Sports performance analysis and the analyst in elite wheelchair basketball

J. Francis

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Abstract

Despite the rise in accessibility of Sports Performance Analysis (SPA), limited attention has been given to understanding how it is used within disability sports. This thesis interpreted the impact of a SPA provision for a men's wheelchair basketball team and the role of the analyst throughout the Rio de Janeiro Paralympic Games cycle (2013-2017) using a mixed methods approach. Through discussions with wheelchair basketball staff, a novel valid and reliable team-specific SPA template was developed for elite men's wheelchair basketball. The template was used to identify the key determinants of team success by analysing 31 games from the 2015 European Wheelchair Basketball Championships. The analysis highlighted the importance of the status of the game at the beginning of a possession, the type of defensive systems faced by the team in possession and the line-up configurations used by the offensive and defensive team. Further analysis of field-goal shot attempts (1,144 shots) from the top five teams from the 2015 European Wheelchair Basketball Championships indicated the importance of the shooting player's shot position, shot location, shot type and shooting with least defensive pressure.

The key findings from these initial studies were disseminated to the British Wheelchair Basketball (BWB) coaches, players and support staff. The data were presented in an attempt to aid the training regimes, the decision-making process of coaches and players, and selection choices, as well as informing upcoming game strategies. A comparison of the team and shooting performances of the men's BWB team during the 2016 Paralympic Games to the performances at the 2015 European Wheelchair Basketball Championships was completed. This comparison indicated the performances only partially aligned with the advice, however, quantifiable improvements were observed regarding the efficiencies of a number of areas.

Following the 2016 Paralympic Games exploratory work was undertaken, moving away from the traditional positivist paradigm within the field to an interpretivist perspective, to understand if the coaches, players and support staff had elected to use the data from the initial studies. The experiences of the coaches, players, support staff and the analyst were thematically analysed to present a story of the participants' perceptions. Informed by the narratives, the establishment of trust was found to be key in cultivating relationships with coaches, players and support staff to increase awareness and buy-in of SPA. The arising power and micropolitical interplay between the coach, players and analyst can be softened through the development of rapport, which can, in turn, lead to an increase in the engagement with SPA by all stakeholders.

Overall the findings of this thesis suggested regardless of how accurate the SPA data are at identifying the key determinates of success, without the buy-in of the coaches and the foundation of trust between all individuals within the SPA process, the marginal gains which SPA could unlock cannot emerge. Subsequently, a new model of how SPA can inform the coaching process is presented. The thesis also highlighted the importance of acknowledging that performance analysts should not just be seen as individuals who work and produce numbers but people who work with people and thus play an important role in making a direct and important contribution to elite wheelchair basketball performance.

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Glossary of key terms

Sports Performance Analysis: The process of recording an individual's or team's actions or behaviours during training or games, which are linked to the video, generating a number-based matrix of critical actions in an attempt to identify patterns of performance. The terms match analysis, notational analysis and game analysis have been used interchangeably in the previous research.

Performance analyst: The individual who undertakes Sports Performance Analysis and reports the findings back to the coaches, players and support staff.

Elite sport: Sport involving athletes or players who regularly compete at international level, attending Paralympic Games, and are funded from the Government and the National Lottery to support their development.

High Performance Programme: A system which supports elite athletes and coaches improve performance through the expert delivery of science, medicine and technology (UKSport, 2016).

British Wheelchair Basketball: The governing body for wheelchair basketball in the United Kingdom. It is a registered charity and is the representative body of wheelchair basketball in England, Northern Ireland, Scotland and Wales. British Wheelchair Basketball selects teams to represent the nation at European, World, and Paralympic Championships. During competitions, the teams compete under the 'Great Britain' or GBR label.

Discrete action variable: A variable which represented an individual's or team's action or behaviour in isolation with no contextual information.

Sequential action variable: A variable that represented an individual's or team's action or behaviour but provided additional context or critical information.

Coaching team: The coaches who form the wider coaching team, i.e. head coach, assistant coach, skills coach, development coach, etc.

Support staff: Individuals who undertake a role related to a scientific discipline, these include physiology, strength and conditioning, sports psychology, sports therapy and rehabilitation, and sports medicine.

Categorical Predictor Variable: The term used to define a collection of action variables, which are placed within a specific category. During an analysed performance, each categorical predictor variable is limited to selecting a single action variable.

International Wheelchair Basketball Federation Player Classification System: "Wheelchair basketball classification is the grouping of players into 8 classes (categories), based on the player's physical capacity to execute fundamental basketball movements…players are assigned a classification between 1.0 and 4.5 in half-point increments. This classification value is the player's "playing points" on the court. At any given time in a game, the total points assigned to a team of five players on court must not exceed 14" (International Wheelchair Basketball Federation, 2014a, p.5). A player's classification is determined by "the limit to which a player can move voluntarily in any direction, and with control return to the upright seated position" (International Wheelchair Basketball Federation, 2014a, p.8). Information is provided in the below table, half-point classifications are awarded to players who do not fit exactly into one class.

Table 0-1: Typical volume of action for each primary classification according to the International Wheelchair Basketball Federation (2014a) player classification manual.

Class 1.0	No active rotation, sideways movement and limited control in a forward plane.
Class 2.0	Active upper trunk rotation, no lower trunk rotation and no sideways movement but, partial controlled movement in a forward plane.
Class 3.0	Complete trunk movement in vertical and forward planes but no controlled movements in a sideways plane
Class 4.0	Complete trunk movements in all three planes, but sideways movement limited to one side.
Class 4.5	Has complete trunk movements in all three planes.

Abbreviations and acronyms

%D	Percentage Distribution
AIC	Akaike Information Criterion
ANOVA	Analysis of Variance
AUC	Area Under the Curve
b	Estimated regression coefficient
BWB	British Wheelchair Basketball
CBGS	Comprehensive Basketball Grading System
CPV	Categorical Predictor Variable
DST	Dynamic Systems Theory
GLiRM	Generalised Linear Regression Modelling
GLoRM	Generalised Logistic Regression Modelling
IWBF	International Wheelchair Basketball Federation
IWRF	International Wheelchair Rugby Federation
LiRM	Linear Regression Modelling
LoRM	Logistic Regression Modelling
MANOVA	Multivariate Analysis of Variance
NBA	National Basketball Association
Ob1	First intra-observer agreement observation
Ob2	Second intra-observer agreement observation
Ob3	Agreed intra-observer agreement observation
Ob4	Coach's inter-observer agreement observation
Ob5	Performance analyst intern's inter-observer agreement observation
OR	Odds Ratio
ROC	Receiver Operating Characteristic
SPA	Sports Performance Analysis
USA	The United States of America
VIF	Variance Inflation Factors

Chapter 1 Introduction

Wheelchair basketball is an invasion sport played by people in wheelchairs with varying physical disabilities with a primary objective of scoring more baskets than their opponents (Frogley, 2010). To achieve this objective, the offensive team endeavour to progress the ball towards the basket by coordinating actions in an attempt to position themselves close to the basket, whilst the defensive team coordinate actions to restrict the offensive players' space to shot and regain possession. The rules of wheelchair basketball are very similar to running basketball albeit with basic rule adaptions to meet the needs of the game in a wheelchair (International Wheelchair Basketball Federation, 2014b). Teams consist of players with a range of disabilities, including amputations, birth defects, cerebral palsy, paralysis due to an accident and spina bifida amongst others (Gil-Agudo, Del Ama-Espinosa and Crespo-Ruiz, 2010). To ensure fair and equitable competition the International Wheelchair Basketball Federation (IWBF) introduced a 'Functional Player Classification System' in 1984 to assess a player's functional capacity to push, pivot, shoot, rebound, dribble, pass and catch (International Wheelchair Basketball Federation, 2014a). The current classification system comprises of eight sport classes (Classes 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0 and 4.5) with half-point classes being used for borderline cases. During a game, the maximum total points of the five on-court players per team must not exceed 14.

Since being introduced in the 1940s as part of rehabilitation programmes for military veterans with spinal cord injuries (Thiboutot and Craven, 1996), wheelchair basketball has continued to grow into one of the most popular sports for individuals with disabilities (Sporner *et al.*, 2009). The Paralympic Games is the pinnacle of the sport (Legg and Steadward, 2011) and wheelchair basketball has featured at every Paralympic Games since the inaugural event in Rome in the summer of 1960 (Thiboutot and Craven, 1996). The IWBF which organises wheelchair basketball's involvement in the Paralympic Games, also overseas other major tournaments including zonal qualifications and World

Championships. The increasing growth in the sport, now being played by over 105 nations (International Wheelchair Basketball Federation, 2016), has led to the performance gap between participation and qualification into a World Championships or Paralympic Games becoming increasingly difficult. For example, the London 2012 Paralympic Games gold medallist in men's wheelchair basketball failed to qualify in the zonal qualification tournament for the 2014 World Championships losing to Mexico in the quarter-finals (International Paralympic Committee 2013).

Nations have elected to become more strategic in the way athletes and teams prepare for competitions (de Bosscher *et al.*, 2008). Directors of sports programmes have realised that they are required to move beyond coaching as the sole platform for improving elite performance (Nolan, 2008; Reade, Rodgers and Spriggs, 2008). Programmes have combined coaches' knowledge with the expertise of sports science and sports medicine disciplines to gain a competitive edge, aid in securing qualification and allow a team to compete for the all-important gold medal (Durrand, Batterham and Danjoux, 2014; Patel, 2016). For example, Great Britain completed a collaborative project with Formula One giants McLaren, BMW, Loughborough University and RGK Wheelchairs to redesign the wheelchair basketball chair and seating system aiming to improve the stability and manoeuvrability of the chair (British Wheelchair Basketball 2012a). Whilst the Dutch national team worked on a similar project to reconfigure their wheelchairs and wheels with inMarket, Harting Bank, the Technical University Delft, The Hague University and InnoSportNL. In addition, the Dutch team also used visual control training to enhance their on-court shooting performance (Oudejans *et al.*, 2012).

One of the newest sports science disciplines to be used in wheelchair basketball, in collaboration with coaches' knowledge, involves the labelling and recording of sports specific actions and behaviours (Sampaio, McGarry and O'Donoghue, 2013). This process is referred to as 'sports performance analysis' (SPA). SPA "is used within a cycle of competing, reflecting, decision making and preparing for future competitions" (O'Donoghue, 2014, p.4) to provide objective feedback to the athlete/s and coaches in a bid to influence a positive change within their performance (Fliess-Douer *et al.*, 2016).

Traditionally the actions of an individual athlete and/or of a team's performance were observed and recorded by coaches (Laird and McLeod, 2009). These observations were largely qualitative, resulting in subjective and less comprehensive feedback being passed to the players (Jayal *et al.*, 2018). More recent developments in SPA software have led to systems that integrate video recordings and computer technology capable of collecting quantitative observations in an objective and systematic manner (Rein and Memmert, 2016). Specifically, trained individuals, known as performance analysts, are employed by teams to assist in integrating the data into the workflow and assist the decision-making processes of coaches, players and support staff (Drust, 2010). From these data, coaches and support staff have used the recorded information to provide objective evidence to support their subjective assessments. SPA has subsequently been used as a bridge to improve the coaches' ability or lack of ability, to recall previous performance information, due to limitations in external memory recall (Franks and Miller, 1986, 1991; Laird and Waters, 2008).

The ability to accurately assess performances through an objective lens (Castañer *et al.*, 2016), enables the numerical data to be used to identify areas of strength, weakness, opportunities for development and threats within the performance (Hibbs and O'Donoghue, 2013). Coaches and support staff have used the data collected by performance analysts to provide feedback to the athlete (Maslovat and Franks, 2015). The delivery of feedback has been shown to assist athletes in understanding their performance, aiding self-correction and enhancing the learning of the skill or behaviour (McGarry, 2009; Aiken, Fairbrother and Post, 2012; Nicholls and Worsfold, 2016). In addition, coaches are able to use the data to support the planning of training sessions, develop game plans and assist with the decision-making process during performances (Wright, Atkins and Jones, 2012). The observation, analysis and evaluation of performance that produces objective evidence to aid feedback and future planning has been referred to as the coaching process (Cushion, 2001). The increasing availability of SPA systems, performance analysts and research findings have supported the integration of the discipline into teams' workflows, with the coaching process proposed in 1983 by Franks, Goodman and Miller (See Figure 1-1) representing today's current practice albeit with specific personnel analysing the performance. However, reviews of SPA have highlighted a frequent disconnect between research and the application of the findings into practice due to a lack of situation-specific context (Hughes and Franks, 2004; Mackenzie and Cushion, 2013).

