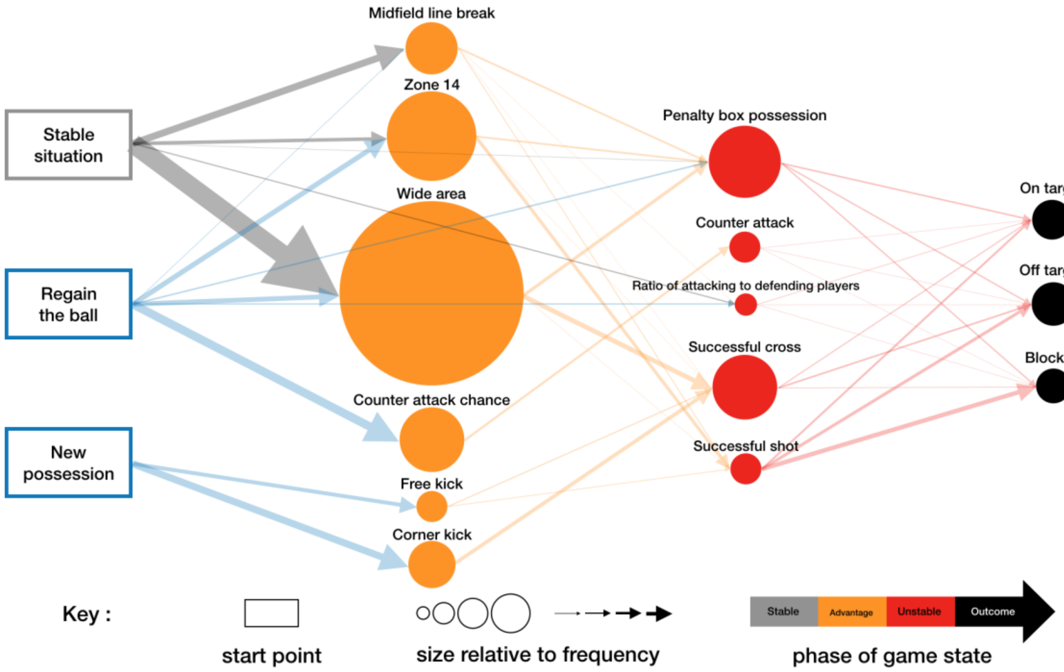

Figure 4.3 The attacking process network of Crystal Palace Football Club in 2017/2018 season

Crystal Palace created 21.5 wide area chances (IQR=9.8) per match, 41.4% of all advantage situations, which was significantly higher (χ^2=88.63, p<.05, Appendix 4.5.1) than the other five advantage situations (midfield line break- Median=5.5, IQR=5.0, zone 14- Median=10.0, IQR=5.0, counter attack chance- Median=7.0, IQR=5.0, free kick- Median=3.0, IQR=2.0, corner kick- Median=5.0, IQR=4.0). However, only 26.6% of wide area chances resulted in unstable situations, the lowest rate (χ^2=190.0, p<0.05, Appendix 4.5.6) compared to the others (Figure 4.4).

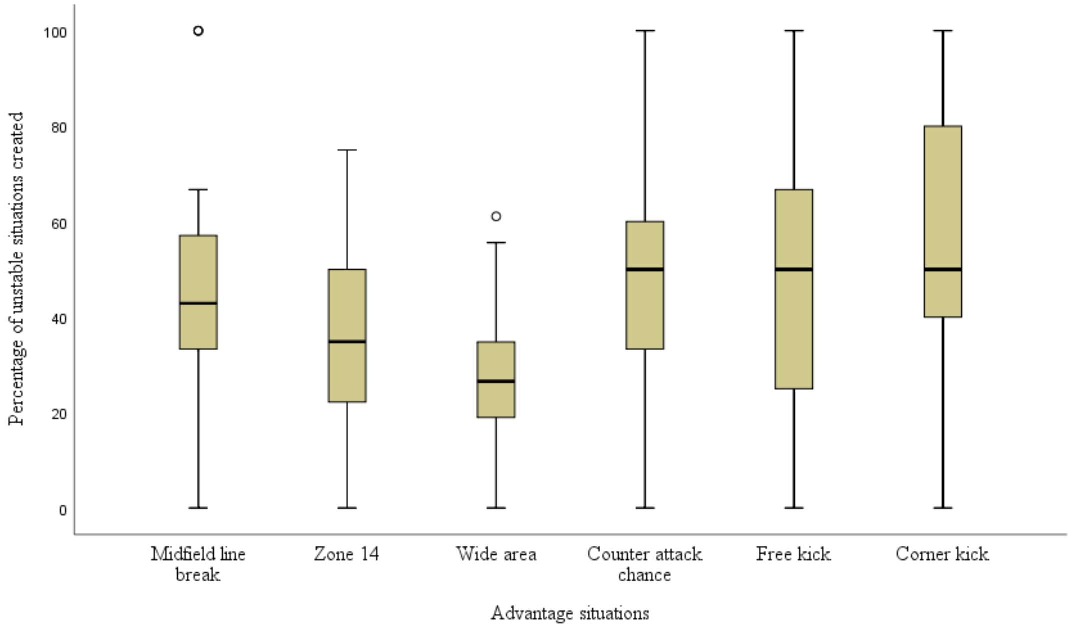

Figure 4.4 Percentage of unstable situations created from advantage situations

79.9% of unstable situations occurred from open play (Median=18.5, IQR=7.8) and 20.1% from set piece (Median=4.0, IQR=3.0). Unstable situations were most likely to be penalty box possessions (Median=8.0, IQR=5.0) or successful crosses (Median=7.0, IQR=4.5), accounting for 63.5% of all unstable situations (χ^2=54.0, p<.05, Figure 4.3, Appendix 4.5.2). Penalty box possessions occurred from midfield line break chances (Median=1.0, IQR=2.0), zone 14 chances (Median=1.0, IQR=1.0), wide area chances (Median=2.5, IQR=2.0) and regaining the ball directly in an unstable situation (Median=1.0, IQR=2.0).

Shots were most likely to occur from successful crosses (Median=3.0, IQR=2.5) and successful shot (Median=3.0, IQR=3.0) situations (χ^2=56.71, p<.05, Appendix 4.5.3) compared to the other unstable situations whilst shots on target occurred most frequently from successful crosses (Median=1.0, IQR=1.0) and penalty box possessions (Median=1.0, IQR=2.0) (χ^2=16.78, p<.05, Appendix 4.5.4). However, in terms of the rate of creating shots, the ratio of attacking to defending players was the most likely situation to result in a shot (48.8%, χ^2=57, p<0.05, Appendix 4.5.5), a shot on target (22.1%, χ^2=16.78, p<0.05, Appendix 4.5.4) and a goal (5.8%, χ^2=15.8, p<0.05, Appendix 4.5.7).

There were no significant differences for total advantage situations, unstable situations and shots (all P>0.05, Table 4.1, Appendix 4.6.1, 4.6.2 and 4.6.3) between playing at home and away. In detail, however, they created more penalty box possession unstable situations (P<0.05, Appendix 4.6.10) when playing at home (Median=10.0, IQR=5.5) than away (Median=7.0, IQR=4.0).

Table 4.1. Frequency of specific advantage and unstable situations by match location

Advantage situation						**Unstable situation**					
	Home		Away		p		Home		Away		p
	Med	IQR	Med	IQR			Med	IQR	Med	IQR	
MLB	5.0	4.0	6.0	5.5	0.67	PBP	10.0	5.5	7.0	4.0	0.02
Z14	12.0	6.0	9.0	4.0	0.05	CA	3.0	4.0	3.0	2.5	0.98
WA	26.0	10.5	20.0	6.0	0.75	RAD	2.0	6.0	2.0	1.5	0.64
CAC	7.0	6.0	7.0	4.0	0.15	SC	7.0	4.0	6.0	4.0	0.42
FK	3.0	3.0	3.0	1.5	0.18	SS	3.0	1.5	3.0	2.5	0.77
CK	5.0	2.5	5.0	4.0	0.95						
Total	59.0	14.0	51.0	12.5	0.10	Total	25.0	7.0	22.0	7.0	0.10

*MLB= Midfield Line Break, Z14= Zone 14, WA= Wide Area, CAC= Counter Attack Chance, FK= Free Kick, CK= Corner Kick, PBP= Penalty Box Possession, CA= Counter Attack, RAD= Ratio of Attacking to Defending players, SC= Successful Cross, SS= Successful Shot.

4.4 DISCUSSION

The identification of a team's playing pattern is highly likely to be beneficial to coaches and sport scientists as this would impact training methodologies as a consequence of having a clear understanding of what teams need to do in order to win (Hewitt et al. 2016). The academic literature, however, has often considered playing pattern as simply 'direct play' or 'possession play', determined by simplistic measures such as the number of passes (e.g. Reep & Benjamin, 1968; Bate, 1988) or duration of team possessions (e.g. Jones et al., 2004; Hughes & Franks, 2005). This classification has clear face validity, given that the terms are ubiquitous in the football media, but offer little insight to applied practice whose goal is performance improvement. This limitation has prompted more recent research to consider multidimensional qualitative variables (e.g. offensive behaviours, Kempe et al., 2014; and factor analysis, Fernandez-Navarro et al., 2016; Lago-Peñas et al., 2017; Gomez et al., 2018). Gonzalez-Rodenas et al. (2019) presented specific actions e.g. penultimate or finishing action and subspaces i.e. areas of the pitch involved in the play, prior to goals being scored. However, no information was provided regarding how teams developed their attacks e.g. midfield line breaks or counter attacks. Similarly, Mitrotasios et al. (2019) presented attacking categories i.e. counter, combinative, fast and direct attacks, but did not consider any further details such as pitch locations, players involved etc. These studies comprehensively described the different features associated with the attacking process but failed to produce a methodology of practical use for performance enhancement. It was this limitation that prompted this study i.e. the development of a classification framework of the attacking process in football, with the aim of providing a suitable methodology for applied practice.

Kim et al. (2019a) presented five specific situations that were described as unstable situations, more importantly defined as potential goal scoring opportunities. Of interest here was "how" one team achieved these in different situations. An analysis of all 38 matches in the 2017/2018 EPL suggested that the attacking process can be encapsulated by three different game situations, stable, advantage and unstable. These situations did not occur for every possession and the transition between situations was not uniform. Indeed, possession could originate in any of the situations with the way a team plays (playing pattern) likely to determine the frequency of each situation. For example, a team that employs the high press frequently is likely to win possession in an unstable situation more often than a team that does not.

In this study, 79.9 % of unstable situations occurred in open play situations, which was similar to the occurrence of penultimate actions leading to goals during open play (75.9%; Gonzalez-Rodenas et al., 2019). Crystal Palace were shown to frequently utilise the wide areas to progress their attacks which resulted in their goal scoring opportunities as a consequence of penalty box possessions and successful crosses. The corner kick was shown to be their most effective method of creating an unstable situation. It is widely perceived that Crystal Palace's best players operate in the attacking wide areas i.e. wingers, Wilfred Zaha and Andros Townsend. It was thus not surprising that these analyses showed the prevalence of attacks from wide areas. Similarly, fullbacks Wan-Bissaka and Patrick van Aanholt are recognised as the players who make passes to the wingers and support their play in the wide area. This paper did not include player names as the purpose was to generate a rigorous methodology rather than a specific analysis of a team. However, names of players would be utilised by teams adopting this approach given their requirement of producing a tactical game plan to defeat a future opponent. The emphasis of Crystal Palace's attacking play using the wide areas supports the notion that they do not have players like to hold onto the ball in midfield areas and build up play using good passes, hence low midfield line breaks and low zone 14 possessions.

Since this research developed a previous study by Kim et al. (2019a) no record was made of unstable situations that occurred subsequent to an initial one occurring during a single team possession. This meant that an accurate portrayal of all unstable situations was not possible. However, this extra information relates to how unstable situations sometimes develop and may provide additional information of value in the future. Similarly, the time during which events took place was not recorded. Temporal information may elucidate specific patterns e.g. Manchester City are well known for slow build up play i.e. the average time of their possessions in stable situations would be very different to a team like Leicester City who tend to focus on quick counter attacks. Time has also been shown to be useful in t-pattern analysis (Borrie et al., 2002) and would be a useful tool for further exploring this type of data. Other factors such as the number of passes, forward passes etc. were also omitted from this study, some of which have been used to discriminate playing patterns e.g. distance of passes (Tenga et al., 2010). Long passes are generally associated with direct play where defenders or midfielders pass to forwards near the opponent's defensive line. In this study these passes were classified as either counter attacks (regain the ball in advantage situation) or when situations changed from stable to unstable but bypassed the advantage situation. Hence, the playing patterns generally referred to as "possession" would typically involve transition from stable to midfield line breaks/zone 14/wide area to penalty box possessions. In contrast direct play would miss out some of these situations either by involving no stable situation or missing out the advantage situation.

This study analysed all matches from a season without considering well-known factors likely to influence performance. For example, match status, whether a team is winning, drawing or losing at the time and opponent quality have all been shown to influence performance. A simple analysis of the effect of match venue showed that Crystal Palace produced slightly more penalty box possession at home compared to away but this did not consider the other factors of importance. In future studies, these factors need to be investigated in a multi-factorial manner e.g. how does a team play when losing against a top rated opponent playing away. This classification framework also needs to be expanded to include individual player contributions if practically useful information is to be gained. Whilst academic literature tends to gravitate towards large data sets and statistical significance the usefulness of such an approach has been questioned for practically useful insights (Mackenzie and Cushion, 2013).

4.5 CONCLUSION

A novel methodology for classifying the attacking process in football has been presented with a view to providing a scientifically valid approach for use in the applied world. However, for this framework to be of practical benefit, future analyses need to consider contextual information in a multi-factorial manner. In this way teams can analyse their future opponents to determine how they create goal scoring opportunities during different scenarios, such as when their main striker is not playing.

CHAPTER 5

STUDY 3. THE INFLUENCE OF SITUATIONAL VARIABLES ON THE ATTACKING PROCESS IN FOOTBALL

CHAPTER 5: THE INFLUENCE OF SITUATIONAL VARIABLES ON THE ATTACKING PROCESS IN FOOTBALL

5.1 INTRODUCTION

In football, a better understanding of playing patterns would facilitate an improvement in a team's tactical performance (Tenga et al., 2015). Similarly, Hewitt et al. (2016) advocated that identifying playing styles would enable coaches to have a clearer understanding of what teams need to do in order to win. However, the term "playing style" had, until recently, been differentiated into the rudimentary measures 'build-up/possession' and 'direct/counter attack' plays. Furthermore, this research typically categorised playing patterns according to the number of passes (Reep & Benjamin, 1968; Bate, 1988; Hughes & Frank, 2005; Redwood-Brown, 2008) or duration of team possessions (James et al., 2002; Jones et al., 2004; Lago, 2009; Lago-Peñas & Dellal, 2010).