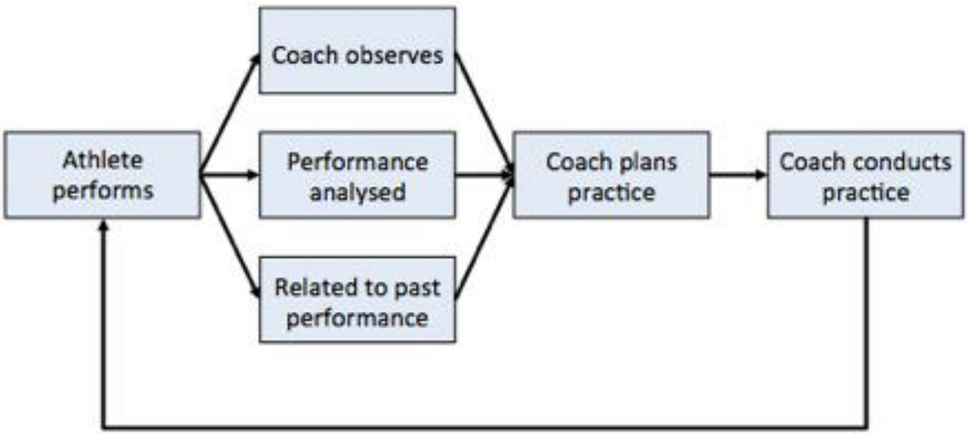


Figure 1-1: Diagram adapted from Franks, Goodman and Miller (1983) representing the coaching process.

Despite SPA research in wheelchair basketball being published since 1995, wheelchair basketball programmes have only recently employed performance analysts to bridge the gap in the coaches' knowledge and unlock objective marginal gains. Vanlandewijck, Spaepen and Lysens (1995) were the first researchers to use box-score data from performances during the 1992

Paralympic Games to explore the relationship between classification and on-court performance. Boxscore data is used to present a summary of an individual's in-game performance and makes use of 13 specific actions and behaviours. The box score data has been used to evaluate an individual's quality in relation to game performance through the Comprehensive Basketball Grading System (CBGS) (Byrnes, 1989). The system considered the following variables when calculating an individual's performance and assigned a total score and average score based on the minutes played: "field goals made (+5), field goals attempted (-2), free throws made (+5), free throws attempted (-2), offensive rebound (+3), defensive rebound (+2). loss of ball possession (-5), personal and technical fouls (-5), assists (+5), turnovers (-5), blocked shots (+3), steals (+5) and forced turnovers on defence (-5)" (Vanlandewijck, Spaepen and Lysens, 1995, p.141).

Vanlandewijck, Spaepen and Lysens (1995) reported that an individual's game efficiency is dependent on their classification, however, no variables were included to consider the individual's disability nor the skills of players in a wheelchair. Attempts were made by Vanlandewijck *et al.* (2003, 2004) to address this issue through the development of a modified CBGS, but the following variables were removed due to a misunderstanding in the operational definitions: back picks, forced turnovers in defence, and both fouls. Subsequently, further SPA research in wheelchair basketball (Molik and Kosmol, 2001; Molik *et al.*, 2009) has also elected to only use 12 instead of the 16 action variables proposed by Byrnes and Hedrick (1994). These variables, referred to as discrete action variables for the remainder of this thesis due to the lack of contextually specific information, do not provide researchers or coaches with holistic insights into game or training performances.

The most recent research in SPA completed by Gómez *et al.* (2014, 2015) combined the individual player box-score data of teams to provide objective insights into team performance in relation to the outcome of a game. Additionally, the researchers added situational variables in an attempt to address the lack of situation-specific context. However, the discrete action variables used in these studies, which are adopted from able-bodied basketball, have been questioned due to failing to provide a holistic and sequential insight into player's performance and thus do not address the issues of box-score data or the CBGS/modified CBGS. Additionally, the individual player discrete action variables do not present an insight into team-specific components. Further to this, Ziv, Lidor and Arnon (2010) highlighted coaches are unable to use the data from box-scores to guide learning and inform future decisions, due to the lack of content validity. Thus, the existing wheelchair basketball studies do not provide insight into the components of success because the findings lack context and situational-specific information (Carling *et al.*, 2014). Jayal *et al.* (2018) believed this was due to the fact that SPA research adopts an approach focused on measuring the cause-and-effect relationship between two variables. Whereas, coaches and performance analysts segment matches and training around the team's perspective in an attempt to ensure the messages coaches, players and performance staff receive are context and situational specific (Wright, Carling and Collins, 2014).

This recent shift in thinking has also resulted in an increase in research exploring the thoughts and experiences of those involved in the SPA process from a case study perspective. Following Blaze *et al.'s* (2004) seminal work exploring the perceptions of SPA in football, further studies have attempted to build on this research (Groom and Cushion, 2004, 2005; Groom, Cushion and Nelson, 2011; Butterworth, Turner and Johnstone, 2012; Wright *et al.*, 2013; Butterworth and Turner, 2014; Nelson, Potrac and Groom, 2014; Taylor *et al.*, 2014, 2017; Williams and Manley, 2014; Francis and Jones, 2014; Booroff, Nelson and Potrac, 2015; Huggan, Nelson and Potrac, 2015; Painczyk, Hendricks and Kraak, 2017; Vinson *et al.*, 2017; Fernandez-Echeverria *et al.*, 2017, 2019; Martin *et al.*, 2018; McKenna *et al.*, 2018; Nicholls *et al.*, 2018). Participants' perspectives have been collected through a variety of tools, including interviews, questionnaires, observations and field-notes, and researchers have been able to identify areas for improvements within the current SPA provision delivered at each club or team. The use of various different qualitative data collection tools has allowed data to be mediated through the researcher, allowing for a rich and deep understanding of key concepts (Atieno, 2009). For example, Wright, Atkins and Jones (2012) discovered that 91 per cent of a SPA provision was designed around the philosophy and needs of the team rather than a generalisable approach, whilst Reeves and Roberts (2013) discovered players believed a tailored and individualised provision assisted in improving their decision-making skills. The interpretative case study approaches adopted in the majority of these studies allowed for an in-depth, personalised and up-close examination of the SPA provision over a prolonged period of time (Baxter and Jack, 2008). The approach is a popular and useful method for applied disciplines allowing for the processes and provisions to be studied to "engender understanding that can improve practice" (Ponelis, 2015, p.536). As a result, through designing and deploying a SPA provision that collected situational and context-specific SPA data and tailored the feedback processes around the needs of the coaches, players and support staff, further objective improvements in performance can be observed (Nicholls *et al.*, 2018).

Adopting a mixed method approach would enable the schism between the traditional research approaches used in SPA and the new and emerging context and situational specific approaches designed around the needs of the users to be bridged (Hall, 2012; Jayal *et al.*, 2018). It would enable applied research to develop, deliver and evaluate provisions and techniques that are closely related to what the researchers use in practice (Johnson and Onwuegbuzie, 2004). Consequently, a mixed method approach, whereby attempts are made to connect the performance insights provided by qualitative and quantitative research together, would assist in enhancing new knowledge. Thus, this would help wheelchair basketball programmes move away from the traditional use of box-score data and the CBGS towards situational and context-specific objective SPA data that is developed around a team's philosophy and continuously evaluated to optimise the process and performance.

1.1 Background

Regardless of the limited wheelchair basketball SPA research, the benefits of SPA have been widely acknowledged (O'Donoghue, 2006; Eaves, 2015; Rein and Memmert, 2016) and thus programmes have subsequently begun using SPA and employing performance analysts. For example, during the London Paralympic Games cycle (2009-2013), wheelchair basketball coaches and players from a range of nations (Australia, Canada, Great Britain, the Netherlands and the United States of America) turned to SPA in an attempt to give them the edge over their competitors (for example, Wheelchair Basketball Canada, 2013). The teams relied on computerised software packages, such as Dartfish and SportsCode, to analyse matches and produce statistical reports instead of relying on box-score data. British Wheelchair Basketball (BWB) coaches had attempted to use SPA during the London Paralympic Games cycle (2009-2013), although they did not employ a performance analyst and struggled to find time to analyse the performance and translate the analytical findings into practice (British Wheelchair Basketball, 2013a). Following London 2012, the performance director, coaches, players and support staff identified SPA as a tool that would allow the men's team to achieve their performance target, which had been set as a medal at the 2016 Rio de Janeiro Paralympic Games by UKSport (2015). Thus, BWB made an executive decision to employ dedicated personnel to analyse performances and provide objective evidence to inform decision making processes of coaches, players and support staff during the Rio de Janeiro Paralympic Games cycle (2013-2017).

This thesis documents the processes undertaken to design, deliver and evaluate a SPA provision to assist the team in preparing for the 2016 summer Paralympic Games. Throughout the thesis process, a dual role as both the BWB men's performance analyst and a PhD student researcher was adopted. Specifically, this thesis outlined the stages undertaken to develop and deploy a SPA provision that moved away from the contextually redundant data towards meaningful analytical insights that would assist the learning of the coaches, players and support staff. In addition, the impact of the provision during the four-year period leading up to and including the 2016 Rio de Janeiro Paralympic Games was reviewed. Since the dual-role adopted focused on providing a SPA provision for the men's team, the thesis is delimited to male wheelchair basketball games that occurred at major competitions during the 2013-2017 Paralympic Games cycle. Although findings from the initial three empirical studies can be generalised to wider wheelchair basketball teams, the variables, terminology and other decisions regarding the direction of this thesis reflected those of the staff and players associated with BWB.

1.2 Aims and objectives of this thesis

Based on the above, the purpose of this thesis was to advance knowledge of the key tactical actions and variables attributed to success in elite wheelchair basketball and interpret the impact of a SPA provision that was provided to one elite men's wheelchair basketball team during the Rio de Janeiro Paralympic Games cycle (2013-2017) using a mixed methods case study approach. To achieve this aim, the research had four main objectives:

1. To design a tool that generates valid and reliable performance data and information in elite male wheelchair basketball.
2. To identify the key determinates of success that discriminate between successful and unsuccessful elite male wheelchair basketball teams.
3. To explore the effectiveness of individual key determinants of success and their impact on event outcome through predictive modelling.
4. To interpret the role of the analyst and understand how the SPA provision was perceived by the wheelchair basketball coaches, players and support staff throughout the Rio de Janeiro Paralympic Games cycle.

This thesis sought to aid the learning and the decision making process of coaches, players and support staff. Additionally, the findings from the this thesis offer insights into new practices for working with a performance analyst and using SPA data to assist teams in improving performances, as well as enhancing the understanding of SPA within the wider context of high performance disability sport.

1.3 Thesis structure

Following this introduction, Chapter Two provides a critical review of the literature surrounding SPA and is divided into five main sections. In the first section, literature relating to the theoretical approaches of SPA is explored. Focus then turns to evaluating the techniques used to gather valid and reliable data in section two. Section three focuses on previous SPA research in disability invasion team sports to identify the specific aspects of performance which have been explored. Section four examines how SPA research is beginning to use regression modelling methods to predict performance and section five critically evaluates the existing research surrounding the application of the SPA data and information into practice through an interpretive lens.

Chapter three details the development of a valid and reliable SPA template for recording and evaluating team performances in elite men's wheelchair basketball. Following a critical review of the validity and reliability procedures previously employed to develop SPA templates, the chapter details the process undertaken to develop a valid and reliable SPA template for analysing team performance within this study, including the processes used to determine validity and those used to assess both inter and intra-observer reliability. The chapter culminates with the presentation of the unique, valid and reliable SPA template.