Recently, factor analysis has been used to discern more complex playing styles by grouping performance variables perceived to be relevant (Fernandez-Navarro et al., 2016; Lago-Peñas et al., 2017; Gomez et al., 2018). For example, Fernandez-Navarro et al. (2016) used 19 variables, which extracted 6 factors to determine whether teams used 1) direct or possession play, 2) crosses, 3) wide or narrow possessions, 4) fast or slow progressions, 5) pressure on wide or central areas and 6) exerted low or high pressure. Thus, Barcelona FC was regarded as a possession play team because they had a high value for factor 1 which loaded on the number of sideward passes, forward passes, average direction of passes, ball possession percentage and passes from the defensive to the attacking third. This type of study identified different playing styles but did not distinguish the “how” different attacking procedures evolved (Kim et al., 2019b).

Kim et al. (2019b) established a framework for categorising the attacking process to differentiate team playing patterns, this referred to the concept of an ‘unstable situation’, defined as a potential goal scoring opportunity in football by James et al. (2012). Kim et al. (2019a) defined and validated 5 different unstable situations from an analysis of all possessions in 18 English Premier League matches. Kim et al.’s (2019b) attacking process comprised three different situations, stable, advantage and unstable, which enabled the identification of the non-linear developmental attacking process through which teams created goal scoring opportunities. In this case study Crystal Palace Football Club, during the 2017/2018 EPL season, frequently utilised wide areas (advantage) to progress their attacks, mostly resulting in the unstable situations penalty box possessions and successful crosses. However, this study did not measure all possessions e.g. stable possessions that did not progress to the advantage situation were not coded, and hence probabilistic information regarding the success and failure of different situations was not possible.

Kim et al. (2019b) also suggested that future studies should consider all relevant situational variables e.g. match status and opponent quality, as this would generate useful information for the applied world. This reiterates Mackenzie & Cushion’s (2013) suggestion that football PA research had typically focused on trying to identify the relationship between performance indicators and match outcomes without providing sufficient context for the variables. Furthermore, Rein and Memmert (2016) suggested that contextual information e.g. external (match venue, kinds of competition, referee and weather), individual (tactical, physiological and technical condition) and historical parameters (opposition quality and current form) were required to understand the complexity of football team tactics.

Studies have identified the influence of situational variables on technical parameters e.g. teams created more shots, passes or longer possessions when playing at home compared to away (Gomez et al., 2012; Armatas & Pollard., 2014), playing against weak teams rather than strong teams (Taylor et al., 2008; Bradley et al., 2014; Liu et al., 2015; Kubayi & Toriola, 2019) and when losing compared to drawing or winning (Lago-Peñas & Gomez-Lopez., 2014; Sgro et al., 2017; Redwood-Brown et al., 2019). Similarly, physical parameters were also influenced by situational variables e.g. max speed, average speed and high-intensity activities were higher when playing at home, against strong teams or when winning (Castellano et al., 2011; Aquino et al., 2016; Redwood-Brown et al., 2018). So, whilst the influence of different situational variables has been shown for various performance parameters, the associated tactical changes which may have accounted for these differences have not. The question of what do teams change e.g. playing style, to facilitate different performance outcomes remains unanswered.

One situational variable, team quality, has been criticised (Carling et al., 2014) on the basis of how it has been derived. Team quality has typically been calculated using the end of season ranking to split teams into two (Aquino et al., 2016; Mao et al., 2017; Mendez-Dominguez et al., 2019), three (Almeida et al., 2014; Liu et al., 2015; Sgro et al., 2017) or four (Lago-Peñas & Lago-Ballesteros, 2011) levels. Carling et al. (2014) suggested this method could be considered arbitrary as teams could miss out on being classified as a strong team by just a few points, despite potentially having been in the top half of the table for the majority of the season. Another potential problem with this classification scheme is that end of season rank only reflects playing quality at the end of the season and does not account for within season fluctuations. This means that it may not be a very accurate quality measure at the time when a game was played, particularly for teams that have periods of relatively poor and good play and occupy different league positions during a season. Therefore, this study considered four different points per match measures (end of season points, previous season points, points gained during the season prior to match and points gained in the previous 5 matches).

The aim of this paper, therefore, was to 1) code all possessions, irrespective of outcome, to present probabilistic information of the attacking process, 2) examine the influence of relevant situational variables i.e. match venue, opposition quality, match status and key player appearance, and 3) consider the interaction of situational variables to identify whether a team changed their attacking strategy e.g. when losing without key player present. Each independent variable was operationally defined, using appropriate criteria developed from the limitations of some previous studies. This rigorous methodology will allow players and coaches to collect pertinent information to identify an opponent's attacking patterns under different conditions. This will enable the planning of appropriate training sessions and game models for match preparation.

5.2 METHODS

5.2.1 SAMPLE

Match data for all 38 Premier League fixtures of Crystal Palace Football Club in the 2017/2018 season were analysed. Ethical approval for this study was provided by the sports science sub-committee of Middlesex University's ethics committee in accordance with the 1964 Helsinki declaration.

5.2.2 VARIABLES

Four independent variables were used to identify the influence of 1) Match Venue (MV): home or away, 2) Opposition Quality (OQ): top, middle or bottom, 3) Match Status (MS): winning, drawing or losing and 4) Key Player (KP): Wilfred Zaha played or not. The level of opposition quality (OQ) was calculated using four different points per match measures i.e. end of season points (divided by 38), previous season points (divided by 38), points gained during the season prior to match (divided by the number of matches already played) and points gained in previous 5 matches (divided by 5). The average of the four measures was then classified into top (≥1.7), middle (>1.1 and <1.7), bottom (≤1.1). This measure sought to overcome problems associated with only using end of season ranking (e.g. Taylor et al., 2008; Almeida et al., 2014; Bradley et al., 2014; Liu et al., 2015) as suggested by Carling et al. (2014).

Thirteen dependent variables were used. The initial two models assessed the ability of Crystal Palace to achieve advantage and unstable situations. Further models assessed the 11 individual advantage and unstable situations (Midfield Line Break (MLB), Zone 14 (Z14), Wide Area (WA), Counter Attack Chance (CAC), Free Kick (FK), Corner Kick (CK), Penalty Box Possession (PBP), Counter Attack (CA), Ratio of Attacking to Defending players (RAD), Successful Cross (SC) and Successful Shot (SS)) as defined by Kim et al. (2019b).

5.2.3 STATISTICAL ANALYSIS

The number of minutes played per match, under different levels of match status (winning, drawing or losing) and key player's appearance (Zaha played or did not play) varied. Hence, dependent variables were normalised relative to the average total match minutes (95.3 minutes) for the 38 matches played i.e. (*dependent variable/minutes played under condition)*95.3*. To avoid errors due to unusual patterns occurring in small samples all performances involving less than 15 minutes were excluded.

Mean and standard deviation values were calculated for each attacking situation. Analysis of variance was used to assess the match status and key player interaction for the frequency of 11 attacking situations (6 advantage and 5 unstable) with simple main effects calculated when these were significant. All data were analysed in IBM SPSS 25.0 and the level of significance set at $p<0.05$.

Due to skewed data Poisson log-linear regression analyses were used to identify the influence of situational variables on the frequency of the 13 different attacking processes. Independent variables were changed to dummy variables where the criterion variable for match venue was home, opposition quality was middle team, match status was drawing and key player was Zaha playing.

The Poisson regression model explains the counting variable Y_i using explicative variables x_i, for $1 \leq i \leq n$. This p-dimensional variable x_i contains characteristics for the *i* th observation (Cameron and Trivedi, 1998).

The Poisson distribution was as follows:

$$\Pr(Y = y|\mu) = \frac{e^{-\mu}\mu^{y}}{y!} \quad (y = 0, 1, 2 \ldots)$$

Expectation of Poisson distribution is μ,

Variance = $\mu \cdot E(Y= y|\mu) = \mu$, $Var(Y= y|\mu) = \mu$

The model of Poisson analysis was as follows:

$$\Pr(Y_i = y_i|\mu_i) = \frac{e^{-\mu_i}(\mu_i)^{y_i}}{y_i!}$$

$$\ln(E(y|\,\mu_i)) = \ln(\mu_i) = (B_1X_1 + B_2X_2 + \cdots + B_kX_k)$$

$$\mu_i = \exp(B_1X_1 + B_2X_2 + \cdots + B_kX_k)$$

If b>0, then exp(b)>1, and the expected count μ = E(y) is exp(b) times larger than when X=0

If b<0, then exp(b)<1, and the expected count μ = E(y) is exp(b) times smaller than when X=0

The likelihood ratio Chi-Square, log likelihood and deviance/df were checked to identify whether the residuals in the model were independent and to control for collinearity effects.

5.2.4 RELIABILITY

Intra- and Inter-observer reliability tests were performed to determine whether the stable, advantage (n=6) and unstable (n=5) situations were reliably categorised (James et al., 2007). The researcher (intra-, over four weeks after the first coding to nullify memory effects) and an independent experimenter (inter-, who was trained for each operational definition) re-coded three randomly selected matches. Stable situations had high Kappa values (K>0.9, Appendix 5.1.1 and 5.2.1) for both intra- (n=256 comparisons) and inter-observer (n=283) tests. Similarly, advantage situations had high Kappa values for intra- (0.86, n=161, Appendix 5.1.2) and inter-observer (0.81, n=164, Appendix 5.2.2) tests. Discrepancies tended to arise when an experimenter missed an event, especially counter attack chances, for intra- (n=3) and midfield line breaks for inter-observer tests (n=3). Unstable situations also had high Kappa values for intra- (0.97, n=91, Appendix 5.1.3) and inter-observer tests (0.87, n=94, Appendix 5.2.3). A discrepancy occurred for distinguishing the ratio of attacking to depending players during the inter-observer tests (n=2).

5.3 RESULTS

Crystal Palace had an average of 114.8 possessions (SD=15.2) per match which resulted in an average 12.3 shots (SD=4.7; Figure 1). Thus, the attacking process involved, on average, 91.3 stable (SD=12.7), 54 advantage (SD=13.5) and 26 unstable (SD=8.9) situations. 25.8% of stable situations lead to advantage situations (M=23.6, SD=7.5) with 38.3% of all advantage situations becoming unstable situations (M=20.7, SD=6.4).

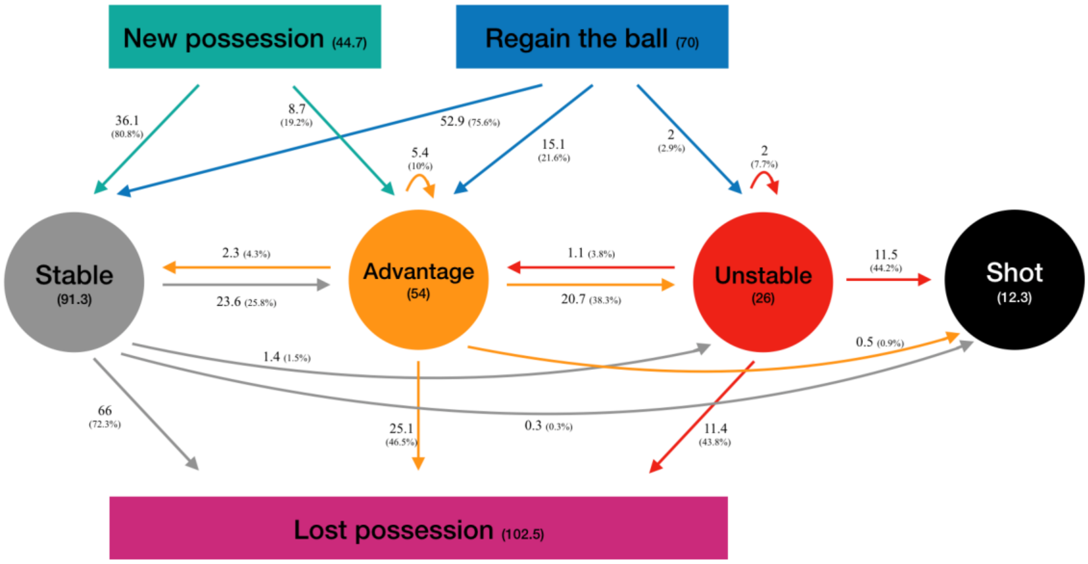

Figure 5.1. The attacking process for Crystal Palace FC during the 2017/2018 season

To assess whether the ability to create advantage and unstable situations were influenced by four independent variables (match venue, match status, opposition quality and key player involvement) Poisson log-linear regression models were run. These showed that Crystal Palace created significantly less advantage and unstable situations when playing against top teams compared to middle teams ($p<0.05$, Table 5.1, Appendix 5.3.1 and 5.3.2), less advantage situations when winning than drawing and less unstable situations without their key player than when he played ($p<0.05$, Appendix 5.3.1 and 5.3.2). Crystal Palace created more advantage ($p=0.15$, Appendix 5.3.1 and 5.3.2) and unstable ($p=0.53$, Appendix 5.3.1 and 5.3.2) situations when playing at home compared to away but these were not significant.

Table 5.1. The influence of match venue, opposition quality, match status and key player on the total number of advantage and unstable situations.

	Advantage			Unstable		
	B	S.E	Exp(B)	B	S.E	Exp(B)
(intercept)	4.228	0.088	68.550	3.517	0.125	33.700
Match Venue	-0.116	0.080	0.891	-0.072	0.113	0.931
Opposition Quality						
vs Top	-0.317	0.102	**0.729****	-0.299	0.146	**0.742***
vs Bottom	-0.162	0.095	0.850	-0.145	0.134	0.865
Match Status						
Winning	-0.242	0.111	**0.785***	-0.196	0.154	0.822
Losing	0.136	0.090	1.146	0.122	0.130	1.130
Key Player	-0.173	0.104	0.841	-0.337	0.154	**0.714***
	χ^2=24.07, p<0.05 LL= -64.02, deviance/df=5.165			χ^2=14.078, p<0.05 LL= -59.233, deviance/df=5.167		

*p<.05, **p<.01 (reference value was home, vs middle, drawing and with key player i.e. Exp(B) was 1 in that case)

In order to better discriminate how Crystal Palace achieved the advantage and unstable situations further analysis of the 6 different advantage and 5 unstable situations was undertaken. Poisson log-linear regressions found that Crystal Palace created more midfield line breaks, zone 14 entries, wide area possessions in the final third, penalty box possessions and less counter attacks when playing at home compared to away (Table 5.2, Appendix 5.3). This was also true when playing against bottom teams compared to middle teams, middle teams compared to top teams, when drawing compared to losing, wining compared to drawing and with key player as opposed to without him.

Table 5.2 The influence of match venue, opposition quality, match status and key player on all advantage and unstable situations (exp(B) value and standard errors into parenthesis).

		Advantage situations							Unstable situations			
		Midfield line break	Zone 14	Wide area	Counter attack chance	Free kick	Corner kick	Penalty box possession	Counter attack	Ratio of attacking to depending players	Successful cross	Successful shot
(Intercept)	e(B)	7.739	11.244	32.713	7.577	3.228	5.575	14.816	3.914	3.392	7.736	3.621
	(s.e)	(0.230)	(0.177)	(0.129)	(0.112)	(0.221)	(0.228)	(0.086)	(0.278)	(0.316)	(0.192)	(0.256)
Match Venue	e(B)	0.966	0.872	0.792	1.172	0.886	1.006	0.852	1.055	0.900	0.886	1.216
	(s.e)	(0.203)	(0.160)	(0.123)	(0.096)	(0.191)	(0.195)	(0.082)	(0.244)	(0.292)	(0.170)	(0.217)
Opposition Quality												
vs Top	e(B)	0.754	0.711	**0.619****	1.137	0.618	0.930	0.711	1.049	1.022	**0.641***	0.685
	(s.e)	(0.270)	(0.206)	**(0.154)**	(0.122)	(0.252)	(0.259)	(0.106)	(0.311)	(0.367)	**(0.216)**	(0.288)
vs Bottom	e(B)	1.003	0.884	**0.724***	0.892	0.962	1.124	0.814	0.927	0.854	0.855	1.087
	(s.e)	(0.241)	(0.189)	**(0.142)**	(0.122)	(0.221)	(0.240)	(0.096)	(0.299)	(0.357)	(0.198)	(0.258)
Match Status												
Winning	e(B)	0.966	0.623	0.747	1.032	1.406	**0.445***	0.769	1.366	0.745	0.812	0.588
	(s.e)	(0.263)	(0.244)	(0.171)	(0.117)	(0.243)	**(0.338)**	(0.11)	(0.282)	(0.383)	(0.250)	(0.340)
Losing	e(B)	1.003	1.344	1.245	**0.510****	1.499	1.442	1.028	0.696	0.810	**1.673****	1.171
	(s.e)	(0.246)	(0.174)	(0.136)	**(0.131)**	(0.221)	(0.207)	(0.096)	(0.332)	(0.356)	**(0.184)**	(0.239)
Key Player	e(B)	0.702	0.867	0.886	0.875	0.988	0.631	**0.499****	0.471	0.449	1.035	1.009
	(s.e)	(0.287)	(0.201)	(0.156)	(0.128)	(0.246)	(0.256)	**(0.125)**	(0.394)	(0.450)	(0.204)	(0.269)
χ^2		4.793	12.946	21.260	11.141	9.674	16.372	19.695	10.336	5.231	15.659	8.193
LL		-53.733	-62.283	-58.630	-57.705	-75.917	-59.594	-62.923	-52.610	-48.411	-65.004	-60.347
deviance/df		4.144	3.463	4.991	3/692	1.762	3.040	3.449	3.203	3.121	3.006	2.567

*p<.05, **p<.01 (reference value was home, vs middle, drawing and with key player)

Since match venue and opposition quality are fixed for any particular match tactical changes within matches would not be evident since data from each match were treated as a single piece of data. However, match status and key player involvement could change during matches and were hence treated as different data points when changes took place within a match. Thus, tactical changes during matches, potentially influencing these different game moments, were analysed using two way (match status and key player involvement) ANOVAS for the 6 different advantage and 5 unstable situations.

No significant interactions were found although for counter attack chances this was close to significance (F= 2.94, df= 2, 58, p=0.06; Figure 2, Appendix 5.4.4).

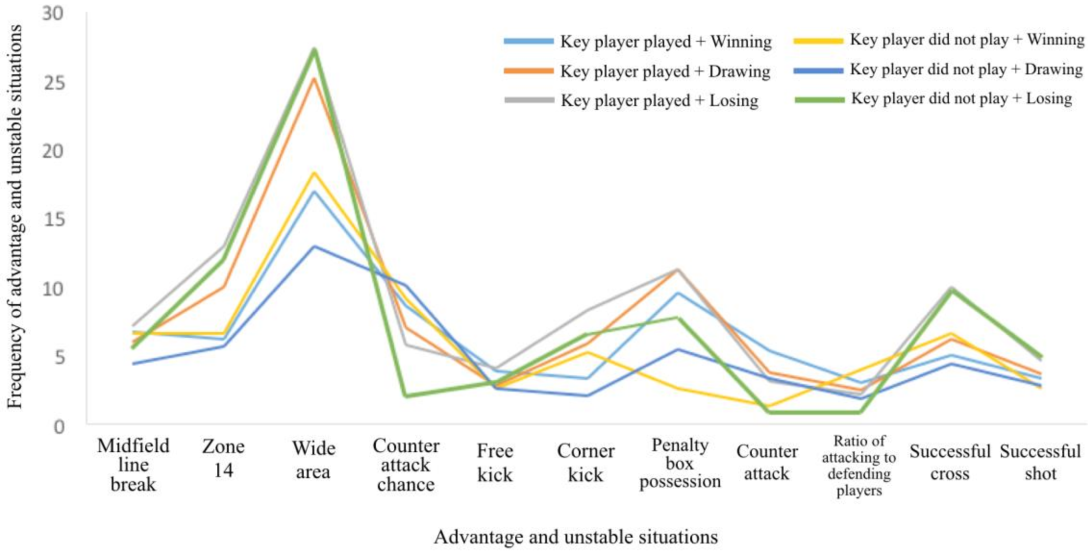

Figure 5.2. The frequency of advantage and unstable situations per match according to the match status/key player interaction.

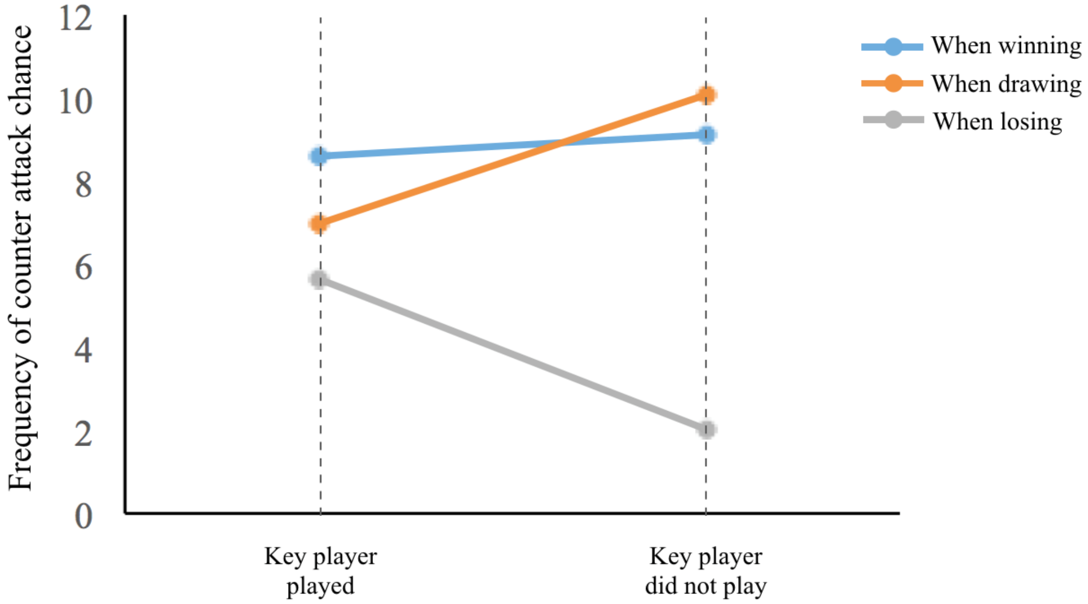

Figure 5.3. The frequency of counter attack chance according to the match status/key player interaction.

Simple main effects revealed that when the key player was absent counter attack chances were significantly different depending on the match status (F=7.03, df = 2, 63, p<.05; Figure 5.3, Appendix 5.5.4).

5.4 DISCUSSION

Match analysis, from a coach's perspective in the applied world, will invariably focus on the why and how events occurred (Lames & McGarry, 2007) rather than the simple statistics prevalent in the research literature, the so called theory-practice gap (Mackenzie & Cushion, 2013). Mackenzie and Cushion (2013) suggested PA research in football simply focused on key performance indicators rather than for developing a deeper understanding of performance e.g. the analysis of the "developmental processes". This study attempted to identify the attacking process objectively to provide a framework for deriving relevant answers in the applied world.

In this study, an average of 26 unstable situations occurred for Crystal Palace per match, which was higher than the 19 found for the Coca-Cola League One team playing at home (12 for away teams) in James et al.'s (2012) study. Crystal Palace tended to create more advantage and unstable situations in particular levels of each situational variable, which was in line with previous studies. Hence, better performance at home compared to away was similarly found for frequency of possessions, shots and goals (Gomez et al., 2012; Armatas & Pollard., 2014), against bottom teams compared to middle (Taylor et al., 2008; Bradley et al., 2014; Liu et al., 2015; Kubayi & Toriola, 2019) and losing compared to drawing (Lago-Peñas & Gomez-Lopez., 2014; Sgro et al., 2017; Redwood-Brown et al., 2019). Crystal Palace had more possessions in zone 14, the wide areas in the final third and penalty box possessions with less counter attack chances at home, when losing, against middle teams compared to top teams and with the key player playing. These findings suggest that strategy changes and/or opponent performance, during these moments of the match, have impacted performance outcomes. The results lend weight to the suggestion that analyses without recourse to relevant independent variables (Mackenzie and Cushion, 2013) is of limited applied value.

A detailed analysis of the match status and key player involvement interaction found that interactions were not significant although from an applied perspective important differences for performance outcomes were evident. For example, when the key player was missing the frequency of counter attack chances was very low when losing. This suggests the key player's involvement in this aspect of play was very influential and tactically changes need to be made during these moments in his absence.

This model of the attacking process did not consider the duration of possessions either for the whole match, within each team possession or within each situation. This information could be useful in the applied world e.g. in which situations do a team attack quickly, but also could have facilitated the alignment of the attacking process described here with previous literature that described possession in terms of how quickly the ball was moved forward. From a statistical perspective, the fact that some situations occurred more frequently than others meant that sample sizes were relatively small in some cases and even not present e.g. there were no situations when Crystal Palace was winning away without the key player against a top team. To rectify this future studies would need to use much larger sample sizes. However, this causes new problems. If a generic profile for a combination of teams was presented the validity of the results for individual teams would be low. If enough data for one team was analysed the validity of the older data (from previous seasons) for a current team would also be low. These are intractable problems in the academic world if practical solutions for the applied world are sought. This identifies one of the problems associated with trying to close Mackenzie & Cushion's (2013) theory-practice gap. If enough data is used, for an analysis of this type to satisfy academic purposes, the answers are unlikely to be of value to the applied world. Alternatively, if data sets of relevance to the applied world are used, the likelihood is, they will be too small to satisfy academic rigour. The approach here has been to present an academically rigorous methodology using data of relevance to the applied world. Hence, the results presented here, are limited in the academic world because of low sample sizes and limited in the applied world because of the lack of detail regarding players and pitch areas. However, this approach does provide a robust and novel methodology which can be adapted for both academic and applied purposes in the future.

5.5 CONCLUSION

This study identified the influences of match venue, opposition quality, match status and key player involvement on the attacking process. This determined how attacking performance changed during different match scenarios such as when losing, without the key player when away against a top team. This methodology will enable practically useful information for applied practice if further details such as player involvement and pitch area are included in the analysis. This approach helps close the theory-practice gap but also exemplifies why the gap exists and the difficulty in closing it fully. The academic rigour of the novel methodology can be used to inform practical problems but further developments should include the duration of possessions and retain the sequence of events to facilitate more detailed analyses.

CHAPTER 6

GENERAL DISCUSSION

CHAPTER 6: GENERAL DISCUSSION

This thesis aimed to provide useful information for the applied world, with the secondary aim of closing the gap between academic and applied practice. Coaches in professional football want to understand an opponent team's attacking and defending processes to better prepare their training sessions i.e. they do not want to rely on simple statistics. Thus, coaches usually undertake a qualitative analysis to include how teams start their attack from the back, movement patterns during transitions between attacking and defending etc. In comparison, academic researchers often conduct quantitative analyses using relatively simple performance indicators. For example, the majority of existing papers related to performance analysis in football measured only selected events, in isolation, such as the number of passes, shots or ball possession measures (Mackenzie & Cushion, 2013). Consequently, the findings from this type of research have generally focussed on what they found but did not provide the so-what (Winter & Nevill, 2014). Indeed, Sporis (2019) asserted that only 0.04% of results and information found from football PA research papers have actually been applied in football clubs. It was these criticisms of scientific research in football that led to the primary goal of this thesis, namely, to attempt to answer relevant questions from the applied world using a novel, scientifically valid methodology.

A key recommendation from the extant literature was the view that understanding patterns of play, exhibited within a game, could help coaching be more specific and objective to facilitate the improvement of tactical performance (Tenga et al., 2015). For this thesis, the identification of a team's attacking process was considered the beneficial information to impact a coach's decision-making regarding training sessions as this would provide a clear understanding of what a team needs to do in order to win (Hewitt et al., 2016). This would be possible, if, unlike previous research that considered a playing pattern as simply “direct” or “possession” play, more detailed specific information was available. To some extent, factor analysis has been used to better classify team playing styles, by grouping performance variables perceived to be relevant measures of playing style. One limitation of these methods, however, is the use of overall match statistics i.e. values for performance variables are summed across the whole match and thus don’t consider the different moments of a match (Hewitt et al., 2016) or other, potentially important, situational variables such as match status. Whilst these methods have identified rudimentary team playing styles, they have typically not distinguished “how” different attacking procedures evolved e.g. how teams initiate or develop build-up play, progress attacks and create goal scoring opportunities. This thesis, therefore, aimed to identify the whole attacking process with a taxonomy of the different ways in which potential goal scoring opportunities arose and thus provide a rigorous methodology for coaches and players to collect information pertinent to identifying their own and their opponent’s attacking patterns of play.