Chapter Four uses the template developed in Chapter Three to investigate the determinants of team success in elite men's wheelchair basketball. A sample of 31 men's wheelchair basketball games was analysed from the 2015 European Wheelchair Basketball Championship. The sample of games consisted of all the top five nations' games during the tournament. The data were exported into categories and subjected to chi-squared tests. Statistically significant categories that are associated with the game's outcome were then used to make predictions with regression analysis to explore the effect of each action variable on the outcome of a game. The key findings were discussed and presented to the coaches, players and support staff of a wheelchair basketball team.

Building on the findings from Chapter Four, Chapter Five develops a valid and reliable field-goal shooting specific SPA template through analysis of 1,144 field-goal attempts from games that involved a top-five team playing another top-five team during the 2015 European Wheelchair Basketball Championships. The shot attempts were exported and subjected to univariable analyses. The statistically significant action variables were then used to make predictions with regression analysis which enabled the effect of each action variable on the outcome of field-goal shot success to be quantified. The findings from the model were discussed in relation to research and practical application. In an attempt to enhance players' shooting ability, the key determinates of shooting success were passed on to the coaching and support staff as well as the players.

Following the findings of Chapter Four and Chapter Five being presented to the BWB team prior to the 2016 Rio de Janeiro Paralympic Games, Chapter Six compares Great Britain's team and shooting performance from the 2015 European Wheelchair Basketball Championships to the 2016 Rio de Janeiro Paralympic Games. Percentage distributions of action variables, which were included in the team and shooting models developed from Chapter Four and Five, were presented from the two tournaments. The data were used to explore whether the BWB coaches, players and support staff adjusted game strategies based on the findings from the above chapters to improve the likelihood of success during the Paralympic Games.

Having provided the coaches, players and support staff with quantitative findings regarding the key determinates of success through the cycle, Chapter Seven aims to understand how, if at all, the data-informed or influenced practice and game strategies during the Rio de Janeiro Paralympic Games. To capture the individual's thoughts and opinions, a paradigm shift occurred whereby an interpretive approach was adopted, allowing for a rich and detailed narrative to be gained. Field notes were used to record observations and help guide semi-structured interview schedules. The interviews were transcribed verbatim and subjected to abductive analysis. Three key themes were identified and discussed. To assist in interpreting and constructing a story of the journey from the individuals' narratives, theoretical perspectives from a range of socio-political factors were drawn upon to explore the impact that the SPA provision and the role of the analyst within training, match preparations and in-game decision making.

Chapter Eight collates and discusses the research findings from Chapters Three to Seven in relation to the overall aim and objectives of this thesis. Through synergising the study findings, the main discussion, theoretical implications and new contribution to knowledge are presented. The thesis' strengths and limitations are presented in addition to the practical implications for coaches, players, support staff and performance analysts to consider. The final section of the chapter presents a number of recommendations for future research directions.

Chapter Nine, presents the overall thesis conclusions, re-stating the aim and objectives and how these were achieved, the main findings from the research and the thesis' original and significant contributions to knowledge.

Chapter 2 Literature review

2.1 Overview

A critical evaluation of the research pertinent to the PhD thesis is presented within this chapter and divided into five sections. The first section (2.2) explores Game Theory/Nash Equilibrium (von Neumann and Morgenstern, 1944; Nash, 1950), Interactive Performance Theory (O'Donoghue, 2009) and Dynamic Systems Theory (DST) in relation to how theoretical concepts could and have been used to underpin SPA research. The second section (2.3) critically evaluates the techniques that have previously been used for establishing a valid and reliable SPA template. The next section (2.4) addresses the existing SPA research topics in disability invasion team sports and identifies the gaps in current SPA research. The fourth section (2.5) critically examines the growing and shifting SPA direction, moving from a reactive to a proactive state of modelling and predicting future performance. The review of literature then culminates (2.6) with a critical evaluation of how and how well, SPA data and information have been used by coaches, athletes and support staff to inform the learning and performances of athletes and teams.

2.2 Theoretical perspectives in SPA

SPA can be used as a tool to provide:

> *"highly accurate, comprehensive and objective information to enable coaches to better interpret the complex nature of a sports performance, facilitate more effective decision-making and further improve the quality and provision of augmented feedback within the coaching process" (Nicholls and Worsfold, 2016, p. 831).*

The SPA process attempts to provide objective evidence to help to understand the dynamic and constant fluctuations that occur during team sports. Individual performers and teams will often display unique traits and/or behaviours regarding how they play, irrelevant of their opponent (Potter and Hughes, 2001; McGarry *et al.*, 2002; Hughes and Bartlett, 2015), and these traits and/or behaviours can be recorded to identify reoccurring patterns (McGarry and Perl, 2004). It is sometimes difficult, however, to identify common behavioural features under the continuously changing dynamics of a performance at different instances due to the unstable and complex nature of team sport (Araújo and Davids, 2016).

Attempts have been made to apply and/or develop a theoretical underpinning for SPA by drawing on a range of existing theoretical perspectives in biology, business, mathematics, political sciences and social sciences. However, researchers do not agree on a single theoretical perspective to use within the discipline due to the continual reductionist and positivist method of focusing on recording discrete 'on-the-ball' actions to identify and measure the relationship between behaviour and outcome (McGarry, 2009). Despite this, Game Theory/Nash Equilibrium (von Neumann and Morgenstern, 1944; Nash, 1950), Interactive Performance Theory (O'Donoghue, 2009) and DST have been used in SPA in an attempt "to obtain an appropriate scientific description of game behaviour" (McGarry, 2009, p.138).

One of the earliest theoretical frameworks to be applied to a SPA setting in an attempt to explain the decision making actions an individual makes was von Neumann and Morgenstern's Game Theory (1944). The theory explained how an individual's actions and behaviour when placed within a 1 v 1 social environment had a profound effect on the other individual (Heifetz, 2012). The theory analysed, interpreted and helped explain the supporting reasons for the individual's actions and how influencing factors affected their decisions. Game Theory can be explained as "a decision-making construct in which an interested player can determine his/her optimal course of action through the analysis of a mathematical method under a competitive or cooperative situation" (Lin 2014: p.762). However, the theory only recognised 1 v 1 scenarios and thus could not be applied to the entirety of situations in team sports. Nash (1950) used the principles of Game Theory to develop a concept: 'Nash Equilibrium'. The theoretical and mathematical perspective could be applied to situations that are greater than 1 v 1 scenarios. Nash equilibrium could, therefore, be applied to situations whereby players were involved in a non-cooperative game and used sets of optimal strategies to destabilise the relationship between the two competing teams to gain an advantage over an opponent (Sindik and Vidak, 2008). Nash equilibrium thus overcame a number of the limitations of von Neumann and Morgenstern's (1944) Game Theory.

Lin (2014) was found to be the only in-depth study that applied Game Theory and Nash Equilibrium to a volleyball scenario to identify an optimal offensive and defensive strategy for achieving success. The Nash Equilibrium principle relied on a state of equilibrium being achieved, however, Lin (2014) found that in volleyball no pure Nash equilibrium existed. When applying the theory, Lin (2014) only explored a one spiker versus two blockers scenario in a training environment and therefore did not take into consideration the positioning of the remaining players on-court. In addition, the theory was only applied in a training environment and therefore the behaviours of both the offensive and defensive players could have been manipulated by a coach attempting to focus on a specific weakness of a player. Further to this point, seven assumptions were made by Lin (2014), regarding volleyball game characteristics, players' skill level, strategy, decision-making principle, information set, available strategies and payoffs, but these were not recorded in the final equation and thus an unrealistic picture of the performance could have been collected. The sporadic application of Game Theory in SPA research could have been due to only viewing events in isolation and not considering the effect of a range of situational variables, however, the exact reasons are unknown.

O'Donoghue (2009) introduced a new theoretical concept, Interacting Performance Theory, in an attempt to provide a theoretical concept that could be applied to SPA through considering a range of situational variables, along with recognising the effect of the entire team on performance. The theory identified potential influencing performance factors that could occur during a sporting performance by considering the influence of the quality and type of opponent on the outcome and process of performance as well as recognising individual player tendencies. The contextualisation of SPA data was found to be restricted by the theory by only acknowledging the impact of quality and type of opposition. Balague *et al.* (2013) argued that sport is complex and thus it is hard to gain a contextualised picture of performance and that it is not possible to account for all variables. By only focusing on a certain number of situational variables, however, it could be possible to begin to develop a clearer insight into performance. One of the limitations of Interacting Performance Theory was that it had only been applied to singles tennis matches and thus the application of the theory to a team sport was unknown. In addition, the theory was developed using discrete action variable data and therefore did not address the questions of how and why an action or behaviour occurred during the performance. As a result, no other studies have attempted to use this theory to provide a scientific underpinning of game behaviour.

In contrast to O'Donoghue's (2009) Interactive Performance Theory, academics have begun to use Dynamic Systems Theory (DST) to aid the explanation and interpretation of SPA data, and answer the how and why an action or behaviour occurred (McGarry *et al.*, 2002; Davids *et al.*, 2003). McGarry (2013) argued the changes in behaviour could be explained by exploring the self-organising interactions between performers. These interactions within a sporting performance were commonly referred to as a dynamical system (McGarry and Perl, 2004). Within a dynamical system, the co-adapting components are in constant interaction in an attempt to optimise their status in a given situation (McGarry, 2013). In a team sports environment, each player in a situation is dependent upon the behaviours of the opposition and what behaviours have been demonstrated over time (Davids, Araújo and Shuttleworth, 2008). The success of a player or team in a given interaction is dependent upon and altered by the emerging actions and behaviours of the opposition players (Davids, Araújo and Shuttleworth, 2008). Therefore, the decisions and actions made by a player and/or a team are constrained by the previous outcomes and will affect the decision and actions made in future interactions. The components of DST focus on recording the sequential events of performance regarding the action sector, configuration of play, intervention sector, mother phase of play, operative image and rapport de forces (see Table 1 in Gréhaigne and Godbout (2014) for definitions of unfamiliar terms).

Gómez, Tsamourtzis and Lorenzo (2006) applied DST principles in able-bodied basketball to explore the interaction between the offensive team and defensive team in relation to the game outcome, by recording the type of defensive system operated (man-to-man half-court pressure, three-quarter court man-to-man pressure, full-court man-to-man pressure, zone half-court pressure, three-quarter court zone pressure, full-court zone pressure and mixed) during 1450 ball possessions. By exploring individual possessions and the events which occurred during a possession, along with the defensive interaction, a holistic picture of ball possession was gained. However, the study only involved eight games in the Spanish Basketball Playoffs series during the 2004-2005 series and thus, due to the small sample size, the utilisation of DST could not be used to identify trends during non-play-off events. However, DST has been applied to other team sports, including association football (Davids, Araújo and Shuttleworth, 2008) and in both codes of rugby (Hendricks *et al.*, 2015). Studies have explored the various sub-phases of games, including 1 v 1, 2 v 2, 3 v 3 and 11 v 11 situations, discovering that the data collected using DST principles allowed a contextual understanding of events by coaches. Through underpinning their work with DST, the objective data and information that could be interpreted from the results provided coaches and players with an understanding of how and why an action occurred. However, within rugby league and rugby union, DST has only been applied to small situations and not in 13 v 13 or 15 v 15 situations and therefore its use within rugby to explore overall team performance is unknown.

The critical evaluation of three SPA theoretical perspectives suggested further work regarding theoretical perspectives is required. However, the principles outlined within DST could offer a greater insight into understanding wheelchair basketball performance in comparison to Game Theory, Nash Equilibrium and Interactive Performance Theory due to the dynamic interactions between players considering situational variables. Despite the increasing use of DST and the ability to help answer the how and why an action occurred, previous SPA research historically analysed the discrete actions of team performance over time (e.g. Lorenzo *et al.*, 2010) and thus has not followed DST principles outlined by Gréhaigne and Godbout (2014). Discrete action variables were commonly collected within SPA research due to the simplistic nature of collecting actions and behaviours in isolation. Passos (2008, p.9) argued analysing the discrete actions would not provide a true objective insight into the entire performance, and recommended SPA "should be based on a continuous data series". Therefore, to understand the complex and unstable nature of team sports, this review has indicated that it is important to identify valid variables that follow DST principles and provide an insight into the relationships between interactions during different situations of a game. If valid variables were used to analyse performances in a reliable manner, trends and patterns may begin to become apparent regarding how a player's and/or team's actions and behaviours are affected by a specific situation (O'Donoghue *et al.*, 2008). The valid and reliable data collected from the identification of the trends and patterns could then be used to provide feedback to athletes and coaches, having the potential to enhance learning (Dar Hilal, Nazir and Muzamil, 2012).