Football teams generally change their tactics during a match dependent on different factors e.g. teams may attack more aggressively when they are losing or playing at home. The patterns of these tactical plans, particularly at team level, is meaningful information for coaches to enable them to plan counter strategies. Whilst this is prevalent in the applied area, academic research has rarely provided sufficient context (Mackenzie & Cushion, 2013) and ignored most situational variables (Rein & Memmert, 2016). Of those that have, some limitations regarding the definition of opposition quality and match status were evident. This thesis, therefore, tried to provide more meaningful information by 1) developing a new criteria of opposition quality, 2) methods of calculating match status, 3) individual player's effect and 4) allowing for the interaction of each situational variable.

6.1 SUMMARY FINDINGS FROM THIS THESIS

This thesis aimed to better understand the attacking process in football i.e. creating goal scoring opportunities. This was initially achieved by classifying stable, advantage and unstable situations using validity and reliability tests to confer scientific rigour. The model was tested using situational variables, selected from the extant literature, for one English Premier League team. The main benefit of this research was the provision of a model that could be used by individual teams to help them identify strengths and weaknesses in their own and opponent's attacking profiles.

A review of literature determined that whilst previous papers identified specific team playing styles e.g. possession or counter attack play, the authors did not typically distinguish "how" different attacking procedures had evolved. For example, a decisive run by an attacker to take a defender out of position could set up a goal scoring opportunity. This type of information is critical for managers and coaches who try to set up practice situations to improve their players ability to create these types of situation. The first study, in this thesis, objectively determined five different unstable situations (penalty box possession, counter attack, ratio of attacking to defending players, successful cross and successful shot) that provided the "how" teams achieved goal scoring opportunities. However, deeper knowledge of these situations would also be possible through qualitative assessments of the key players involved in each situation. At this point in the thesis the research had produced a rigorous methodology for identifying unstable situations which occurred, on average, 26.6 times per match for the three different quality EPL teams sampled. The analysis of the sampled teams confirmed expectations, based on previous research and relatively basic football knowledge, that different teams created unstable situations differently, due to the quality of the team which is a by-product of the qualities of individual players. These differences are indicative of differences in team tactics, as different tactics will inevitably translate to different patterns of creating goal scoring opportunities. A secondary finding from these analyses was that the frequency of unstable situations supported home advantage and opposition strength effects, hence increasing the validity of this measure as a performance indicator (Hughes & Bartlett, 2002). Both home advantage and opposition strength have been found to consistently impact performance and hence their influence in this study was expected and would have been a cause for concern if not present. This study was thus seen as the successful first stage in the production of a taxonomy of the attacking process in football.

Study 2 developed a model for the whole attacking process. Given the complexity of football, for example, teams can play with different formations and utilise different attacking strategies, it was not surprising that this was not evident in the literature. Whilst research had identified some attacking processes, e.g. long ball and build up play, it was obvious that these simplistic labels were not sufficient to describe all forms of attack in football. It was thus recognised that to capture the multitude of attacking behaviours a model would have to consider pitch areas for where possession started and where the possession developed, the organisation of the defence, which would be different depending on the circumstances e.g. counter attacks, set pieces and open play and finally the recognition that a stage occurred when a team had the opportunity to create an unstable situation. This is the first time this stage has been classified as independent although James et al. (2012) presented the concept of perturbation attempts as attempts to create goal scoring opportunities where the event either successfully caused, or was part of, a change in game state (perturbation) or was unsuccessful and a perturbation didn't occur. However, James et al. (2012) only recorded the situations when the player attempted to create an unstable situation i.e. they didn't consider the times when the opportunity was available but not acted upon. The formalisation of this "advantage" situation was fundamental in the development of this taxonomy as the attacking process in football involves a decision-making process whereby teams can, for example, pass side-wards, backwards or forwards. This is most important, from a coaching analysis perspective, when this decision-making occurs in critical areas of the pitch or where the decision creates or doesn't create a critical situation. The classification of the "advantage" situation thus encapsulated these critical decision-making moments into a well-defined situation for analysis purposes. With the advent of this new category of action the five unstable situations identified in study 1 were incorporated into a new taxonomy of the attacking process with a final categorisation of six advantage situations (midfield line break, zone 14, wide area in final third, counter attack chance, free kick and corner kick) occurring between stable and unstable situations. The six advantage situations were differentiated by pitch location, game circumstance or set piece. One English Premier League team Crystal Palace Football Club was used as a pilot study and results showed they created a median of 53.5 advantage situations, 40 attempts and 23 successful attempts to create unstable situations, 12 shots and 1 goal per match. They frequently utilised wide areas (advantage situations) to progress their attack which resulted in goal scoring opportunities frequently as a consequence of penalty box possessions and successful crosses (unstable situations). The working model presented in this study did not include details such as player names, temporal information or number of passes. Each of these would serve a purpose in better identifying attacking strategies, particularly if this model was used by a professional team to impact training. However, within the limits of an academic study these were omitted for the sake of developing the basic structure of an analysis system. Similarly, well known factors likely to influence performance, such as match status, were not assessed in the analysis of Crystal Palace although undoubtedly these would be considered when implementing the model in practice. As a major goal of this thesis was to close the theory practice gap (Mackenzie and Cushion, 2013) the model needed to be tested more fully in study 3.

Study 3 more fully tested the model developed in the first two studies by including four situational variables (match venue, opposition quality, match status and key player appearance) for a season's worth of data for one English Premier League team. Additionally, this study analysed all possessions i.e. stable possessions that did not progress to the advantage situation were coded so that probabilistic information regarding the success and failure of all different situations could be calculated. Since the number of minutes played per match under different levels of match status (winning, drawing or losing) and key player's appearance (Zaha played or did not play) varied, dependent variables were normalised relative to the average total match minutes (95.3 minutes). To avoid errors due to the possibility of unusual patterns occurring in small samples, all performances involving less than 15 minutes were excluded. Crystal Palace had an average of 114.8 possessions per match, of which there were 91.3 stable situations, resulting in an average of 12.3 shots. Poisson log-linear regression models showed that the situational variables had effects that were in line with expectations based on previous studies i.e. teams created more advantage and unstable situations when playing at home than away, losing than drawing, against weak team than strong teams. However, the model was also able to determine the influence of one key player in different attacking situations. For example, when their key player played they created more midfield line breaks, counter attack, successful cross etc. However, when the key player was missing the frequency of counter attack chances was very low when losing. These detailed findings are the sort of key information desired by coaches to help set up the team for forthcoming matches. It is also the detail that is often missing in contemporary sports science research, which has led to the criticisms noted in this thesis. However, whilst this study presented an academically sound model it was also suggested that the applied world would still add further information to make the findings more ecologically valid. For example, individual player, pitch location and time variables could be incorporated to provide contextually rich analyses although sample size would likely prohibit statistically meaningful results. Indeed, this is a crucial factor when considering the theory practice gap. Academic studies are bound by statistical rules that necessitate the collection of reasonably large random samples of data with explanatory power to discern meaningful patterns related to populations. In contrast the applied world is concerned with determining small differences that may only be meaningful for one team or player. Statistical rules are of limited value to a coach who often has to make decisions based on limited information perhaps even on a hunch. The academic world cannot solve this problem but it can provide levels of confidence associated with limited data. This thesis has attempted to bridge this divide and has recognised some of the problems associated with making meaningful insights on limited data. Indeed, even based on a full season's data there were no situations when Crystal Palace was winning away without the key player against a top-rated team.

6.2 KEY LIMITATIONS IDENTIFIED FROM THIS THESIS

The model of the attacking process did not consider the duration of possessions as a whole or within the individual situations of the model. This information could be useful in the applied world e.g. pre match opposition analysis of attacking plays, but could also have facilitated the alignment of the attacking process described here with previous literature that described possession in terms of how quickly the ball was moved forward.

The model did not consider sequential dependencies beyond the immediately following category. Hence it was not possible to calculate the frequency of three or more situations occurring in set sequences. This type of analysis could identify more frequent patterns that may facilitate coaching to help defend such events (see Borrie et al., 2010 for an example of this type of analysis).

Sample sizes were relatively small or consisted of only one team. Thus, the findings could only be exemplars of performance and did not present profiles of teams in general or of sufficient context for use on one team in the applied world.

6.3 FUTURE RESEARCH DIRECTIONS

This thesis has presented a model of the attacking process in football which is academically rigorous. Whilst a stated goal of this research was to provide a framework on which the applied world could add specific complexity e.g. individual player information, there are also academic developments that would be desirable. The addition of two important measures, the duration of possession and pitch location, would enable a more complex analysis of sequential dependencies. This would clearly facilitate a better understanding of playing patterns, something that, anecdotally, my experience of elite football coaches suggests is very important. The method for assessing these patterns would likely involve computer science methodologies such as pattern recognition algorithms. This type of research would require using large data samples to identify general trends and team profiles which again would need to be adapted for use in the applied world.

CHAPTER 7

CONCLUSION

CAHPTER 7: CONCLUSION

This thesis attempted to help close the 'theory-practice gap' and enable academic rigour to inform practical problems. Mackenzie and Cushion (2013) suggested that previous PA research tended to consider only selected events in isolation for analysis without implicit meaning, hence the gap has been created when researchers did not ask relevant questions and produced methodologies which had no relevance to practitioners. A primary goal of this thesis was, therefore, to attempt to answer relevant questions from the applied world using a novel, scientifically valid, methodology for classifying the attacking process in football. After establishing a rigorous framework of the attacking process, one professional football club (Crystal Palace) from the English Premier League was analysed as a case study. This analysis identified the team's developmental process of creating goal scoring opportunities by measuring the frequency of specific, mutually exclusive, situations. However, the model did not consider the duration of possessions, thus, sequential dependencies were not considered. Due to low sample sizes, individual player's contributions were not assessed, however, this would be important information in the applied world where academically rigorous statistical analysis would not be the primary goal of analysis. Indeed, a logical conclusion of this thesis as a whole would be that academic and applied work have different agendas and should therefore employ different methodological approaches. Academic rigour requires sound statistical approaches that produce defensible conclusions. In contrast, the applied world should place confidence in the data analysis as the main consideration. Thus, an analyst working for a football team should be able to state the confidence level associated with any findings so that coaches and players have reasonable expectations of match analysis.

CHAPTER 8

REFERENCE LISTS

CAHPTER 8: REFERENCE LISTS

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Appendices

Appendix 3.1 Ethical approval letter for data used in Study 1

Middlesex University London

London Sport Institute REC

The Burroughs
Hendon
London NW4 4BT

Main Switchboard: 0208 411 5000

22/08/2016

APPLICATION NUMBER: 0643

Dear JONGWON KIM

Re your application title: Perturbations in football

Supervisor: NIC JAMES

Thank you for submitting your application. I can confirm that your application has been given approval from the date of this letter by the London Sport Institute REC.

Please ensure that you contact the ethics committee if any changes are made to the research project which could affect your ethics approval.

The committee would be pleased to receive a copy of the summary of your research study when completed.

Please quote the application number in any correspondence.

Good luck with your research.

Yours sincerely

Dr Rhonda Cohen

London Sport Institute REC

Appendix 3.2 Intra-observer reliability test results for Study 1

3.2.1 Intra-observer test for unstable situations

Observer 1 Unstable Situations * Observer 2 Unstable Situations Crosstabulation

Count

		Observer 2 Unstable Situations						Total
		PBP	CA	RAD	SC	SS	Nothing	
Observer 1 Unstable Situations	PBP	42	0	0	0	0	0	42
	CA	0	28	0	0	0	0	28
	RAD	0	0	15	0	0	0	15
	SC	0	0	0	49	0	2	51
	SS	0	0	0	0	25	0	25
	Nothing	0	0	0	0	0	0	0
Total		42	28	15	49	25	2	161

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.984	.011	23.797	.000
N of Valid Cases		161			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 3.2 Intra-observer reliability test results for Study 1 (contd.)

3.2.2 Intra-observer test for outcomes

Observer 1 Outcomes * Observer 2 Outcomes Crosstabulation

Count

		Observer 2 Outcomes				
		On target	Off target	Goal	Nothing	Total
Observer 1 Outcomes	On target	20	0	0	0	20
	Off target	0	51	0	1	52
	Goal	0	0	7	0	7
	Nothing	1	0	0	0	1
Total		21	51	7	1	80

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.951	.033	10.987	.000
N of Valid Cases		80			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 3.3 Inter-observer reliability test results for Study 1

3.3.1 Inter-observer test for unstable situations

Observer 1 Unstable Situations * Observer 2 Unstable Situations Crosstabulation

		Observer 2 Unstable Situations						
		PBP	CA	RAD	SC	SS	Nothing	Total
Observer 1 Unstable Situations	PBP	42	0	0	0	0	0	42
	CA	0	24	0	0	0	4	28
	RAD	0	1	14	0	0	0	15
	SC	0	0	0	49	0	2	51
	SS	0	0	0	1	24	0	25
	Nothing	1	0	0	0	0	0	1
Total		43	25	14	50	24	6	162

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.928	.023	22.930	.000
N of Valid Cases		162			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

3.3.2 Inter-observer test for outcomes

Observer 1 Outcomes * Observer 2 Outcomes Crosstabulation

		Observer 2 Outcomes				
		On target	Off target	Goal	Nothing	Total
Observer 1 Outcomes	On target	20	0	0	0	20
	Off target	0	50	0	2	52
	Goal	0	0	7	0	7
	Nothing	0	0	0	0	0
Total		20	50	7	2	79

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.951	.034	10.958	.000
N of Valid Cases		79			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 3.4 Chi-Square tests for determining statistical differences of three different quality teams

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.578[a]	8	.171
Likelihood Ratio	11.652	8	.167
Linear-by-Linear Association	5.946	1	.015
N of Valid Cases	507		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.00.