2.3 Validity and reliability in SPA

Previous SPA research highlights a discrepancy regarding the processes undertaken to identify valid action variables and develop reliable SPA templates, particularly referring to the action variables, performance indicators, operational definitions and reliability test procedures. Prior to the publication of the International Journal of Performance Analysis in Sport's special edition, concerning reliability issues in 2007, only 41 per cent of the articles measuring technical and/or tactical variables published from 2001-2006 reported the operational definitions and the stages undertaken to establish the variables (32 articles of 78 articles), and 58 per cent provided details regarding the reliability procedures completed (45 articles of 78 articles) (See Table 2-1). Within the special edition's editorial, O'Donoghue (2007a, p. i) stated SPA "takes reliability very seriously because many methods involve human operators where there are many sources of measurement error". As a result of the publication of the special edition, the number of studies measuring technical and/or tactical variables between 2007 and 2015 (312 articles) presented information regarding the reliability procedures increased to 68 per cent (211 articles), however, the number of studies outlining the validation processes and operational definitions reduced to 40 per cent (125 articles) (See Table 2-1). Although the number of studies reporting reliability procedures increased following the issue, 32 per cent of the articles published between 2007 and 2015 still did not report any information regarding the reliability procedures undertaken. This was despite Brown and O'Donoghue (2007) highlighting the importance of reporting validity and reliability procedures in relation to the analytical goal within the special edition. Through reporting these procedures and scores, other researchers and practitioners could use the templates or data to inform future practice by collecting accurate data. The exploration of 576 articles published in the International Journal of Performance Analysis in Sport (2001-2015) highlighted that further work within the discipline, regarding reliability and validity procedures and their reporting, is still required to ensure valid and reliable research findings are presented.

Table 2-1: Detailed overview of the validity and reliability procedures reported in the International Journal of Performance Analysis in Sport from 2001 through to 2015.

Year	Total Articles	Number of Articles Measuring Technical and/or Tactical Variables	Operational Definitions and/or Validity Process Mentioned	Reliability Process Completed			Reliability Test Completed			
				Intra-Observer	Inter-Observer	Intra & Inter-Observer	Pearson or Spearman's Rank Correlation	Kappa or Weighted Kappa	Percentage Agreement	Other
2001	10	2	0	0	0	2	1	0	1	0
2002	8	4	1	1	0	2	0	2	3	0
2003	15	12	4	6	0	1	1	2	4	0
2004	20	13	8	1	1	6	1	2	11	0
2005	33	25	13	2	2	7	3	4	13	0
2006	28	22	6	8	2	4	7	5	5	1
2007	32	28	13	4	4	13	2	9	24	3
2008	40	31	13	12	3	3	3	3	13	2
2009	31	26	14	3	4	9	8	11	5	0
2010	25	21	6	1	4	7	6	7	6	2
2011	51	35	9	15	6	4	8	11	10	2
2012	45	20	7	2	2	6	3	5	2	3
2013	68	27	6	5	5	10	10	8	4	0
2014	71	49	30	10	11	16	13	14	6	6
2015	99	75	27	5	16	31	11	31	2	12

2.3.1 Establishing validity in SPA

Hughes (2004a) developed a schematic chart to highlight the steps required by a performance analyst to move from data collection to the development of a performance profile (See Figure 2-1). He proposed that analysts work in collaboration with coaches to identify the key indicators that provide insight into performance. Williams (2012) suggested the initial establishment of action variables are typically undertaken by experts within the sport. This is due to the fact that the most important aspects of performance cannot be 'teased out' by performance analysts working independently (Hughes and Bartlett, 2002), instead, a combined holistic approach must be adopted. This potentially drew parallels and reflected the schematic diagram presented by Hughes in (2004a). By combining the perspectives of athletes, coaches and/or other experts within the field, a comprehensive list of action variables could be created (Hughes, Hughes, *et al.*, 2015). Eaves (2006) developed his list of variables in collaboration with a panel of experts that included a Rugby Union Development Officer, Coach/Coach educator, RFU tutor/assessor, a retired professional rugby league player and a rugby fitness coordinator, and applicable research. Bringing together these multiple individuals from an array of backgrounds in the sport and variety of literature can be argued to remove any potential personal bias (Hopkins, 2000). However, the two different codes of rugby have distinctly different playing styles and rules (Hendricks *et al.*, 2015); thus, Eaves decision to separate these into two sport-specific systems and use multiple experts appeared fitting.

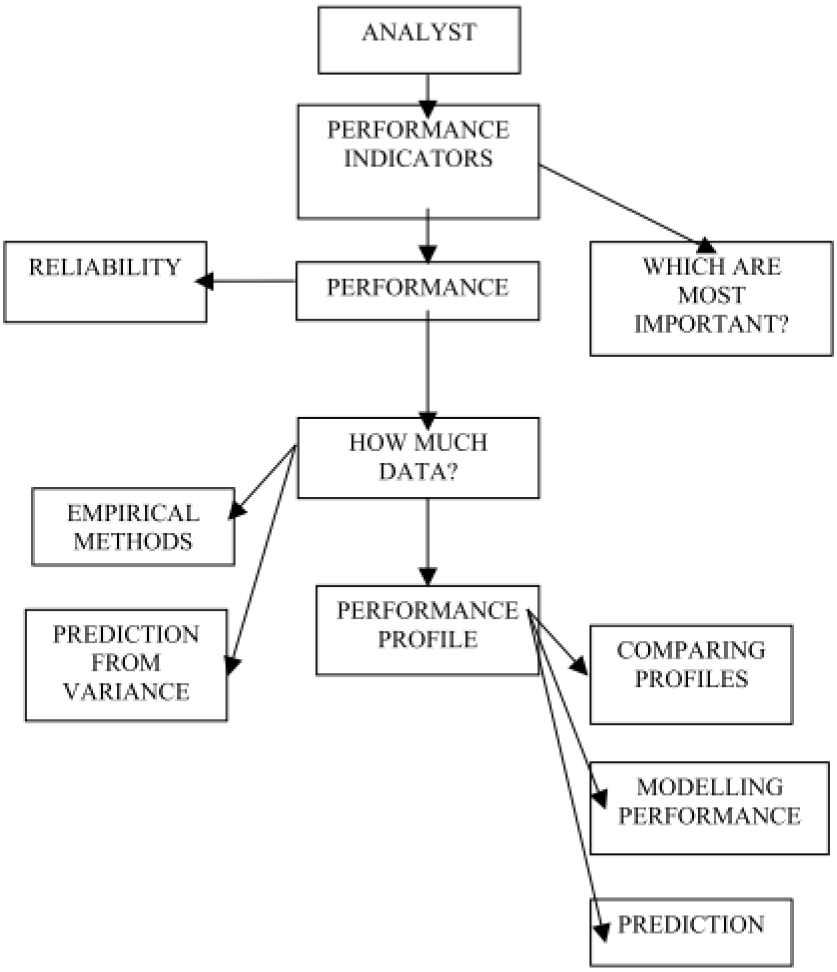


Figure 2-1: A schematic chart of the steps required in moving from data gathering to producing a performance profile ((Hughes, 2004a, p.99)

Similar to Eaves (2006), Hughes *et al.* (2012) sought the experiences of experts; and drew on university academic staff, students from across Europe and representatives from three performance analyst software companies to contribute their knowledge and experience in determining valid action variables in elite male association football. The participants with the most experience (two academic staff members and three software representatives) adopted the role of mentors and the remaining 61 participants were distributed amongst seven positional groups. Each group was assigned a position (e.g. goalkeeper) and tasked with establishing action variables for the respective position. This holistic approach enabled a comprehensive list of positional-specific action variables to be created, although, a number of the participants involved in the study had limited or no knowledge of the key performance aspects of association football. The mentors' experience also varied from three years to 32 years which meant that they might not have been the most knowledgeable individuals regarding association football. In addition, there were only five mentors and seven groups, and therefore two groups did not have a mentor. To ensure the list created by each group achieved content validity, each group's list was presented to all seven groups and subjected to a round-table debate and further discussions.

In contrast to Eaves' (2006) and Hughes *et al.*'s (2012) work, Thomson, Lamb and Nicholas (2013) used a smaller group of sport-specific personnel to establish action variables within boxing. The lead author, who had participated in 25 amateur boxing contests, and a boxing coach, with more than three years' experience, used their own knowledge base to create an initial list of boxing action variables. The use of a boxing coach who only had three years' experience, in comparison to Hughes *et al.'s* (2012) work, could raise further questions over the coach's sport-specific knowledge. James, Mellalieu and Jones (2005), in comparison, combined the knowledge and experience of the research team, who had a total 40 years' experience in SPA and 50 years in rugby union, with previous academic research to create a list of positional-specific action variables in rugby union. The three experts in James, Mellalieu and Jones' (2005) study had both SPA experience and sport-specific experience, ensuring they were able to combine their knowledge base to establish a valid list of action variables. Although, Lames and McGarry (2007) believed if researchers are drawing upon the knowledge and expertise of a small number of experts, there is potential for some areas of sporting performance to be overlooked due to personal beliefs and bias. The use of sport-specific personnel, rather than individuals from different sports, could remove any apparent bias due to their ability to provide context-rich actions and behaviours. Also, it is important to note that action variables and performance indicators could still be missed or excluded from research due to the complexity or feasibility of recording or measuring such actions or behaviours.

To overcome the potential issue of overlooking some aspects of performance, Thomson, Lamb and Nicholas (2013) used a technical coaching book endorsed by the Amateur Boxing Association of England (Hickey, 2006) when establishing the list of action variables. James, Mellalieu and Jones (2005) in contrast used existing literature within the field of rugby union in an attempt to remove the subjective opinions of the coaches and/or the experts involved with the creation of sport-specific action variables. Within James, Mellalieu and Jones' (2005) work, the focus of this phase was to identify the key behaviours which defined a successful or unsuccessful performance, not to create an exhaustive list of positional-specific behaviours. However, if experts have been asked to focus on a specific aspect the likelihood of key aspects being missed increases (Jarvis, MacKenzie and Podsakoff, 2003).

In an attempt to overcome this issue, James, Mellalieu and Jones (2005) and Thomson, Lamb and Nicholas (2013) undertook an additional step to ensure the lists accurately represented the sports and addressed the research questions. Within the two studies, the developed lists were scrutinised by additional external experts. Thomson, Lamb and Nicholas' (2013) experts consisted of a senior boxing coach and another boxer, who had been involved in 25 contests. James, Mellalieu and Jones (2005) in contrast, employed the skills of three additional elite level coaches, who had a combined coaching and playing experience of 50 years, to edit and adjust the initial list. Although the external experts used in both of these studies did not have any additional years of experience, they brought an external viewpoint and removed any subjective bias by the original experts. However, no information was presented regarding how the external experts were related to the original experts and thus potential bias could exist. Despite this lack of information regarding the methodological stage, presenting the developed lists of action variables to external experts established content validity because the lists were subjected to external scrutiny (James, Mellalieu and Jones, 2005).

After the panel of experts, within James, Mellalieu and Jones' (2005) work, had scrutinised the list of action variables, operational definitions were created to reduce the uncertainty or confusion of the observers. However, Thomson, Lamb and Nicholas (2013) presented the external coach and boxer with a list of action variables and operational definitions. Presenting the external reviewers with a list of the action variables and accompanying operational definitions allowed the reviewers to gain clarity of the meaning of each action variable. Within a sport, a coach’s terminology regarding a specific action or behaviour can differ in the context in which they are delivering and is affected by their past experiences (Gilbert and Trudel, 2002). Therefore if the experts are presented with both the action variables and operational definitions the validation process is strengthened (Thomson, Lamb and Nicholas, 2013). James, Mellalieu and Jones' (2005) decision to not present the operational definitions during the establishment of the list could result in two action variables being recorded which referred to the same behaviour. To further gain clarity of a specific action variable, Berk (2009) highlighted the use of video clips, within an educational context, allowed a greater understanding and improved learning of a topic. Within the validation process, video clips could allow the experts to ensure the observers understand, both verbally and visually, each action variable, and therefore the understanding of the expert and researcher could be improved resulting in the recording of both valid and reliable data.

Subsequently, the processes undertaken to develop sport-specific action variables have differed. Researchers have used literature and experts with sport-specific knowledge to develop an initial list of action variables. The processes of when operational definitions have been established differ between the studies. However, it appeared that these are typically defined following an agreement of the action variables, potentially saving time in the process of developing valid variables. The list, containing operational definitions, has then be shown to either other experts or video clips to establish content validity and inform the design of SPA data collection tools.

2.3.2 Establishing the accuracy of recorded events

Following the establishment of agreed action variables that represent a specific and relevant aspect of performance (validity) and the identification of a suitable means of measuring the indicator that removes any subjective judgment (objectivity), O'Donoghue (2014) believed that it was integral to ensure observers could measure the identified action variables in an accurate and consistent manner (reliability). This can be achieved by developing a valid and reliable SPA template. Following the development of a SPA data collection template, operators can undertake a period of piloting or familiarisation prior to completing a reliability test. Familiarisation or piloting of the coding system is likely to reduce the occasions when errors occur (Reed and Hughes, 2006). For example, Eaves (2006) undertook several pilot studies to assess the effectiveness and consistency of the observer to learn the notational system that was developed. Although adjustments were made to the system based on this initial testing, the time spent familiarising the system was not highlighted in the thesis. Whereas the operators in Thomson, Lamb and Nicholas' (2013) work undertook less than one hour of familiarisation prior to completing a reliability test. In contrast, the operators within Tenga *et al.*'s (2009) work undertook a four-week period of intensive familiarisation prior to the operators completing a reliability test. Cooper *et al.* (2007) highlighted the precise length of time for an operator to become familiar with a system cannot be determined due to an individual's learning ability being unique. Although, research has suggested that an individual's ability at executing a skill effectively increases as time spent practising the skill increases (Wulf, 2007). Siemens (2005) suggested the time to complete the learning process of a new skill is reducing due to the establishment of new modern technology. Thus, it has been suggested that it is only when the operator feels comfortable in operating the system that reliability tests should be conducted (Cooper *et al.*, 2007). Smith, Smoll and Hunt (1977) discovered operators were more consistent when allowed adequate time to learn the system. As a result, Smith, Smoll and Hunt (1977) findings support Cooper *et al.*'s (2007) recommendations regarding an adequate period of time being provided to the operators in order for system familiarisation to occur before the completion of a reliability test or the collection of performance data.

Previous SPA research has used two types of reliability tests to explore the accuracy of observations: intra-operator agreement and inter-operator agreement (Tenga *et al.*, 2009). An intra-operator agreement test is where one operator observes and analyses the same performance on two or more occasions (O'Donoghue, 2010). To remove any chance of the operator recalling events, and therefore predicting the forthcoming events, a gap between the observations is recommended, however, the precise time of this gap differs greatly from one week (O'Donoghue, 2014) to six weeks (James, Mellalieu and Hollely, 2002). Research completed by Taylor, Mellalieu and James (2005) indicated the greater the gap between observations, the less likely it is for the operator to recall events and thus any possible learning effects will have been negated. This notion is supported by Dickerson and Eichenbaum (2010) who found the ability to retrieve experiences was affected by the emotional attachment to the task, with an increased gap producing a reduction in the accuracy of recalling events. Although intra-operator agreement tests provide an objective measure of the consistency of one operator, they do not demonstrate the objectivity of a SPA template (Lames and McGarry, 2007). The test can be used to simply measure the consistency of the single operator to classify particular performance events into the defined category. It does not measure whether another operator would produce the same results (O'Donoghue, 2010), but provide an indication of the ability of one individual to use a SPA in a consistent manner.

The inter-operator agreement test, on the other hand, can be used to provide an insight into the consistency of multiple operators to achieve the same data utilising the same system (O'Donoghue, 2010). The test involves two or more individuals observing and analysing the same performance, but only on one occasion (Hughes, Cooper and Nevill, 2004). The test highlights any independent individual operator perceptions, bias and errors regarding the events they have observed within a performance (Williams *et al.*, 2007). It is, therefore, common research practice for new templates to be subjected to both an intra-observer and inter-observer agreement test to determine the accuracy of the observers to record events within a SPA template (James, Taylor and Stanley, 2007). O'Donoghue (2007b) advised, to establish a template's 'true' reliability, both intra-operator agreement and inter-operator agreement should be conducted. The intra-operator agreement cannot determine the reliability of a system alone (Taylor, Mellalieu and James, 2005; Choi, O'Donoghue and Hughes, 2007). James, Taylor and Stanley (2007) highlighted if a study only conducted intra-operator agreement, the single operator could misapply an operational definition but still retain a good level of agreement. Although the importance of conducting an intra-observer and inter-observer reliability test has been outlined, a consensus on which statistical approach should be used to compare the agreement of the datasets is yet to be reached (See Table 2-1 & Table 2-2).

Table 2-2: Comparison of intra-observer and inter-observer agreement statistical tests undertaken in previous SPA research

Test Name	Test Description	Research Example
Chi-square	Compared the distribution of categorical variables from one another (Nevill *et al.*, 2002).	**Tennis** (O'Donoghue, 2009); **Volleyball** (Araújo, Mesquita and Marcelino, 2009)
Cronbach's Alpha	Measured the relationship between a set of items to a single aspect (Cronbach, 1951).	**Association Football** (Suzuki, 2005) **Judo** (Miller *et al.*, 2015) **Table Tennis** (Wilson and Barnes, 1998)
Kappa/Weighted Kappa	Measured inter-rater agreement factoring the agreement occurring by chance (Cohen, 1960) or the Weighted Kappa which can acknowledge the magnitude of an error.	**Association Football** (Tenga *et al.*, 2009) **Basketball** (Lamas *et al.*, 2011) **Volleyball** (Costa *et al.*, 2011)
Pearson's r Correlation	Measured the linear relationship between two variables assigning a value between +1 and -1 (Pearson, 1895).	**Australian Football** (Hiscock *et al.*, 2012) **Cricket** (Moore, Turner and Johnstone, 2012)
Percentage Agreement	Measured the proportion of all observations, for which the two or more observers agree regarding whether or not an action occurred (Birkimer and Brown, 1979).	**Association Football** (Evans, Whipp and Lay, 2012) **Rugby Union** (Eaves, Hughes and Lamb, 2005)
Percentage Error	Measured the difference that exists between two values and is expressed as a percentage (Hughes, Cooper and Nevill, 2004).	**Association Football** (Jones, James and Mellalieu, 2004; Worsfold and Macbeth, 2009) **Gaelic Football** (Carroll, 2013) **Rugby** (Williams *et al.*, 2007) **Volleyball** (Medeiros *et al.*, 2014)
Spearman's Rank Order Correlation Coefficient	Measured the relationship between two variables placing each variable into an order (Spearman, 1904).	**Basketball** (Mexas *et al.*, 2005) **Wheelchair Basketball** (Vanlandewijck, Daly and Theisen, 1999)
T-Test	Measured the degrees of freedom between two values to determine whether the means differ (Student, 1908).	**Baseball** (Keeley *et al.*, 2014)
Yule's Q	Measured the correlation of two related dichotomous events, comparing the odds of agreeing to not agreeing (Yule, 1912).	**Association Football** (Georgievna, Ricardo and Lima, 2014)

Choi, O’Donoghue and Hughes (2007) undertook a study exploring the effectiveness of four inter-operator reliability tests (percentage error, chi-square, Pearson’s r, Kappa) for SPA data (nominal scale) between four observers. Comparisons between each observer (six pairs of observations) differed depending on the reliability statistics used to determine the accuracy of the observations. The study reported lower agreement levels for the observations when chi-square and Pearson’s r were used. The inaccuracies of these tests are highlighted when two sets of data are compared, with the first data set being double the value of the second data set (synthetic observation). Within the above example, Pearson’s r would produce a value of 1.0 as a straight gradient would be produced on a scatter plot, whereas Chi-square would produce a value of 0.0 due to the proportion of the two data sets being identical. Additionally, if percentage error was considered using the above example, the agreement levels would be deemed unacceptable because the difference is above the five per cent error limit and therefore does not demonstrate construct validity.

Kappa, on the other hand, acknowledged the aspect of ‘chance’ and therefore the data from an observation would be deemed acceptable (Cody and Smith, 1997). However, the Kappa statistic treats disagreements equally. Whereas a Weighted Kappa (Cohen, 1968) has been shown to assign a greater error, dependent on the magnitude of the disagreement, and thus the result provides greater insight into the cause of the error in comparison to the Kappa or percentage error (McHugh, 2012). The reliability statistics presented in Choi, O’Donoghue and Hughes' (2007) study were calculated from data collected in real-time. It, therefore, may not provide an accurate insight into reliability statistics because the majority of SPA research is collected using lapsed-time analysis or post-event analysis. However, the purpose of Choi, O’Donoghue and Hughes' (2007) work was to compare the reliability statistics on a variety of tests and not to compare the data collection method. In addition, the study only explored the reliability of nominal data and did not attempt to explore the reliability of ordinal data and therefore did not provide a definitive answer into the most appropriate reliability statistic. Furthermore the comparison of multiple operator reliability observations, according to Lucas *et al.* (2010), should be completed by multiple-rater tests including multi-rater Kappa (Randolph, 2005) or Krippendorff's alpha (Krippendorff, 2011). However, Lucas *et al.* (2010) suggested if observers are part of the validation process and have agreed on the criteria, standard reliability testing measures can be used. In addition, these multi-rater statistical tests typically decreased the disagreements proportionally based on the sample and number of observes, potentially disguising missing data or disagreements (Gwet, 2011). Despite these limitations, Choi, O’Donoghue and Hughes (2007) concluded that the Kappa statistical test is the most promising reliability statistic for determining agreement levels with nominal scale data.

More recently, O’Donoghue (2010) explained the Weighted Kappa statistic is a more insightful reliability statistic when the operator has a chronologically ordered sequence of values placed into groups. SPA data historically have been presented as accumulated totals, however, the growing trend in chronological data could suggest that the Weighted Kappa is a viable alternative reliability statistic to present the level of agreement. The statistic measures data on a nominal or ordinal scale, typical apparent in SPA, whereby action variables are classified into groups (Vuckovic *et al.*, 2014). A limitation of the Kappa statistic is that all disagreements between actions variables within a group are treated equally (Kraemer, 2015; Vanbelle, 2016). However, within SPA some action variables are similarly related in a group (e.g., defensive rebound and offensive rebound) and thus it may be preferable to apply a weight to the disagreement dependent on the magnitude of the disagreements (Gómez, Prieto, *et al.*, 2013). For example, Gómez, Lorenzo, *et al.* (2013) used the Weighted Kappa to determine the intra-observer and inter-observer reliability of a new SPA template for analysing basketball games between four observers, identifying good and very good values. In particular, the use of weights allowed for the identification of disagreements in relation to court zone, passing frequency per possession and defensive system. However, if the data are not presented in an ordered sequence or in groups, the Weighted Kappa statistic cannot be used and an alternative reliability statistic has to be found to present the level of agreement.