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.151	.171
	Cramer's V	.107	.171
N of Valid Cases		507	

Appendix 3.5 Mann-Whitney U test results for determining statistical differences of match location (home/away)

Test Statistics[a]

	Venue
Mann-Whitney U	88.500
Wilcoxon W	259.500
Z	-2.327
Asymp. Sig. (2-tailed)	.020
Exact Sig. [2*(1-tailed Sig.)]	.019[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

Appendix 3.6 Kruskal H test results for determining statistical differences of opposition quality (vs top/middle/bottom)

Test Statistics[a,b]

	Opponent Quality
Kruskal-Wallis H	7.113
df	2
Asymp. Sig.	.029

a. Kruskal Wallis Test

b. Grouping Variable: Opponent Quality

Appendix 4.1 Ethical approval letter for data used in Study2 and 3

Middlesex University London

London Sport Institute REC

The Burroughs
Hendon
London NW4 4BT

Main Switchboard: 0208 411 5000

08/02/2019

APPLICATION NUMBER: 6816

Dear Jongwon Kim

Re your application title: Perturbation process of creating unstable situations

Supervisor: Nic James

Co-investigators/collaborators:

Thank you for submitting your application. I can confirm that your application has been given approval from the date of this letter by the London Sport Institute REC.

Although your application has been approved, the reviewers of your application may have made some useful comments on your application. Please look at your online application again to check whether the reviewers have added any comments for you to look at.

Also, please note the following:

1. Please ensure that you contact your supervisor/research ethics committee (REC) if any changes are made to the research project which could affect your ethics approval. There is an Amendment sub-form on MORE that can be completed and submitted to your REC for further review.

2. You must notify your supervisor/REC if there is a breach in data protection management or any issues that arise that may lead to a health and safety concern or conflict of interests.

3. If you require more time to complete your research, i.e., beyond the date specified in your application, please complete the Extension sub-form on MORE and submit it your REC for review.

4. Please quote the application number in any correspondence.

5. It is important that you retain this document as evidence of research ethics approval, as it may be required for submission to external bodies (e.g., NHS, grant awarding bodies) or as part of your research report, dissemination (e.g., journal articles) and data management plan.

6. Also, please forward any other information that would be helpful in enhancing our application form and procedures - please contact MOREsupport@mdx.ac.uk to provide feedback.

Good luck with your research.

Yours sincerely

Appendix 4.2 Permission letter to use match data from Crystal Palace Football Club

---

CRYSTAL PALACE F.C.

1ST February 2019

Dear Jongwon Kim

I give permission for Jongwon to use/collect match analysis data from Crystal Palace FC full season's match data (2017/18 season) (downloaded from Wyscout company) consisting of all 38 Premier League Fixtures based on the following considerations:

- Confidentiality is maintained throughout (including data and video footage)
- The project is given full ethical approval by the university
- Results of the project are given back to the club

Many thanks,

Tom Johnson
Head of Academy Performance Analysis

Crystal Palace Football Club, Selhurst Park Stadium, London, SE25 6PU
T: +44 (0)20 8768 6000 F: +44 (0)20 8658 6420 W: cpfc.co.uk

Premier League | 万博 ManBetX

Registered Office: CPFC Limited, Selhurst Park, London, SE25 6PU Company No: 07270793 VAT No: 9975936

Appendix 4.3 Intra-observer reliability test results for Study 2

4.3.1 Intra-observer test for advantage situations

Intra Advantage 1 * Intra Advantage 2 Crosstabulation

Count

		Intra Advantage 2							
		Midfield line break	Zone 14	Wide area	Counter attack chance	Free kick	Corner kick	Nothing	Total
Intra Advantage 1	Midfield line break	40	0	3	2	0	0	0	45
	Zone 14	0	56	0	0	0	0	0	56
	Wide area	0	0	168	1	0	0	2	171
	Counter attack chance	0	0	0	37	0	0	0	37
	Free kick	0	0	0	0	17	0	0	17
	Corner kick	0	0	0	0	0	34	1	35
	Nothing	0	0	0	0	0	0	1	1
Total		40	56	171	40	17	34	4	362

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.965	.011	35.433	.000
N of Valid Cases		362			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 4.3 Intra-observer reliability test results for Study 2 (contd.)

4.3.2 Intra-observer test for unstable situations

Intra Unstable 1 * Intra Unstable 2 Crosstabulation

Count

		Intra Unstable 2						
		PBP	CA	RAD	SC	SS	Nothing	Total
Intra Unstable 1	PBP	39	0	0	0	0	1	40
	CA	0	15	0	0	0	0	15
	RAD	0	1	17	0	0	0	18
	SC	0	1	0	34	0	1	36
	SS	0	1	0	0	25	0	26
	Nothing	2	0	0	0	0	1	3
Total		41	18	17	34	25	3	138

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.935	.024	21.672	.000
N of Valid Cases		138			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 4.3 Intra-observer reliability test results for Study 2 (contd.)

4.3.3 Intra-observer test for outcomes

Intra Shot 1 * Intra Shot 2 Crosstabulation

Count

		Intra Shot 2				
		On target	Off target	Blocked shot	No shot	Total
Intra Shot 1	On target	26	0	0	1	27
	Off target	0	29	0	0	29
	Blocked shot	0	0	19	0	19
	No shot	0	0	1	0	1
Total		26	29	20	1	76

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.961	.027	12.060	.000
N of Valid Cases		76			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 4.4 Inter-observer reliability test results for Study 2

4.4.1 Inter-observer test for advantage situations

Inter Advantage 1 * Inter Advantage 2 Crosstabulation

Count

		Inter Advantage 2							
		Midfield line break	Zone 14	Wide area	Counter attack chance	Free kick	Corner kick	Nothing	Total
Inter Advantage 1	Midfield line break	34	3	3	2	0	0	4	46
	Zone 14	1	56	1	0	0	0	0	58
	Wide area	1	2	159	2	0	0	8	172
	Counter attack chance	1	2	1	33	0	0	2	39
	Free kick	0	0	0	0	17	0	0	17
	Corner kick	0	0	0	0	0	34	1	35
	Nothing	1	0	4	0	0	0	0	5
Total		38	63	168	37	17	34	15	372

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.856	.021	32.734	.000
N of Valid Cases		372			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 4.4 Inter-observer reliability test results for Study 2 (contd.)

4.4.2 Inter-observer test for unstable situations

Inter Unstable 1 * Inter Unstable 2 Crosstabulation

Count

		Inter Unstable 2						
		PBP	CA	RAD	SC	SS	Nothing	Total
Inter Unstable 1	PBP	41	0	0	0	0	0	41
	CA	0	16	0	0	0	0	16
	RAD	2	3	13	0	0	0	18
	SC	0	0	0	35	0	2	37
	SS	0	1	0	0	25	0	26
	Nothing	0	4	0	3	0	1	8
Total		43	24	13	38	25	3	146

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.870	.031	21.210	.000
N of Valid Cases		146			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 4.4 Inter-observer reliability test results for Study 2 (contd.)

4.4.3 Inter-observer test for outcomes

Inter Shot 1 * Inter Shot 2 Crosstabulation

Count

		Inter Shot 2				
		On target	Off target	Blocked shot	No shot	Total
Inter Shot 1	On target	26	0	0	1	27
	Off target	0	29	0	0	29
	Blocked shot	0	0	19	0	19
	No shot	0	0	1	0	1
Total		26	29	20	1	76

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.961	.027	12.060	.000
N of Valid Cases		76			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 4.5 Kruskal-Wallis H test results for Study 2

4.5.1 Kruskal-Wallis H test for advantage situations

Test Statistics[a,b]

	Advantage situation
Kruskal-Wallis H	124.506
df	5
Asymp. Sig.	.000

a. Kruskal Wallis Test
b. Grouping Variable: Advantage situations

Test Statistics[a]

	Advantage situation
N	228
Median	6.50
Chi-Square	88.632[b]
df	5
Asymp. Sig.	.000

a. Grouping Variable: Advantage situations
b. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 19.0.

Appendix 4.5 Kruskal-Wallis H test results for Study 2 (contd.)

4.5.2 Kruskal-Wallis H test for unstable situations

Test Statistics[a,b]

	Unstable Situation
Kruskal-Wallis H	78.404
df	4
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: Unstable situation

Test Statistics[a]

	Unstable Situation
N	190
Median	4.00
Chi-Square	54.041[b]
df	4
Asymp. Sig.	.000

a. Grouping Variable: Unstable situation

b. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.6.

Appendix 4.5 Kruskal-Wallis H test results for Study 2 (contd.)

4.5.3 Kruskal-Wallis H test for shots leaded from unstable situations

Test Statistics[a,b]

	Shots
Kruskal-Wallis H	66.525
df	4
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: Unstable situations

Test Statistics[a]

	Shots
N	190
Median	2.0000
Chi-Square	56.714[b]
df	4
Asymp. Sig.	.000

a. Grouping Variable: Unstable situations

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.4.

Appendix 4.5 Kruskal-Wallis H test results for Study 2 (contd.)

4.5.4 Kruskal-Wallis H test for shots on target leaded from unstable situations

Test Statistics[a,b]

	Shots on target
Kruskal-Wallis H	18.480
df	4
Asymp. Sig.	.001

a. Kruskal Wallis Test

b. Grouping Variable: Unstable situations

Test Statistics[a]

	Shots on target
N	190
Median	.0000
Chi-Square	16.783[b]
df	4
Asymp. Sig.	.002

a. Grouping Variable: Unstable situations

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 17.8.

Appendix 4.5 Kruskal-Wallis H test results for Study 2 (contd.)

4.5.5 Kruskal-Wallis H test for rate leading to shots from unstable situations

Test Statistics[a,b]

	Rate to shots
Kruskal-Wallis H	80.547
df	4
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: Unstable situations

Test Statistics[a]

	Rate to shots
N	190
Median	.4000
Chi-Square	57.000[b]
df	4
Asymp. Sig.	.000

a. Grouping Variable: Unstable situations

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 18.0.

Appendix 4.5 Kruskal-Wallis H test results for Study 2 (contd.)

4.5.6 Kruskal-Wallis H test for rate leading to unstable situations from advantage situations

Test Statistics[a,b]

	Advantage to Unstable Rate
Kruskal-Wallis H	28.287
df	5
Asymp. Sig.	.000

a. Kruskal Wallis Test

b. Grouping Variable: Advantage situation

Test Statistics[a]

	Advantage to Unstable Rate
N	228
Median	40.45
Chi-Square	31.158[b]
df	5
Asymp. Sig.	.000

a. Grouping Variable: Advantage situation

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 19.0.

Appendix 4.5 Kruskal-Wallis H test results for Study 2 (contd.)

4.5.7 Kruskal-Wallis H test for rate leading to goals from unstable situations

Test Statistics[a,b]

	Goals
Kruskal-Wallis H	13.845
df	4
Asymp. Sig.	.008

a. Kruskal Wallis Test

b. Grouping Variable: Unstable situations

Test Statistics[a]

	Goals
N	190
Median	.0000
Chi-Square	15.801[b]
df	4
Asymp. Sig.	.003

a. Grouping Variable: Unstable situations

b. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 5.4.

Appendix 4.6 Mann-Whitney U test results for Study 2

4.6.1 Mann-Whitney U test for Advantage situations by match location (home/away)

Test Statistics[a]

	Advantage situation
Mann-Whitney U	124.500
Wilcoxon W	314.500
Z	-1.637
Asymp. Sig. (2-tailed)	.102
Exact Sig. [2*(1-tailed Sig.)]	.103[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.2 Mann-Whitney U test for Unstable situations by match location (home/away)

Test Statistics[a]

	Unstable Situation
Mann-Whitney U	122.500
Wilcoxon W	312.500
Z	-1.697
Asymp. Sig. (2-tailed)	.090
Exact Sig. [2*(1-tailed Sig.)]	.091[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.3 Mann-Whitney U test for Shots by match location (home/away)

Test Statistics[a]

	Shot
Mann-Whitney U	114.500
Wilcoxon W	304.500
Z	-1.935
Asymp. Sig. (2-tailed)	.053
Exact Sig. [2*(1-tailed Sig.)]	.053[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

Appendix 4.6 Mann-Whitney U test results for Study 2 (contd.)

4.6.4 Mann-Whitney U test for Midfield line break by match location (home/away)

Test Statistics[a]

	Midfield Line Break
Mann-Whitney U	165.000
Wilcoxon W	355.000
Z	-.455
Asymp. Sig. (2-tailed)	.649
Exact Sig. [2*(1-tailed Sig.)]	.665[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.5 Mann-Whitney U test for Zone 14 by match location (home/away)

Test Statistics[a]

	Zone 14
Mann-Whitney U	114.000
Wilcoxon W	304.000
Z	-1.945
Asymp. Sig. (2-tailed)	.052
Exact Sig. [2*(1-tailed Sig.)]	.053[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.6 Mann-Whitney U test for Wide area by match location (home/away)

Test Statistics[a]

	Wide Area
Mann-Whitney U	169.500
Wilcoxon W	359.500
Z	-.323
Asymp. Sig. (2-tailed)	.746
Exact Sig. [2*(1-tailed Sig.)]	.751[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

Appendix 4.6 Mann-Whitney U test results for Study 2 (contd.)

4.6.7 Mann-Whitney U test for Counter attack chance by match location (home/away)

Test Statistics[a]

	Counter Attack Chance
Mann-Whitney U	130.500
Wilcoxon W	320.500
Z	-1.465
Asymp. Sig. (2-tailed)	.143
Exact Sig. [2*(1-tailed Sig.)]	.146[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.8 Mann-Whitney U test for Free kick by match location (home/away)

Test Statistics[a]

	Free Kick
Mann-Whitney U	134.500
Wilcoxon W	324.500
Z	-1.369
Asymp. Sig. (2-tailed)	.171
Exact Sig. [2*(1-tailed Sig.)]	.181[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.9 Mann-Whitney U test for Corner kick by match location (home/away)

Test Statistics[a]

	Corner Kick
Mann-Whitney U	178.000
Wilcoxon W	368.000
Z	-.074
Asymp. Sig. (2-tailed)	.941
Exact Sig. [2*(1-tailed Sig.)]	.954[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

Appendix 4.6 Mann-Whitney U test results for Study 2 (contd.)

4.6.10 Mann-Whitney U test for Penalty box possession by match location (home/away)

Test Statistics[a]

	Penalty Box Possession
Mann-Whitney U	100.500
Wilcoxon W	290.500
Z	-2.356
Asymp. Sig. (2-tailed)	.018
Exact Sig. [2*(1-tailed Sig.)]	.018[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.11 Mann-Whitney U test for Counter attack by match location (home/away)

Test Statistics[a]

	Counter Attack
Mann-Whitney U	179.000
Wilcoxon W	369.000
Z	-.044
Asymp. Sig. (2-tailed)	.965
Exact Sig. [2*(1-tailed Sig.)]	.977[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.12 Mann-Whitney U test for Ratio of attacking to defending players by match location (home/away)

Test Statistics[a]

	Ratio of Attacking to Defending players
Mann-Whitney U	164.000
Wilcoxon W	354.000
Z	-.492
Asymp. Sig. (2-tailed)	.623
Exact Sig. [2*(1-tailed Sig.)]	.644[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

Appendix 4.6 Mann-Whitney U test results for Study 2 (contd.)