Hughes, Cooper and Nevill (2004) proposed the use of a percentage error calculation to determine the reliability of nominal scale data with a singular percentage error value. Calculations of percentage error have been used by researchers in SPA for intra-observer and inter-observer calculations. Hughes, Cooper and Nevill (2004) provided an explanation of the method describing the process as expressing the sum of the absolute difference in frequencies between two operators divided by the total sum of the mean frequencies multiplied by 100. The use of this statistical test will give a powerful and visual representation of the operators accuracy of collecting SPA data (Hughes, 2004a). However, the method has been criticised because the calculation has been shown to conceal the values of individual variables (O'Donoghue 2014, p.161). For example, two operators during an inter-operator reliability test could both activate 258 incidences during their coding, however, the two operators could have recorded different discrepancies and thus some elements of the operators' data are concealed when the data are expressed as the sum of the mean frequency. Additionally, the test divides the absolute difference by the mean of the two values and thus can present lower percentage error scores than have actually been presented (Brown and O'Donoghue, 2007).

To overcome these issues, O'Donoghue (2010) proposed expressing the values for each indicator being evaluated, within the coding template. This allowed the error percentage for each variable to be identified individually. By expressing each variable's error percentage, the operators can identify where potential errors within the coding template were found. As a result, utilising this statistical test to determine the reliability of each individual variable is an easily interpretable method of determining the reliability of a SPA template (Waldron and Worsfold, 2010; Evans and O'Donoghue, 2013). However, the percentage error statistic treats each error as the same, irrelevant of the cause of the error. Despite this, the percentage error statistic is typically used by individuals, both in research and the applied field, to determine the ability of observers to accurately measure specific actions. Additionally, the percentage error statistic provides an initial indication of the level of agreement which can then be explored by using alternative reliability statistical tests.

Thus, the percentage error and Weighted Kappa statistics can provide an accurate insight into an individual's ability to observe individual actions and behaviours. If a template's validity and reliability have been explored and fall within the agreed limits, the objective performance data can be used by coaches, players and support staff to provide accurate feedback to enhance learning and performance. Additionally, as Lucas *et al.* (2010) suggested, if observers of reliability tests have been used in the development and creation of variables and definitions, percentage error and Weighted Kappa reliability test statistics can be used in favour of multiple-rater methods. Furthermore, developments in computerised SPA software now allow data to be exported as both frequency and sequentially-order event information, enabling both the percentage error and Weighted Kappa statistical tests to be used to determine the validity and reliability of new wheelchair basketball SPA templates.

2.4 Analysing performance in disability invasion team sports

SPA research in disability invasion team sports has received limited exploration in comparison to the able-bodied version of the sports. For example, association football has received a breadth of SPA research within the last decade including published books (Franks and Hughes, 2016) and review articles (Mackenzie and Cushion, 2013; Sarmento, Marcelino, *et al.*, 2014); whereas, very limited or no SPA research has been published in journals or books regarding blind football (Gamonales, León, *et al.*, 2018; Gamonales, Muñoz, *et al.*, 2018), cerebral palsy football (Boyd *et al.*, 2016), partially sighted football or powerchair football. However, SPA research in sledge ice hockey, wheelchair rugby and wheelchair basketball has been published more widely in peer-reviewed journals (See Appendix 1).

As outlined in the previous sections, the importance of developing valid, objective and reliable data was essential to providing accurate and informative feedback to assist athletes' development and learning. However, only one of the 13 studies reviewed outlined the validity and reliability process undertaken to collect their data. This finding identifies the overarching trend in disability SPA research (See Appendix 1). Three studies made no reference to any validity or reliability processes completed. One study outlined the validity process completed but did not explore the reliability of the data, whereas one study outlined the reliability process undertaken, but did not present the validation procedures completed. Three studies completed reliability tests and determined their validity through statistical methods. Whilst four wheelchair basketball studies completed reliability procedures and made reference to a previous study's validation procedures.

The presented studies in Appendix 1 provided an overview of the existing and relevant disability SPA research articles, highlighting the aims, methods and findings. For example, Molik *et al.* (2008) used two coaches to establish a game efficiency sheet to evaluate wheelchair rugby players. However, the two coaches had no wheelchair rugby knowledge but had coaching experience in wheelchair basketball. The two sports have very limited cross-over because the players have less functional ability, are unable to bounce the ball and instead of propelling the ball towards a basket the ball has to cross an end zone (International Wheelchair Basketball Federation, 2014b; International Wheelchair Rugby Federation, 2015). The two sports are only similar in terms of the use of a wheelchair and the playing area of the court. Therefore, the coaches' sport-specific knowledge has to be questioned. During the development of the template, the researchers did not draw upon any previous literature or consult with wheelchair rugby coaches, as other template development studies have, and thus the researchers' findings can be argued to be neither valid nor reliable. Despite this, Molik *et al.* (2008: p.340) justified the reason for not exploring the validity of the sheet by stating the template "measures the tangible behaviours of athletes during the game analogous to time in a sprint, a shot scored, or a rebound made". However, the study eliminated three action variables due to achieving low reliability results. This elimination could suggest, if a validation process was completed, in which sport-specific action variables were created with objective operational definitions, the variables could have been included in the final results.

Beckman, Kudláček and Vanlandewijck (2007), when creating an observation protocol in sledge ice hockey, drew on the experience of sport-specific experts, including a sledge hockey coach from the USA, an ex-player with 10 years' experience (who had become a coach) and the manager of the Czech Republic national sledge ice hockey team. The use of individuals with sport-specific knowledge allowed for an in-depth understanding of the technical and tactical requirements of the sport. The reliance on these sport-specific experts was used by researchers in rugby union and boxing when creating a new SPA system and was discussed in the above section. However, the validation process differed in comparison to previous studies because there was no external verification method of the protocol. In addition, the frequencies of actions were placed on a 10-point scale, however, the researchers did not provide any supporting evidence to justify the weighting of each variable. The 10-point scale was also not a linear scale as, if the player was observed completing a specific action more than three times during a performance, their frequency count was amended into a ratio. However, if the player completed an action once or twice they would receive five points and the player was awarded a zero if they were not observed completing an action. This amendment would affect the overall score a player received regarding a performance. As a result, the scoring system has not been subjected to statistical procedures to objectify the weighting of each variable and provide a rationale as to why frequencies above three were amended into a ratio. Thus, the methodological processes undertaken to produce the results and recommendations of the study could be deemed invalid.

Hayrinen *et al.* (2011), in addition to collaborating with a Finnish sledge ice hockey coach, drew on supporting invasion game literature to establish a list of action variables. The team-specific action variables were placed into seven-match analysis categories (passing, received pass, dribbling, shooting, face-off, checks and checks received), which included 27 action variables, and six shooting analysis categories (duration of attack, starting zone of attack, start type of attack, attack type, interfering goalkeeper and shooting zone) which included 21 action variables. In comparison to the other 12 studies, the team-specific action variables presented an insight into team performance instead of combining individual action variables in an attempt to evaluate teams' efficiency. However, the action variables were collated and presented as overall frequencies and therefore the sequential nature of events, along with the how and why the behaviour occurred, was unknown. Although this process made attempts to draw upon literature and coaching knowledge, the list was only presented to one coach and thus personal bias could have existed. In addition, the literature which was used to support the development was from the previously completed SPA research in sledge ice hockey (Beckman, Kudláček and Vanlandewijck, 2007; Kudláček *et al.*, 2009), which was deemed invalid, and a review article of performance indicators (Hughes and Bartlett, 2002) that did not present any specific actions or behaviours in similar invasion sports such as hockey or ice hockey.

In contrast to the use of coaches or literature to develop action variables, Vanlandewijck *et al.* (2003) and Molik *et al.* (2009, 2012) did not disclose the procedures to establish their action variables but validated their action variables through statistical methods. The three studies used a Spearman's rank correlation coefficient to identify the relationship between the action variables and either ranking or the modified CBGS. Although this approach proved that the selected action variables indicated that higher ranked teams or higher classified players achieved superior scores in comparison to lower ranked teams or lower classified players, the action variables used may not provide an objective insight into a player's game efficiency. For example, Molik *et al.* (2012) attempted to explore the effect of disability on an individual's performance, however, the variables that were selected to evaluate performance only examined on-puck activities and did not record the off-puck actions. This trend was also apparent in Vanlandewijck *et al.*'s (2003) and Molik *et al.*'s (2009) work, whereby the action variables used focused upon on-ball activities in wheelchair basketball and therefore an accurate insight into player performance may not be provided. García-López *et al.* (2013) also highlighted the importance of recording both on-ball and off-ball activities to gain a holistic insight into an individual's contribution to overall game performance and enable coaches to provide contextually relevant feedback.

Although previous studies within wheelchair basketball do not present the specific validation process undertaken within their study (Vanlandewijck, Spaepen and Lysens, 1995; Vanlandewijck *et al*., 2004; Gómez *et al*., 2014, 2015), reference is made to either the work of Gil-Agudo, Del Ama-Espinosa and Crespo-Ruiz (2010) or Byrnes and Hedrick (1994) in suggesting the use of either a modified CBGS or the standardised CBGS is a valid assessment tool for evaluating player contributions in wheelchair basketball. Further to this, Byrnes and Hedrick's (1994) study added one additional wheelchair basketball action variable, back-pick, and adjusted the technical fouls variable to factor in a recent amendment to the rules to create a modified CBGS tool. Although, when examining previous IWBF (1998) rulebooks over a 15-year period (1985-2000), no such rule amendment occurred. Within Molik *et al.*'s (2009) work the adapted criterion was used, however, back picks, forced defensive turnovers and fouls were omitted due to a misunderstanding of the operational definitions. This omission of the wheelchair basketball specific indicators highlighted the required sport-specific understanding of the observers. The addition and modification of two sport-specific action variables to the able-bodied basketball CBGS (Mullens, 1978) did not ensure a valid and objective tool had been developed to evaluate wheelchair basketball players' performance. The tool has also been used to compare the performance level between male and female players with no adjustments being made. Furthermore, the tool has not been adjusted to take into consideration further rule changes, therefore its future use in research has to be questioned. As a result of this, the validity and reliability of the data collected and the recommendations made from studies which have used the CBGS and modified CBGS do not accurately and objectively provide an insight into a player's performance.

Despite the limitations acknowledged of using either the CBGS or the modified CBGS, recent studies in wheelchair basketball have continued to use the tool and have also included a number of situational variables when recording events in an attempt to contextualise the data. Gómez *et al.* (2014) used K-means clustering to create two groups which indicated whether the games were balanced (points difference: 1-12) and unbalanced (points difference: 13+). K-means clustering is "a prototype-based, simple partitional clustering algorithm that attempts to find *K* non-overlapping clusters" (Wu, 2012: p.7). The study included both men's and female's games with the data being separated dependent upon gender. However, the K-means clustering included both male and female games in determining the two groups. Vanlandewijck *et al.* (2004) found a clear distinction between men and women wheelchair basketball players in relation to shooting percentage and also suggested there were larger differences between established and non-established national women's programmes. Therefore, not separating the genders prior to conducting the K-means clustering could affect the representation of balanced versus unbalanced games in both male and female wheelchair basketball games.

Gómez *et al.* (2015) used the same tournament data but focused only on female players. Instead of building on the previous work which considered balanced versus unbalanced games, the effects of team strength and playing time in addition to classification were explored. A K-means clustering was used again to establish two team-strength groups (1st to 5th; 6th to 10th) and two playing-time groups (important players: 32.2±5.4 minutes; less important players: 14.2±5.2 minutes). The clustering of playing time resulted in some confusion between the placing of some players because there was a gap of 7.4 minutes between the two groups' highest and lowest standard deviations. Therefore, if a player averaged being on the court for 24 minutes they fell between being an important or a less important player. Despite this, the incorporation of two situational variables enabled a more in-depth consideration and contextualisation of the importance of specific action variables in certain situations. However, the action variables used in the study are from the CBGS, which has been shown to be invalid, and are therefore discrete variables, which inhibit the ability to understand the how and why a player performed a specific action or behaviour.

Further to the development of action variables, 12 of the 13 SPA studies have used individual player discrete action variables to evaluate a player's performance. The researchers within these 12 studies then made recommendations regarding how their findings could be used to inform future decisions during training and games regarding team performance aspects. However, recording the discrete actions of an individual's performance has been argued to only present an isolated picture. The data and findings of the studies do not answer the important question of why or how an event occurred, and thus are methodological issues for the studies. Actions need to be explored in a sequential nature to understand the sub-phases of a game in an attempt to contextualise the performance (McGarry, 2013). It is only when an individual's performance is collected within a sequential nature that the findings can be considered in relation to supporting team performance aspects (McGarry and Perl, 2004). Therefore, if a theoretical approach such as DST had been used within the studies, to support the development of the action variables, the how and why an action occured could have been answered and individual performance data could then be applied to a team scenario.

Eight of the reviewed studies conducted reliability tests and deemed the observers' ability to accurately record events in the SPA templates, however, inconsistencies have been identified within these studies. For example, Gómez *et al.* (2015) noted that an inter-observer reliability test was completed on four games by one analyst repeating the observation on two occasions. This reliability process described in Gómez *et al.'s* (2015) work referred to an intra-observer rather than an inter-observer reliability test due to the utilisation of only one analyst. Molik *et al.* (2009) presented inter-observer reliability results for the observations but did not mention the number of games nor the number of observers involved in the process and their level of experience. Even though

Vanlandewijck *et al.* (2003, 2004) used five observers to conduct an inter-observer reliability test, which could suggest a robust approach was undertaken, the observers had limited wheelchair basketball knowledge because they were physical education teachers who taught adapted lessons. Thus, due to observers not being part of the validation processes, multiple-rater reliability test (multi-rater Kappa or Krippendorff's alpha) should have been used (Lucas *et al*., 2010). The studies also did not mention the familiarisation period completed prior to the undertaking of the observation. The range of reliability procedures presented above-raised questions concerning the accuracy of the data and the academic quality and rigour of the studies. However, the decisions of the journals in terms of the validation processes and the statistical tests being used could be due to the author, peer-review process or editorial decisions in favouring specific methodological processes. Subsequently, the collection of unreliable and invalid data can result in inaccurate feedback being provided to coaches, athletes and support staff, thus having a detrimental effect on an individual's learning and decision-making processes (Pulling, Bunyan and Sinfield, 2015).

With the exception of the intra-observer reliability procedures completed by Gómez *et al.* (2015), the remaining seven studies completed inter-observer reliability procedures. The studies explored the agreement levels through either utilising Spearman rank order correlations, Intraclass Correlation Coefficients or Cohen's (1960) Kappa. However, the use of correlation to evaluate agreement levels was questioned by Choi, O'Donoghue and Hughes (2007) because the test assumes the relationship between the two observations is linear and tests association. Despite this, the wheelchair basketball studies reported acceptable agreement levels for all action variables. However, as mentioned earlier, Molik *et al.* (2009) removed three action variables prior to reliability testing due to a misunderstanding of operational definitions. More recently, Gómez *et al.* (2015) also removed back-picks, technical fouls and turnovers from the final dataset, but still reported high Kappa coefficients for the action variables during the reliability procedure. However, the reasons for the removal of the three action variables were not disclosed.

Hayrinen *et al.* (2011) also used Kappa coefficients as a measure of the agreement between observations but set a benchmark of above *k* 0.70 for action variables to be included in the final dataset. However, it was unclear how many action variables fell below the threshold because only those variables with a Kappa coefficient of 0.70 or above were displayed and selected for further analysis. Cohen's Kappa coefficients can range from −1 to +1, with values between 0.81-1.00 representing very good agreement and 0.61-0.80 representing good agreement levels (Cohen, 1960). However, judgements about what level of Kappa coefficient should be deemed acceptable have been questioned. For example, McHugh (2012) believed that in health research, Kappa scores as low as 0.41 are deemed good. Whilst, Hale and Fleiss (1993) suggested Kappa coefficients of 0.50 to 0.75 were of acceptable. Whereas, Tenga *et al.* (2009) stated Kappa coefficients of 1.0-0.81 illustrate very good agreement with a coefficient ranging from 0.8-0.61 demonstrating a good level of agreement within SPA research. The choice of such benchmarks, however, inevitably arbitrary, must be considered in magnitude (Sim and Wright, 2005). Therefore, Hayrinen *et al.*'s (2011) decision to use 0.7 as a threshold, did not support the coefficient bands used in previous SPA research but could be considered acceptable due to the complexity of the SPA template. Regardless of the different benchmarks used by Hayrinen *et al.* (2011), the work is the only disability invasion team sport study to date which presented details regarding the validity and reliability procedures undertaken. The procedures that were completed by Hayrinen *et al.* (2011) drew parallels to the methodological processes, with the exception of external reviewers, and combined some of the development process completed by Hughes (2004a), James, Mellalieu and Jones (2005), Eaves (2006) and Thomson, Lamb and Nicholas (2013) which have become the established process when developing new SPA templates.

Combining these different SPA development processes could prove pertinent in developing a valid and reliable wheelchair basketball SPA template that is able to answer how and why actions and behaviours occur. Although the validity and reliability procedures have been questioned in the establishment of accurate performance data in wheelchair basketball using the current SPA template, the findings of each study identified significant differences between low-point players (classification 1.0-3.0) and high-point players (classification 3.5-4.5), with high-point players being superior for most variables in comparison to low-point players. When team-strength was considered, Gómez *et al.* (2015) reported players from the stronger team achieved better values for the following indicators: assists, fouls received, successful free-throws and turnovers. However, Vanlandewijck, Spaepen and Lysens (1995) discovered high within-classification variability for each of the indicators, emphasising the wide range of disabilities incorporated within each functional classification group and the range of positions played by each functional group. However, Vanlandewijck *et al.* (2004, p.674) found "the Player Classification System for Wheelchair Basketball reflects the existing differences in performance of elite female players'". Therefore, the classification system used in wheelchair basketball could be argued to adequately represent an individual's contribution to team performance and ensure a level playing field is achieved.

Even though similarities within the results were discovered across the wheelchair basketball studies, Vanlandewijck *et al.* (2003) found players with a classification of 2.0-3.5 were slightly underestimated within the CBGS due to their functional ability. However, no under or overestimation of these classification groups was observed in later studies. This could be due to the IWBF's more stringent and objective approach towards classification in the past decade, which now entails assessing players in their playing environment instead of in the medical room (Perriman, 2014). Or it could be due to improvements in national training programmes, facilities, coaching and athlete welfare and support (Etchells, 2016). The underlying reasons are unknown, however, the importance of the classification system in attempting to create a level playing field has been reiterated by the findings in wheelchair basketball SPA research.

Vanlandewijck *et al.* (2003) also questioned comparing the results using participants from different competition levels. The previous studies have analysed the performances of players and teams at a range of competitions from major international competitions (e.g. Gómez *et al.*, 2015) through to national leagues in Greece and Lithuania (e.g. Skucas *et al.*, 2009). Vanlandewijck *et al.* (2003) recommended caution when interpreting data from across a range of tournaments. Players who compete in national leagues generally compete for recreational purposes and will not develop optimal skill sets. Therefore, if comparisons are made between elite and recreational athletes the frequency counts between classification groups could be distorted. However, the vast focus of research within the field has used video recordings from either the European Championships, the World Championships or the Paralympic Games, with a particular focus on one competition involving elite athletes. Limited studies have compared performances across major competitions, with the exception of Gómez *et al.* (2014). The timing in which major competitions occur, typically on a cycle of every two or four years, results in player, coaching and staff turnover, technological and coaching advancements, rule changes and classification adjustments. These changes potentially cause the ability to make generalisations and comparisons between performances difficult as found by Kalinski *et al*. (2016) who attempted to compare performances on the world stage between 2008 and 2015 in gymnastics. Although, if a focus has been on one league or team's development over a course of time a greater understanding and insight into the determinants of success can be gained. For example, through conducting a longitudinal case study analysis of Japanese rugby union, Sasaki *et al.* (2007) identified teams adopted common strategic and tactical facets to overcome the physical disadvantage by adopting a quick attacking phase style of play. The knowledge learnt from these longitudinal case studies, specific to a small population, has allowed individuals working within the context to make relevant adaptions to training programmes to prepare players for competitions.

Despite the flaws acknowledged by McGarry and Perl (2004) and McGarry (2013) of using individual player performance data to make recommendations regarding team aspects, Gómez *et al.* (2015: p.281) stated the results of the study "allow coaches, trainers and sport scientists to prepare players more effectively for competition according to actual game constraints" and "the information obtained should be important for coaches who determine different roles for players during wheelchair basketball games and who determine team tactics". However, because the research has not explored the collective effectiveness of the five players on the court and the interactive effects of the opposition team, a holistic insight into game performance and the associated constraints cannot be gained to assist with competition preparation and inform tactical decisions. What the wheelchair basketball SPA studies have presented is an insight into individual classification groups' ability to provide an assist, shot or rebound the ball and receive or commit fouls, and a cross-comparison between classification groups. However, the collection of the data have been shown to be neither valid nor reliable.

The disability invasion team sport SPA studies presented above have considered the effect of classification on individual player indicators, attempting to identify the discriminant variables associated with an individual's success, with the exception of Hayrinen *et al's* (2011). Despite the similarities presented across the studies regarding the methodological processes and the importance of the classification system, a number of issues were identified: (i) the opponents' actions were not considered when attempting to analyse the patterns of play of a team (i.e. the attacker's actions and patterns were analysed without taking into consideration the defender's actions and the defender's actions and patterns were analysed without considering what the attacker was doing); (ii) the line-up combinations of the attacking and defensive teams were not considered when collecting performance data; (iii) discrete actions were recorded in frequencies or percentages and used to decipher teams' patterns of play; and (iv) studies have used participants from a range of different competition levels which affects the generalisability of the data.

Presenting the frequencies or percentages of discrete actions does not provide any explanation of the reasons why the actions occurred or how a team or an individual produced a successful or unsuccessful outcome (Passos *et al.*, 2008). McGarry and Perl (2004) recommended that to answer why and how an action occurred, it is pertinent to explore the sequential passages of play. According to insights into DST, the actions of the attackers are influenced and affected by the actions and behaviours of the defenders and fellow team members (Gréhaigne and Godbout, 2014). Within wheelchair basketball, it is important to not only take into consideration the defender's actions but the effect of the interaction between both the attackers and defenders in any given situation. Researchers have acknowledged the importance of taking into consideration the interactions between opponents and team members in an attempt to answer how and why an action occurred (Reed and Hughes, 2006). SPA research in able-bodied team sports has acknowledged the importance of recording sequential action variable data (Sarmento, Anguera, *et al.*, 2014) and as a result, the use of modelling techniques to contextualise performance has also increased to assist the understanding of how and why an event occurred (Magel and Unruh, 2013). Researchers and performance analysts are attempting to move from a reactive to a proactive approach by using modelling techniques, enabling them to predict future events and provide a richer holistic insight into performance.

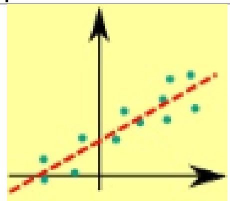
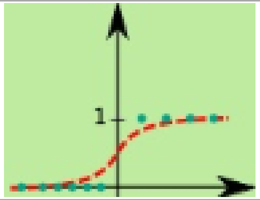
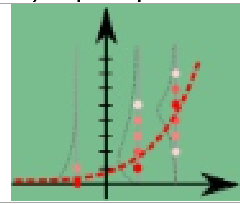
2.5 Linear and logistic regression modelling in wheelchair basketball and able-bodied basketball

The evolution of computerised SPA systems and automated tracking system technology has increased the ease of collecting and analysing human performance data (Araújo and Davids, 2016). Specifically, in team sports, a player's or team's performance emerges from a dynamic process of human behaviour which is based on a series of interacting components (Stöckl, Plück and Lames, 2017). For example, within wheelchair basketball, there are 10 players coupled with each other through intra-couplings (each player is coupled with their fellow team players) or inter-couplings (Team A v Team B). The game follows an ebb-and-flow as ball possession alternates between Team A and Team B. Throughout the changes of possession, intra-couplings and inter-couplings are formed and broken dependent on the context of the game in relation to which team is in possession and the location of the offensive and defensive players on the court (McGarry *et al.*, 2002; Frencken *et al.*, 2012). During the game, Team A will attempt to convert the possession into points, whilst Team B simultaneously endeavour to (re)secure possession and prevent Team A from gaining points. Thus, once both teams have neutralised each other's offensive and defensive strategies, well-organised line-ups are formed and stable player patterns emerge (Vilar *et al.*, 2013). According to Stöckl, Plück and Lames (2017), the intra-couplings and inter-couplings are non-linear. This is due to an error by one individual subsequently having nearly no implications or very significant implications if space opens up and provides the team in possession with a scoring opportunity. It is these patterns of performance and the intra-couplings and inter-couplings that can be identified through modelling techniques to allow coaches, players and support staff with contextually relevant objective data (Schumaker, Solieman and Chen, 2010).