4.6.13 Mann-Whitney U test for Successful cross by match location (home/away)

Test Statistics[a]

	Successful Cross
Mann-Whitney U	152.500
Wilcoxon W	342.500
Z	-.822
Asymp. Sig. (2-tailed)	.411
Exact Sig. [2*(1-tailed Sig.)]	.418[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

4.6.14 Mann-Whitney U test for Successful shot by match location (home/away)

Test Statistics[a]

	Successful Shot
Mann-Whitney U	170.500
Wilcoxon W	360.500
Z	-.296
Asymp. Sig. (2-tailed)	.767
Exact Sig. [2*(1-tailed Sig.)]	.773[b]

a. Grouping Variable: Venue

b. Not corrected for ties.

Appendix 5.1 Intra-observer reliability test results for Study 3

5.1.1 Intra-observer test for stable situations

Intra Stable 1 * Intra Stable 2 Crosstabulation

Count

		Intra Stable 2		
		Stable	Nothing	Total
Intra Stable 1	Stable	245	8	253
	Nothing	3	0	3
Total		248	8	256

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	-.017	.008	-.313	.754
N of Valid Cases		256			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

5.1.2 Intra-observer test for advantage situations

Intra Advantage 1 * Intra Advantage 2 Crosstabulation

Count

		Intra Advantage 2							
		Midfield line break	Zone 14	Wide area	Counter attack chance	Free kick	Corner kick	Nothing	Total
Intra Advantage 1	Midfield line break	20	1	0	1	0	0	2	24
	Zone 14	1	21	0	1	0	0	0	23
	Wide area	0	0	58	0	0	0	1	59
	Counter attack chance	0	0	0	22	0	0	3	25
	Free kick	0	0	0	0	7	0	0	7
	Corner kick	0	0	0	0	0	15	0	15
	Nothing	3	0	3	2	0	0	0	8
Total		24	22	61	26	7	15	6	161

Appendix 5.1 Intra-observer reliability test results for Study 3 (contd.)

5.1.2 Intra-observer test for advantage situations (contd.)

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.857	.031	22.709	.000
N of Valid Cases		161			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

5.1.3 Intra-observer test for unstable situations

Intra Unstable 1 * Intra Unstable 2 Crosstabulation

Count

		Intra Unstable 2					
		PBP	CA	RAD	SC	SS	Total
Intra Unstable 1	PBP	36	0	0	0	0	36
	CA	0	14	0	0	0	14
	RAD	0	1	12	0	0	13
	SC	0	0	0	14	0	14
	SS	0	0	0	0	13	13
	Nothing	0	1	0	0	0	1
Total		36	16	12	14	13	91

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.971	.020	17.658	.000
N of Valid Cases		91			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 5.2 Inter-observer reliability test results for Study 3

5.2.1 Inter-observer test for stable situations

Inter Stable 1 * Inter Stable 2 Crosstabulation

Count

		Inter Stable 2		
		Stable	Nothing	Total
Inter Stable 1	Stable	230	23	253
	Nothing	30	0	30
Total		260	23	283

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	-.101	.014	-1.723	.085
N of Valid Cases		283			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

5.2.2 Inter-observer test for advantage situations

Inter Advantage 1 * Inter Advantage 2 Crosstabulation

Count

		Inter Advantage 2							
		Midfield line break	Zone 14	Wide area	Counter attack chance	Free kick	Corner kick	Nothing	Total
Inter Advantage 1	Midfield line break	17	1	2	1	0	0	3	24
	Zone 14	1	21	0	1	0	0	0	23
	Wide area	0	0	57	0	0	0	2	59
	Counter attack chance	0	0	0	22	0	0	3	25
	Free kick	0	0	0	0	7	0	0	7
	Corner kick	0	0	0	0	0	15	0	15
	Nothing	3	1	4	3	0	0	0	11
Total		21	23	63	27	7	15	8	164

Appendix 5.2 Inter-observer reliability test results for Study 3 (contd.)

5.2.2 Inter-observer test for advantage situations (contd.)

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.806	.035	21.803	.000
N of Valid Cases		164			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

5.2.3 Inter-observer test for unstable situations

Inter Unstable 1 * Inter Unstable 2 Crosstabulation

Count

		Inter Unstable 2						
		PBP	CA	RAD	SC	SS	Nothing	Total
Inter Unstable 1	PBP	36	0	0	0	0	0	36
	CA	0	14	0	0	0	0	14
	RAD	0	3	8	0	0	2	13
	SC	0	0	0	14	0	0	14
	SS	0	0	0	0	13	0	13
	Nothing	2	1	0	1	0	0	4
Total		38	18	8	15	13	2	94

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Measure of Agreement	Kappa	.874	.039	16.707	.000
N of Valid Cases		94			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3

5.3.1 Poisson log-linear regression for total number of advantage situations

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	Advantage	64	11	97	52.69	18.000

Goodness of Fit[a]

	Value	df	Value/df
Deviance	294.406	57	5.165
Scaled Deviance	57.000	57	
Pearson Chi-Square	279.172	57	4.898
Scaled Pearson Chi-Square	54.051	57	
Log Likelihood[b,c]	-330.663		
Adjusted Log Likelihood[d]	-64.020		
Akaike's Information Criterion (AIC)	675.325		
Finite Sample Corrected AIC (AICC)	677.325		
Bayesian Information Criterion (BIC)	690.437		
Consistent AIC (CAIC)	697.437		

Dependent Variable: Advantage

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
24.070	6	.001

Dependent Variable: Advantage

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.1 Poisson log-linear regression for total number of advantage situations (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	4.228	.0878	4.055	4.400	2318.080	1	.000	68.550	57.712	81.424
[Match Venue=1]	-.116	.0799	-.272	.041	2.091	1	.148	.891	.762	1.042
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.317	.1021	-.517	-.117	9.624	1	.002	.729	.597	.890
[Opposition Quality=2]	-.162	.0947	-.348	.024	2.923	1	.087	.850	.706	1.024
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.242	.1107	-.459	-.025	4.758	1	.029	.785	.632	.976
[Match Status=2]	.136	.0904	-.041	.313	2.259	1	.133	1.146	.960	1.368
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.173	.1035	-.376	.030	2.804	1	.094	.841	.686	1.030
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	5.165[b]									

Dependent Variable: Advantage

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.2 Poisson log-linear regression for total number of unstable situations

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	Unstable	64	3	50	25.97	11.701

Goodness of Fit[a]

	Value	df	Value/df
Deviance	294.517	57	5.167
Scaled Deviance	57.000	57	
Pearson Chi-Square	273.894	57	4.805
Scaled Pearson Chi-Square	53.009	57	
Log Likelihood[b,c]	-306.054		
Adjusted Log Likelihood[d]	-59.233		
Akaike's Information Criterion (AIC)	626.108		
Finite Sample Corrected AIC (AICC)	628.108		
Bayesian Information Criterion (BIC)	641.220		
Consistent AIC (CAIC)	648.220		

Dependent Variable: Unstable

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
14.078	6	.029

Dependent Variable: Unstable

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.2 Poisson log-linear regression for total number of unstable situations (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	Hypothesis Test df	Hypothesis Test Sig.	Exp(B)	95% Wald Confidence Interval for Exp(B) Lower	95% Wald Confidence Interval for Exp(B) Upper
(Intercept)	3.517	.1248	3.273	3.762	794.421	1	.000	33.700	26.387	43.038
[Match Venue=1]	-.072	.1134	-.294	.150	.402	1	.526	.931	.745	1.162
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.299	.1460	-.585	-.013	4.187	1	.041	.742	.557	.987
[Opposition Quality=2]	-.145	.1344	-.408	.118	1.163	1	.281	.865	.665	1.126
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.196	.1542	-.498	.106	1.621	1	.203	.822	.608	1.112
[Match Status=2]	.122	.1301	-.133	.377	.879	1	.348	1.130	.875	1.458
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.337	.1540	-.639	-.035	4.794	1	.029	.714	.528	.965
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	5.167[b]									

Dependent Variable: Unstable

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.3 Poisson log-linear regression for midfield line break

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	MLB	64	0	25	6.42	5.136

Goodness of Fit[a]

	Value	df	Value/df
Deviance	236.201	57	4.144
Scaled Deviance	57.000	57	
Pearson Chi-Square	237.501	57	4.167
Scaled Pearson Chi-Square	57.314	57	
Log Likelihood[b,c]	-222.663		
Adjusted Log Likelihood[d]	-53.733		
Akaike's Information Criterion (AIC)	459.327		
Finite Sample Corrected AIC (AICC)	461.327		
Bayesian Information Criterion (BIC)	474.439		
Consistent AIC (CAIC)	481.439		

Dependent Variable: MLB
Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]
a. Information criteria are in smaller-is-better form.
b. The full log likelihood function is displayed and used in computing information criteria.
c. The log likelihood is based on a scale parameter fixed at 1.
d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
4.793	6	.571

Dependent Variable: MLB
Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]
a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.3 Poisson log-linear regression for midfield line break (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	2.046	.2296	1.596	2.496	79.432	1	.000	7.739	4.934	12.136
[Match Venue=1]	-.035	.2031	-.433	.364	.029	1	.865	.966	.649	1.438
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.282	.2699	-.811	.247	1.094	1	.295	.754	.444	1.280
[Opposition Quality=2]	.003	.2407	-.469	.475	.000	1	.991	1.003	.626	1.607
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.035	.2629	-.550	.480	.018	1	.895	.966	.577	1.617
[Match Status=2]	.003	.2425	-.473	.478	.000	1	.991	1.003	.623	1.613
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.354	.2865	-.916	.207	1.529	1	.216	.702	.400	1.230
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	4.144[b]									

Dependent Variable: MLB

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.4 Poisson log-linear regression for zone 14

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	Z14	64	0	21	8.86	5.330

Goodness of Fit[a]

	Value	df	Value/df
Deviance	197.377	57	3.463
Scaled Deviance	57.000	57	
Pearson Chi-Square	170.951	57	2.999
Scaled Pearson Chi-Square	49.369	57	
Log Likelihood[b,c]	-215.670		
Adjusted Log Likelihood[d]	-62.283		
Akaike's Information Criterion (AIC)	445.341		
Finite Sample Corrected AIC (AICC)	447.341		
Bayesian Information Criterion (BIC)	460.453		
Consistent AIC (CAIC)	467.453		

Dependent Variable: Z14

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
12.946	6	.044

Dependent Variable: Z14

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.4 Poisson log-linear regression for zone 14 (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	2.420	.1769	2.073	2.767	187.150	1	.000	11.244	7.950	15.904
[Match Venue=1]	-.137	.1602	-.451	.177	.728	1	.394	.872	.637	1.194
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.340	.2056	-.744	.063	2.741	1	.098	.711	.475	1.065
[Opposition Quality=2]	-.124	.1893	-.494	.247	.426	1	.514	.884	.610	1.281
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.474	.2442	-.953	.005	3.767	1	.052	.623	.386	1.005
[Match Status=2]	.296	.1741	-.046	.637	2.881	1	.090	1.344	.955	1.890
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.143	.2008	-.536	.251	.504	1	.478	.867	.585	1.285
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.463[b]									

Dependent Variable: Z14

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.5 Poisson log-linear regression for wide area

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	WA	64	0	49	22.09	11.020

Goodness of Fit[a]

	Value	df	Value/df
Deviance	284.486	57	4.991
Scaled Deviance	57.000	57	
Pearson Chi-Square	245.553	57	4.308
Scaled Pearson Chi-Square	49.199	57	
Log Likelihood[b,c]	-292.623		
Adjusted Log Likelihood[d]	-58.630		
Akaike's Information Criterion (AIC)	599.246		
Finite Sample Corrected AIC (AICC)	601.246		
Bayesian Information Criterion (BIC)	614.358		
Consistent AIC (CAIC)	621.358		

Dependent Variable: WA

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
21.260	6	.002

Dependent Variable: WA

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.5 Poisson log-linear regression for wide area (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	Hypothesis Test df	Hypothesis Test Sig.	Exp(B)	95% Wald Confidence Interval for Exp(B) Lower	95% Wald Confidence Interval for Exp(B) Upper
(Intercept)	3.488	.1286	3.236	3.740	735.071	1	.000	32.713	25.423	42.094
[Match Venue=1]	-.233	.1225	-.473	.007	3.635	1	.057	.792	.623	1.007
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.480	.1537	-.781	-.178	9.736	1	.002	.619	.458	.837
[Opposition Quality=2]	-.322	.1420	-.601	-.044	5.155	1	.023	.724	.548	.957
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.292	.1714	-.628	.044	2.902	1	.088	.747	.534	1.045
[Match Status=2]	.219	.1358	-.047	.485	2.609	1	.106	1.245	.954	1.625
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.121	.1556	-.426	.184	.606	1	.436	.886	.653	1.202
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	4.991[b]									

Dependent Variable: WA

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.6 Poisson log-linear regression for counter attack chance

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	CAC	64	0	18	6.92	5.103

Goodness of Fit[a]

	Value	df	Value/df
Deviance	210.470	57	3.692
Scaled Deviance	57.000	57	
Pearson Chi-Square	190.875	57	3.349
Scaled Pearson Chi-Square	51.693	57	
Log Likelihood[b,c]	-213.073		
Adjusted Log Likelihood[d]	-57.705		
Akaike's Information Criterion (AIC)	440.146		
Finite Sample Corrected AIC (AICC)	442.146		
Bayesian Information Criterion (BIC)	455.258		
Consistent AIC (CAIC)	462.258		

Dependent Variable: CAC

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
11.141	6	.084

Dependent Variable: CAC

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.6 Poisson log-linear regression for counter attack chance (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	Hypothesis Test df	Hypothesis Test Sig.	Exp(B)	95% Wald Confidence Interval for Exp(B) Lower	95% Wald Confidence Interval for Exp(B) Upper
(Intercept)	2.025	.2155	1.603	2.447	88.338	1	.000	7.577	4.967	11.558
[Match Venue=1]	.158	.1854	-.205	.522	.729	1	.393	1.172	.815	1.685
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	.128	.2335	-.329	.586	.301	1	.583	1.137	.719	1.796
[Opposition Quality=2]	-.114	.2345	-.574	.346	.236	1	.627	.892	.563	1.413
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	.031	.2247	-.409	.471	.019	1	.890	1.032	.664	1.602
[Match Status=2]	-.673	.2532	-1.169	-.176	7.058	1	.008	.510	.311	.838
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.134	.2462	-.616	.349	.294	1	.588	.875	.540	1.418
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.692[b]									

Dependent Variable: CAC

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.7 Poisson log-linear regression for free kick

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	FK	64	0	10	3.17	2.236

Goodness of Fit[a]

	Value	df	Value/df
Deviance	100.461	57	1.762
Scaled Deviance	57.000	57	
Pearson Chi-Square	82.246	57	1.443
Scaled Pearson Chi-Square	46.665	57	
Log Likelihood[b,c]	-133.801		
Adjusted Log Likelihood[d]	-75.917		
Akaike's Information Criterion (AIC)	281.601		
Finite Sample Corrected AIC (AICC)	283.601		
Bayesian Information Criterion (BIC)	296.714		
Consistent AIC (CAIC)	303.714		

Dependent Variable: FK

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
9.674	6	.139

Dependent Variable: FK

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.7 Poisson log-linear regression for free kick (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval Lower	95% Wald Confidence Interval Upper	Hypothesis Test Wald Chi-Square	Hypothesis Test df	Hypothesis Test Sig.	Exp(B)	95% Wald Confidence Interval for Exp(B) Lower	95% Wald Confidence Interval for Exp(B) Upper
(Intercept)	1.172	.2212	.738	1.605	28.076	1	.000	3.228	2.093	4.980
[Match Venue=1]	-.121	.1905	-.494	.253	.401	1	.526	.886	.610	1.287
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.481	.2517	-.974	.012	3.650	1	.056	.618	.377	1.013
[Opposition Quality=2]	-.039	.2210	-.472	.394	.031	1	.861	.962	.624	1.483
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	.341	.2429	-.135	.817	1.967	1	.161	1.406	.873	2.263
[Match Status=2]	.405	.2209	-.028	.838	3.360	1	.067	1.499	.972	2.312
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.012	.2455	-.494	.469	.003	1	.960	.988	.610	1.598
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	1.762[b]									

Dependent Variable: FK

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.8 Poisson log-linear regression for corner kick

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	CK	64	0	17	5.20	4.091

Goodness of Fit[a]

	Value	df	Value/df
Deviance	173.261	57	3.040
Scaled Deviance	57.000	57	
Pearson Chi-Square	146.530	57	2.571
Scaled Pearson Chi-Square	48.206	57	
Log Likelihood[b,c]	-181.145		
Adjusted Log Likelihood[d]	-59.594		
Akaike's Information Criterion (AIC)	376.290		
Finite Sample Corrected AIC (AICC)	378.290		
Bayesian Information Criterion (BIC)	391.403		
Consistent AIC (CAIC)	398.403		

Dependent Variable: CK
Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]
a. Information criteria are in smaller-is-better form.
b. The full log likelihood function is displayed and used in computing information criteria.
c. The log likelihood is based on a scale parameter fixed at 1.
d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
16.372	6	.012

Dependent Variable: CK
Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]
a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.8 Poisson log-linear regression for corner kick (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	1.718	.2275	1.272	2.164	57.020	1	.000	5.575	3.569	8.708
[Match Venue=1]	.006	.1947	-.375	.388	.001	1	.974	1.006	.687	1.474
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.073	.2593	-.581	.435	.079	1	.779	.930	.559	1.546
[Opposition Quality=2]	.117	.2398	-.353	.587	.238	1	.626	1.124	.702	1.799
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.810	.3382	-1.473	-.147	5.737	1	.017	.445	.229	.863
[Match Status=2]	.366	.2074	-.041	.772	3.110	1	.078	1.442	.960	2.165
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.460	.2562	-.962	.043	3.218	1	.073	.631	.382	1.043
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.040[b]									

Dependent Variable: CK

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.9 Poisson log-linear regression for penalty box possession

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	PBP	64	0	23	9.59	5.871

Goodness of Fit[a]

	Value	df	Value/df
Deviance	196.579	57	3.449
Scaled Deviance	57.000	57	
Pearson Chi-Square	165.956	57	2.912
Scaled Pearson Chi-Square	48.121	57	
Log Likelihood[b,c]	-217.005		
Adjusted Log Likelihood[d]	-62.923		
Akaike's Information Criterion (AIC)	448.010		
Finite Sample Corrected AIC (AICC)	450.010		
Bayesian Information Criterion (BIC)	463.122		
Consistent AIC (CAIC)	470.122		

Dependent Variable: PBP

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
19.695	6	.003

Dependent Variable: PBP

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.9 Poisson log-linear regression for penalty box possession (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	2.696	.1603	2.382	3.010	282.819	1	.000	14.816	10.821	20.284
[Match Venue=1]	-.160	.1526	-.460	.139	1.105	1	.293	.852	.632	1.149
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.341	.1970	-.727	.045	3.004	1	.083	.711	.483	1.046
[Opposition Quality=2]	-.206	.1777	-.554	.143	1.339	1	.247	.814	.575	1.153
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.263	.2032	-.662	.135	1.679	1	.195	.769	.516	1.144
[Match Status=2]	.028	.1787	-.323	.378	.024	1	.877	1.028	.724	1.459
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.695	.2323	-1.151	-.240	8.964	1	.003	.499	.316	.786
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.449[b]									

Dependent Variable: PBP

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.10 Poisson log-linear regression for counter attack

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	CA	64	0	16	3.42	3.380

Goodness of Fit[a]

	Value	df	Value/df
Deviance	182.556	57	3.203
Scaled Deviance	57.000	57	
Pearson Chi-Square	172.247	57	3.022
Scaled Pearson Chi-Square	53.781	57	
Log Likelihood[b,c]	-168.497		
Adjusted Log Likelihood[d]	-52.610		
Akaike's Information Criterion (AIC)	350.994		
Finite Sample Corrected AIC (AICC)	352.994		
Bayesian Information Criterion (BIC)	366.106		
Consistent AIC (CAIC)	373.106		

Dependent Variable: CA

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
10.336	6	.111

Dependent Variable: CA

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.10 Poisson log-linear regression for counter attack (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	1.365	.2780	.820	1.910	24.089	1	.000	3.914	2.270	6.750
[Match Venue=1]	.053	.2441	-.425	.532	.048	1	.827	1.055	.654	1.702
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	.048	.3112	-.562	.658	.024	1	.878	1.049	.570	1.931
[Opposition Quality=2]	-.076	.2985	-.661	.509	.065	1	.799	.927	.516	1.664
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	.290	.2816	-.262	.842	1.060	1	.303	1.336	.770	2.321
[Match Status=2]	-.363	.3320	-1.014	.288	1.195	1	.274	.696	.363	1.333
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.752	.3935	-1.523	.019	3.656	1	.056	.471	.218	1.019
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.203[b]									

Dependent Variable: CA

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.11 Poisson log-linear regression for ratio of attacking to depending players

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	RAD	64	0	11	2.36	2.710

Goodness of Fit[a]

	Value	df	Value/df
Deviance	177.881	57	3.121
Scaled Deviance	57.000	57	
Pearson Chi-Square	173.284	57	3.040
Scaled Pearson Chi-Square	55.527	57	
Log Likelihood[b,c]	-151.076		
Adjusted Log Likelihood[d]	-48.411		
Akaike's Information Criterion (AIC)	316.152		
Finite Sample Corrected AIC (AICC)	318.152		
Bayesian Information Criterion (BIC)	331.264		
Consistent AIC (CAIC)	338.264		

Dependent Variable: RAD

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
5.231	6	.515

Dependent Variable: RAD

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.11 Poisson log-linear regression for ratio of attacking to depending players (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	1.221	.3158	.602	1.840	14.955	1	.000	3.392	1.826	6.299
[Match Venue=1]	-.105	.2917	-.677	.467	.130	1	.719	.900	.508	1.595
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	.022	.3673	-.698	.742	.004	1	.952	1.022	.498	2.100
[Opposition Quality=2]	-.158	.3568	-.857	.542	.196	1	.658	.854	.424	1.719
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.294	.3830	-1.044	.457	.588	1	.443	.745	.352	1.579
[Match Status=2]	-.211	.3564	-.909	.487	.351	1	.554	.810	.403	1.628
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	-.801	.4499	-1.683	.080	3.174	1	.075	.449	.186	1.084
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.121[b]									

Dependent Variable: RAD

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.12 Poisson log-linear regression for successful cross

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	SC	64	0	18	6.95	4.809

Goodness of Fit[a]

	Value	df	Value/df
Deviance	171.340	57	3.006
Scaled Deviance	57.000	57	
Pearson Chi-Square	164.309	57	2.883
Scaled Pearson Chi-Square	54.661	57	
Log Likelihood[b,c]	-195.401		
Adjusted Log Likelihood[d]	-65.004		
Akaike's Information Criterion (AIC)	404.801		
Finite Sample Corrected AIC (AICC)	406.801		
Bayesian Information Criterion (BIC)	419.913		
Consistent AIC (CAIC)	426.913		

Dependent Variable: SC

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
15.659	6	.016

Dependent Variable: SC

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.12 Poisson log-linear regression for successful cross (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	2.046	.1915	1.671	2.421	114.164	1	.000	7.736	5.315	11.258
[Match Venue=1]	-.121	.1698	-.454	.211	.511	1	.475	.886	.635	1.235
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.445	.2158	-.868	-.022	4.254	1	.039	.641	.420	.978
[Opposition Quality=2]	-.157	.1984	-.545	.232	.623	1	.430	.855	.580	1.261
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.208	.2500	-.698	.282	.694	1	.405	.812	.497	1.325
[Match Status=2]	.514	.1836	.155	.874	7.854	1	.005	1.673	1.167	2.397
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	.034	.2035	-.365	.433	.028	1	.867	1.035	.694	1.542
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	3.006[b]									

Dependent Variable: SC

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.13 Poisson log-linear regression for successful shot

Continuous Variable Information

		N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable	SS	64	0	11	3.56	2.760

Goodness of Fit[a]

	Value	df	Value/df
Deviance	146.305	57	2.567
Scaled Deviance	57.000	57	
Pearson Chi-Square	123.334	57	2.164
Scaled Pearson Chi-Square	48.051	57	
Log Likelihood[b,c]	-154.897		
Adjusted Log Likelihood[d]	-60.347		
Akaike's Information Criterion (AIC)	323.794		
Finite Sample Corrected AIC (AICC)	325.794		
Bayesian Information Criterion (BIC)	338.907		
Consistent AIC (CAIC)	345.907		

Dependent Variable: SS

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

c. The log likelihood is based on a scale parameter fixed at 1.

d. The adjusted log likelihood is based on an estimated scale parameter and is used in the model fitting omnibus test.

Omnibus Test[a]

Likelihood Ratio Chi-Square	df	Sig.
8.193	6	.224

Dependent Variable: SS

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player[a]

a. Compares the fitted model against the intercept-only model.

Appendix 5.3 Poisson log-linear Regression results for thirteen dependent variables for Study 3 (contd.)

5.3.13 Poisson log-linear regression for successful shot (contd.)

Parameter Estimates

Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
			Lower	Upper	Wald Chi-Square	df	Sig.		Lower	Upper
(Intercept)	1.287	.2555	.786	1.787	25.352	1	.000	3.621	2.194	5.974
[Match Venue=1]	.196	.2170	-.230	.621	.812	1	.367	1.216	.795	1.861
[Match Venue=2]	0[a]	.	.	.	.	.	.	1	.	.
[Opposition Quality=1]	-.379	.2880	-.943	.186	1.728	1	.189	.685	.389	1.204
[Opposition Quality=2]	.084	.2581	-.422	.589	.105	1	.746	1.087	.656	1.803
[Opposition Quality=3]	0[a]	.	.	.	.	.	.	1	.	.
[Match Status=1]	-.530	.3401	-1.197	.136	2.432	1	.119	.588	.302	1.146
[Match Status=2]	.158	.2387	-.310	.626	.438	1	.508	1.171	.734	1.870
[Match Status=3]	0[a]	.	.	.	.	.	.	1	.	.
[Key Player=1]	.009	.2691	-.518	.537	.001	1	.972	1.009	.596	1.710
[Key Player=2]	0[a]	.	.	.	.	.	.	1	.	.
(Scale)	2.567[b]									

Dependent Variable: SS

Model: (Intercept), Match Venue, Opposition Quality, Match Status, Key Player

a. Set to zero because this parameter is redundant.

b. Computed based on the deviance.

Appendix 5.4 Univariate analysis of variance for interaction of match status and key player for Study 3

5.4.1 Univariate analysis for Midfield line break

Tests of Between-Subjects Effects

Dependent Variable: Midfield line break

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	80.857[a]	5	16.171	.619	.686
Intercept	855.160	1	855.160	32.745	.000
Match Status	1.515	2	.757	.029	.971
Key Player	29.527	1	29.527	1.131	.292
Match Status * Key Player	2.429	2	1.215	.047	.955
Error	1514.697	58	26.115		
Total	4250.380	64			
Corrected Total	1595.554	63			

a. R Squared = .051 (Adjusted R Squared = -.031)

5.4.2 Univariate analysis for Zone 14

Tests of Between-Subjects Effects

Dependent Variable: Zone 14

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	253.398[a]	5	50.680	2.053	.085
Intercept	1687.070	1	1687.070	68.335	.000
Match Status	100.840	2	50.420	2.042	.139
Key Player	18.575	1	18.575	.752	.389
Match Status * Key Player	3.947	2	1.973	.080	.923
Error	1431.922	58	24.688		
Total	6925.270	64			
Corrected Total	1685.320	63			

a. R Squared = .150 (Adjusted R Squared = .077)

Appendix 5.4 Univariate analysis of variance for interaction of match status and key player for Study 3 (contd.)

5.4.3 Univariate analysis for Wide area

Tests of Between-Subjects Effects

Dependent Variable: Wide area

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	641.685[a]	5	128.337	1.225	.309
Intercept	10519.151	1	10519.151	100.375	.000
Match Status	264.072	2	132.036	1.260	.291
Key Player	111.737	1	111.737	1.066	.306
Match Status * Key Player	102.190	2	51.095	.488	.617
Error	6078.285	58	104.798		
Total	38582.220	64			
Corrected Total	6719.970	63			

a. R Squared = .095 (Adjusted R Squared = .018)

5.4.4 Univariate analysis for Counter attack chance

Tests of Between-Subjects Effects

Dependent Variable: Counter attack chance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	350.982[a]	5	70.196	3.179	.013
Intercept	1260.753	1	1260.753	57.100	.000
Match Status	263.494	2	131.747	5.967	.004
Key Player	.057	1	.057	.003	.960
Match Status * Key Player	129.623	2	64.811	2.935	.061
Error	1280.628	58	22.080		
Total	4680.030	64			
Corrected Total	1631.610	63			

a. R Squared = .215 (Adjusted R Squared = .147)

Appendix 5.4 Univariate analysis of variance for interaction of match status and key player for Study 3 (contd.)

5.4.5 Univariate analysis for Free kick

Tests of Between-Subjects Effects

Dependent Variable: Free kick

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	28.048[a]	5	5.610	1.129	.356
Intercept	231.907	1	231.907	46.655	.000
Match Status	10.819	2	5.409	1.088	.344
Key Player	2.204	1	2.204	.443	.508
Match Status * Key Player	5.336	2	2.668	.537	.588
Error	288.300	58	4.971		
Total	906.230	64			
Corrected Total	316.347	63			

a. R Squared = .089 (Adjusted R Squared = .010)

5.4.6 Univariate analysis for Corner kick

Tests of Between-Subjects Effects

Dependent Variable: Corner kick

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	195.603[a]	5	39.121	2.447	.044
Intercept	526.770	1	526.770	32.945	.000
Match Status	81.446	2	40.723	2.547	.087
Key Player	22.799	1	22.799	1.426	.237
Match Status * Key Player	14.032	2	7.016	.439	.647
Error	927.381	58	15.989		
Total	2934.550	64			
Corrected Total	1122.984	63			

a. R Squared = .174 (Adjusted R Squared = .103)

Appendix 5.4 Univariate analysis of variance for interaction of match status and key player for Study 3 (contd.)

5.4.7 Univariate analysis for Penalty box possession

Tests of Between-Subjects Effects

Dependent Variable: Penalty box possession

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	126.759[a]	5	25.352	1.216	.313
Intercept	751.275	1	751.275	36.022	.000
Match Status	25.097	2	12.548	.602	.551
Key Player	49.250	1	49.250	2.361	.130
Match Status * Key Player	3.766	2	1.883	.090	.914
Error	1209.664	58	20.856		
Total	4057.350	64			
Corrected Total	1336.424	63			

a. R Squared = .095 (Adjusted R Squared = .017)

5.4.8 Univariate analysis for Counter attack

Tests of Between-Subjects Effects

Dependent Variable: Counter attack

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	44.277[a]	5	8.855	.872	.505
Intercept	140.584	1	140.584	13.849	.000
Match Status	13.359	2	6.679	.658	.522
Key Player	10.579	1	10.579	1.042	.312
Match Status * Key Player	20.857	2	10.428	1.027	.364
Error	588.767	58	10.151		
Total	1111.560	64			
Corrected Total	633.044	63			

a. R Squared = .070 (Adjusted R Squared = -.010)

Appendix 5.4 Univariate analysis of variance for interaction of match status and key player for Study 3 (contd.)

5.4.9 Univariate analysis for Ratio of attacking to defending players

Tests of Between-Subjects Effects

Dependent Variable: Ratio of attacking to defending players

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	36.342[a]	5	7.268	1.308	.273
Intercept	89.339	1	89.339	16.080	.000
Match Status	13.054	2	6.527	1.175	.316
Key Player	.143	1	.143	.026	.873
Match Status * Key Player	6.166	2	3.083	.555	.577
Error	322.247	58	5.556		
Total	615.790	64			
Corrected Total	358.589	63			

a. R Squared = .101 (Adjusted R Squared = .024)

5.4.10 Univariate analysis for Successful cross

Tests of Between-Subjects Effects

Dependent Variable: Successful cross

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	317.934[a]	5	63.587	3.253	.012
Intercept	1111.026	1	1111.026	56.845	.000
Match Status	193.412	2	96.706	4.948	.010
Key Player	4.204	1	4.204	.215	.645
Match Status * Key Player	11.649	2	5.824	.298	.743
Error	1133.596	58	19.545		
Total	4055.080	64			
Corrected Total	1451.529	63			

a. R Squared = .219 (Adjusted R Squared = .152)

Appendix 5.4 Univariate analysis of variance for interaction of match status and key player for Study 3 (contd.)

5.4.11 Univariate analysis for Successful shot

Tests of Between-Subjects Effects

Dependent Variable: Successful shot

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	57.428[a]	5	11.486	1.673	.156
Intercept	201.424	1	201.424	29.334	.000
Match Status	19.275	2	9.637	1.404	.254
Key Player	.967	1	.967	.141	.709
Match Status * Key Player	1.097	2	.548	.080	.923
Error	398.262	58	6.867		
Total	1036.500	64			
Corrected Total	455.690	63			

a. R Squared = .126 (Adjusted R Squared = .051)

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3

5.5.1 Simple main effects analysis for Midfield line break

Tests of Significance for MLB using UNIQUE sums of squares

Dependent Variable: Midfield line break

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1544.22	59	26.17		
Match status within Key Player (1)	2.92	2	1.46	0.06	0.95
Match status within Key Player (2)	45.01	2	22.50	0.86	0.43
(Model)	51.33	4	12.83	0.49	0.74
(Total)	1595.55	63	25.33		

Tests of Significance for MLB using UNIQUE sums of squares

Dependent Variable: Midfield line break

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1516.21	60	25.27		
Key Player within Match status (1)	18.08	1	18.08	0.72	0.40
Key Player within Match status (2)	53.09	1	53.09	2.10	0.15
Key Player within Match status (3)	21.04	1	21.04	0.83	0.37
(Model)	79.34	3	26.45	1.05	0.38
(Total)	1595.55	63	25.33		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.2 Simple main effects analysis for Zone 14

Tests of Significance for Z14 using UNIQUE sums of squares

Dependent Variable: Zone 14

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1450.50	59	24.58		
Match status within Key Player (1)	212.14	2	106.07	4.31	0.02
Match status within Key Player (2)	22.60	2	11.30	0.46	0.63
(Model)	234.82	4	58.71	2.39	0.06
(Total)	1685.32	63	26.75		

Tests of Significance for Z14 using UNIQUE sums of squares

Dependent Variable: Zone 14

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1532.76	60	25.55		
Key Player within Match status (1)	77.17	1	77.17	3.02	0.09
Key Player within Match status (2)	20.46	1	20.46	0.80	0.37
Key Player within Match status (3)	34.96	1	34.96	1.37	0.25
(Model)	152.56	3	50.85	1.99	0.13
(Total)	1685.32	63	26.75		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.3 Simple main effects analysis for Wide area

Tests of Significance for WA using UNIQUE sums of squares

Dependent Variable: Wide area

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	6190.02	59	104.92		
Match status within Key Player (1)	279.63	2	139.81	1.33	0.27
Match status within Key Player (2)	241.30	2	120.65	1.15	0.32
(Model)	529.95	4	132.49	1.26	0.30
(Total)	6719.97	63	106.67		

Tests of Significance for WA using UNIQUE sums of squares

Dependent Variable: Wide area

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	6342.36	60	105.71		
Key Player within Match status (1)	36.69	1	36.69	0.35	0.56
Key Player within Match status (2)	256.86	1	256.86	2.43	0.12
Key Player within Match status (3)	42.81	1	42.81	0.40	0.53
(Model)	377.61	3	125.87	1.19	0.32
(Total)	6719.97	63	106.67		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.4 Simple main effects analysis for Counter attack chance

Tests of Significance for CAC using UNIQUE sums of squares

Dependent Variable: Couner attack chance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1280.69	59	21.71		
Match status within Key Player (1)	44.53	2	22.26	1.03	0.37
Match status within Key Player (2)	305.23	2	152.62	7.03	<0.05
(Model)	350.92	4	87.73	4.04	<0.05
(Total)	1631.61	63	25.90		

Tests of Significance for CAC using UNIQUE sums of squares

Dependent Variable: Counter attack chance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1544.12	60	25.74		
Key Player within Match status (1)	29.08	1	29.08	1.13	0.29
Key Player within Match status (2)	2.54	1	2.54	0.10	0.76
Key Player within Match status (3)	53.38	1	53.38	2.07	0.16
(Model)	87.49	3	29.16	1.13	0.34
(Total)	1631.61	63	25.90		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.5 Simple main effects analysis for Free kick

Tests of Significance for FK using UNIQUE sums of squares

Dependent Variable: Free kick

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	290.50	59	4.92		
Match status within Key Player (1)	24.90	2	12.45	2.53	0.09
Match status within Key Player (2)	2.29	2	1.14	0.23	0.79
(Model)	25.84	4	6.46	1.31	0.28
(Total)	316.35	63	5.02		

Tests of Significance for FK using UNIQUE sums of squares

Dependent Variable: Free kick

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	299.12	60	4.99		
Key Player within Match status (1)	2.57	1	2.57	0.52	0.48
Key Player within Match status (2)	3.53	1	3.53	0.71	0.40
Key Player within Match status (3)	9.68	1	9.68	1.94	0.17
(Model)	17.23	3	5.74	1.15	0.34
(Total)	316.35	63	5.02		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.6 Simple main effects analysis for Corner kick

Tests of Significance for CK using UNIQUE sums of squares

Dependent Variable: Corner kick

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	950.18	59	16.10		
Match status within Key Player (1)	123.10	2	61.55	3.82	0.03
Match status within Key Player (2)	48.25	2	24.13	1.50	0.23
(Model)	172.80	4	43.20	2.68	0.04
(Total)	1122.98	63	17.83		

Tests of Significance for CK using UNIQUE sums of squares

Dependent Variable: Corner kick

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1008.83	60	16.81		
Key Player within Match status (1)	30.08	1	30.08	1.79	0.19
Key Player within Match status (2)	44.46	1	44.46	2.64	0.11
Key Player within Match status (3)	23.93	1	23.93	1.42	0.24
(Model)	114.16	3	38.05	2.26	0.09
(Total)	1122.98	63	17.83		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.7 Simple main effects analysis for Penalty box possession

Tests of Significance for PBP using UNIQUE sums of squares

Dependent Variable: Penalty box possession

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1258.91	59	21.34		
Match status within Key Player (1)	50.43	2	25.21	1.18	0.31
Match status within Key Player (2)	23.31	2	11.65	0.55	0.58
(Model)	77.51	4	19.38	0.91	0.47
(Total)	1336.42	63	21.21		

Tests of Significance for PBP using UNIQUE sums of squares

Dependent Variable: Penalty box possession

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1234.76	60	20.58		
Key Player within Match status (1)	0.93	1	0.93	0.05	0.83
Key Player within Match status (2)	67.56	1	67.56	3.28	0.08
Key Player within Match status (3)	30.81	1	30.81	1.50	0.23
(Model)	101.66	3	33.89	1.65	0.19
(Total)	1336.42	63	21.21		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.8 Simple main effects analysis for Counter attack

Tests of Significance for CA using UNIQUE sums of squares

Dependent Variable: Counter attack

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	599.35	59	10.16		
Match status within Key Player (1)	1.05	2	0.52	0.05	0.95
Match status within Key Player (2)	32.49	2	16.25	1.60	0.21
(Model)	33.70	4	8.42	0.83	0.51
(Total)	633.04	63	10.05		

Tests of Significance for CA using UNIQUE sums of squares

Dependent Variable: Counter attack

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	602.13	60	10.04		
Key Player within Match status (1)	1.63	1	1.63	0.16	0.69
Key Player within Match status (2)	1.18	1	1.18	0.12	0.73
Key Player within Match status (3)	29.38	1	29.38	2.93	0.09
(Model)	30.92	3	10.31	1.03	0.39
(Total)	633.04	63	10.05		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.9 Simple main effects analysis for Ratio of attacking to defending players

Tests of Significance for RAD using UNIQUE sums of squares

Dependent Variable: Ratio of attacking to defending players

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	322.39	59	5.46		
Match status within Key Player (1)	19.47	2	9.74	1.78	0.18
Match status within Key Player (2)	13.77	2	6.88	1.26	0.29
(Model)	36.20	4	9.05	1.66	0.17
(Total)	358.59	63	5.69		

Tests of Significance for RAD using UNIQUE sums of squares

Dependent Variable: Ratio of attacking to defending players

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	335.30	60	5.59		
Key Player within Match status (1)	4.55	1	4.55	0.81	0.37
Key Player within Match status (2)	10.20	1	10.20	1.83	0.18
Key Player within Match status (3)	5.69	1	5.69	1.02	0.32
(Model)	23.29	3	7.76	1.39	0.26
(Total)	358.59	63	5.69		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.10 Simple main effects analysis for Succesesful cross

Tests of Significance for SC using UNIQUE sums of squares

Dependent Variable: Successful cross

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1137.80	59	19.28		
Match status within Key Player (1)	236.17	2	118.08	6.12	<0.01
Match status within Key Player (2)	72.25	2	36.13	1.87	0.16
(Model)	313.73	4	78.43	4.07	<0.01
(Total)	1451.53	63	23.04		

Tests of Significance for SC using UNIQUE sums of squares

Dependent Variable: Successful cross

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	1327.01	60	22.12		
Key Player within Match status (1)	106.99	1	106.99	4.84	0.03
Key Player within Match status (2)	19.02	1	19.02	0.86	0.36
Key Player within Match status (3)	7.76	1	7.76	0.35	0.56
(Model)	124.52	3	41.51	1.88	0.14
(Total)	1451.53	63	23.04		

Appendix 5.5 Simple main effects analysis for interaction of match status and key player for Study 3 (contd.)

5.5.11 Simple main effects analysis for Successful shot

Tests of Significance for SS using UNIQUE sums of squares

Dependent Variable: Successful shot

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	399.23	59	6.77		
Match status within Key Player (1)	39.12	2	19.56	2.89	0.06
Match status within Key Player (2)	18.57	2	9.28	1.37	0.26
(Model)	56.46	4	14.12	2.09	0.09
(Total)	455.69	63	7.23		

Tests of Significance for SS using UNIQUE sums of squares

Dependent Variable: Successful shot

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Within residual	417.54	60	6.96		
Key Player within Match status (1)	37.25	1	37.25	5.35	0.02
Key Player within Match status (2)	4.13	1	4.13	0.59	0.44
Key Player within Match status (3)	0.05	1	0.05	0.01	0.94
(Model)	38.15	3	12.72	1.83	0.15
(Total)	455.69	63	7.23		