Models are analytical abstractions and used to represent an approximation of the real world (Crawley, 2007; Field, 2016). Within the context of SPA, modelling thus relies on a sample of performance data to approximate reality and make predictions from this approximation regarding aspects of a teams' and/or an individual's performance (Hughes, 2004a; Reed and O'Donoghue, 2005; O'Donoghue, 2010; Tümer and Koçer, 2017). The process of modelling identifies the relationship between performance and variables, and the magnitude of a change of a variable on performance (Yeadon and King, 2008; McGarry, 2009; Malcata, Hopkins and Richardson, 2012). The modelling process and the developed models offer an opportunity to identify features and regularities of game events in relation to offensive and defensive patterns of performance. The information extracted from these models has been shown to identify the key determinants of both individual and team efficiency and success, allowing for a criterion for training and game strategies to be developed (Travassos *et al.*, 2013; Lopez and Matthews, 2015). However, in order to achieve a deeper insight into these key determinants of success, Garganta (2009, p.82) stated that "it is necessary to record the substantial tactical actions in a chronological, sequential order, so the stream of tactical behaviour can be recognized". Importantly, this not only means recording the input and output behaviour but also the interacting components (Palut and Zanone, 2005). From this perspective, recording and modelling how these interactions occur through using previous competitive performance data has been argued to facilitate the coaching process and offer advantages to game preparation (Pfeiffer, 2008).

To date, a variety of modelling techniques have been employed within SPA research: empirical modelling, stochastic modelling, momentum, perturbations and artificial intelligence (expert systems and artificial neural networks) (Hughes, Hughes, *et al.*, 2015). However, a form of predictive modelling that has increased in recent years in SPA is the use of regression analysis (e.g. Zambom-Ferraresi, Rios and Lera-López, 2018), which investigates the relationship between dependent and independent variables (Crawley, 2015). There are a number of regression modelling approaches, including linear, logistic and Poisson, however, which regression modelling technique is used is determined by the number of independent variables, the shape of the regression line, the type of dependent variable and the distribution of the data (Vik, 2014). For example, linear regression is used when the two variables are measured at the continuous level; logistic regression is used when the dependent variable is measured on a dichotomous scale; whilst Poisson regression is used when the dependent variable is an observed count (see Table 2-3). Typically, the function between the response and the explanatory variables are known (Crawley, 2007). Thus, the models can be argued to be examples of parametric regression models. However, in many situations the relationship between the variables was unknown and therefore nonparametric models should be used (Härdle *et al.*, 2004). Subsequently, the response and explanatory variables can be adjusted to capture and explain any unusual features of the data. Although, within sports performance, it can be argued that an understanding of the relationship is typically known and thus parametric regression techniques can be used (Hopkins *et al.*, 2009).

Table 2-3: Summary of the differences in regression techniques: linear, logistic and Poisson (Crawley, 2007, 2015; Field, Miles and Field, 2013).

	Linear Regression	Logistic Regression	Poisson Regression
Equation	$y = \beta_0 + \beta_1 x$	$\log(p/(1-p)) = \beta_0 + \beta_1 x$	$\log(count) = \beta_0 + \beta_1 x$
			
Output	Negative or greater than 1	Displayed as a probability between 0 to 1	Displayed as a count, but not quite so wide in range as a continuous variable
Dependent variable	Response variable is continuous	Response variable is categorical in nature	Response variable is continuous
Coefficient interpretation	A unit increase in x increase y by β_1	A unit increase in x increase log odds by β_1	A unit increase in x multiples y by the error term squared by β_1
Error minimisation technique	Uses ordinary least squares method	Uses maximum likelihood method	Uses iteratively reweighted least squares
Model Building Process	1. Exploratory data analysis 2. Univariable analyses 3. Checking independence 4. Model development 5. Model diagnostics	1. Descriptive analysis 2. Univariable analyses 3. Testing of collinearity 4. Model development through the training set 5. Model diagnostics and validation	1. Data visualisation 2. Model development 3. Model diagnostics and overdispersion
Goodness-of-fit	Examining residuals from the model; outlier detection; R^2; adjusted R^2; Pearson chi-square statistic, X^2; training-validation set	Pearson chi-square statistic, X^2; Deviance, G^2 and Likelihood ratio test and statistic, ΔG^2; Hosmer-Lemeshow test, Pseudo R-squared, Receiver Operating Characteristic (ROC) curve, Area Under the Curve (AUC)	Pearson chi-square statistic, X^2; Deviance, G^2; Likelihood ratio test, and statistic, ΔG^2
Example	The analysis of a player's batting average in a given year from their batting average in the previous year.	The analysis of game statistics that are important in determining a game outcome.	Calculating the distribution of the number of goals scored in sport involving two teams.

SPA research within basketball and wheelchair basketball are not alone in following this emerging trend, electing to use parametric linear regression modelling or parametric logistic regression modelling approaches to explore the relationship between variables. The parametric linear and logistic regression-based approaches have enabled coaches, players and support staff to identify the impact of individual variables that affect a player's and/or team's performance (Garganta, 2009). This information can then be used to inform decisions and assist coaches in adjusting the content of training sessions, thus moving away from a reactive state to a proactive state of predicting performance (Lebed and Bar-Eli, 2013). An exploration into studies that have elected to use linear and/or logistic regression modelling will follow.

Linear regression modelling was used by Casals and Martinez (2013) to evaluate player performance (15 independent variables) in the 2007 National Basketball Association (NBA) league regular season in relation to points made by an individual player (dependent action variable) and win score (dependent action variable). Two linear regression models were used to explore the two dependent action variables, however, due to 'win score' being expressed as a metric and thus an inconsistent variable, a generalised linear regression model was developed in addition to the linear regression model for exploring points made by an individual player. Generalised linear regression modelling is used to explore the relationship between the independent action variables and the dependent action variable, when the variance of the dependent action variable is not constant and/or the errors that occur are not normally distributed (Crawley, 2007). Further to this, developing two stand-alone models to explore the two dependent action variables does not enable the effect of points made versus win score to be explored. Likewise, Berri (2012) found players who scored more points played on the winning teams and thus a single model should be developed to explore the effect of these two variables.

In contrast to Casals and Martinez's (2013) work, Gómez *et al.* (2014), Mertz *et al.* (2016) and Sampaio *et al.* (2010) used one dependent action variable to explore game outcome at the 2010 Wheelchair Basketball World Championships, inverse player rank in the NBA and game quarter outcome in the Spanish Professional Basketball League, respectively. The three studies developed linear regression models to explore the relationship between the dependent action variables and the independent action variables. However, the dependent action variable within Mertz *et al.*'s (2016) work comprised of a mathematical formula which included three of the five independent action variables used to develop the model. Therefore, the model would produce positive correlations assuming higher ranked players would produce higher frequency counts of points scored, rebounds and assist. These independent action variables, which represented individual player actions, only equated to a small number of actions that a player completed during a game. In addition, Mertz *et al.* (2016) highlighted the inclusion of points scored within both the independent action variable and the formula, which was used to calculate player ranking, had a large effect on the overall ranking. As a result, if only on-ball actions are recorded, in particular, shooting actions, to evaluate a player's performance and predict player ranking, a holistic insight into player performance cannot be gained from the developed model.

Gómez *et al.* (2014) collated individual player performance statistics in wheelchair basketball, which predominately focused on on-ball actions, to develop a linear regression model using the outcome of the game as the dependent action variable. In contrast, Sampaio *et al.*'s (2010) dependent action variables, game outcome and game quarter outcome, respectively, were calculated by subtracting the difference in points between the two teams. However, the difference in points at the end of each quarter fluctuated between the two competing teams and was therefore not a constant action variable and the errors that were produced were not normally distributed. Based on the unstable nature of the dependent action variable and Casals and Martinez's (2013) reasons for utilising generalised linear regression modelling within their research, generalised linear regression modelling should have been adopted by Sampaio *et al.* (2010) instead of a linear regression modelling to develop their regression model.

Furthermore, Gómez *et al.* (2014) and Sampaio *et al.* (2010) developed a single model but tested two different sets of data dependent upon the final score difference (balanced games and unbalanced games), which were calculated through K-means clustering. The balance of the game was included within the model because an additional independent action variable could have supported the final results and the application of the results into practice. However, Sampaio *et al.* (2010) did not conduct any descriptive or univariate analyses and thus the significance of this information and the likelihood of the balance of the game's effect on the model is unknown. In contrast, Gómez *et al.* (2014) conducted a univariate analysis to compare which game-related variables discriminate between winning and losing teams. Gómez *et al.* (2014) were able to identify the statistical significance of action variables between winning and losing teams during balanced games and also the winning and losing teams during unbalanced games. Although Gómez *et al.* (2008) found only two of 13 action variables (defensive rebounds and assists) recorded had a significant relationship between game outcome and the balance of the game, no statistical significant action variables suggested the balance of a game did not affect game outcome.

With regards to the process undertaken to develop the linear regression models, Sampaio *et al.* (2010) did not provide any details regarding how the model building process was undertaken in the study. Therefore, it was assumed that no action variables were added or removed dependent upon their statistical significance or collinearity. The validity of the model in predicting the outcome of the game quarter was questioned. This was due to no univariable analyses being conducted to identify any statistical significance of individual action variables in relation to the dependent action variable. Gómez *et al.* (2014) in comparison completed univariate analysis regarding the individual player action variables. However, the linear regression model included new action variables and/or performance indicators which had not been subjected to univariate analysis and thus statistical significance and validity of the linear regression model was unknown.

Although Mertz *et al.* (2016) did not outline the exact model building approach used, it can be deciphered that a form of backwards elimination was adopted (Field, Miles and Field, 2012). Prior to model building, action variables were tested for multicollinearity, normality or homoscedasticity, confirming no action variables impacted on the regression results. The undertaking of these processes confirmed there were no multivariate outliers, the data were normally distributed and the variability in scores did not adjust dependent upon ranking values, thus confirming the data were suitable to be used for linear regression modelling. In comparison, to the work of Gómez *et al.* (2014) and Sampaio *et al.* (2010) attempts were made to explore the quality of the data prior to model building. Casals and Martinez (2013) completed the same testing procedures on the data, however, the exact model building process differed from the approach adopted by Mertz *et al.* (2016).

Mertz *et al.* (2016) did not clearly outline the model building process which was used to develop a linear regression model. A baseline regression model was created, which included the significant action variables, and then singular action variables were removed. The process in which action variables were removed depended upon how their statistical significance or standard error values affected the r-square values of the linear regression model. R-squared values demonstrated “the amount of variance in the outcome explained by the model relative to how much variation there was to explain in the first place” (Field, Miles and Field, 2013, p.302). The final model, which was developed included three action variables but produced a lower r-squared value than the first two linear regression models. Field, Miles and Field (2013) indicated a linear regression model that produced a lower r-squared value had less predictable power than a linear regression model which produced a higher r-squared value. Therefore, the final linear regression model developed by Mertz *et al.* (2016) lacked validity and did not explain the variance as well as the previously developed linear regression model. In addition, only using r-squared values to validate a model had been found to potentially overestimate and overfit a model (Malthouse and Blattberg, 2005; Yang and Berdine, 2015). Thus, the alternative goodness of fit tests should be used including splitting the data into a training-validation dataset or conducting a Person chi-square statistic (Field, Miles and Field, 2013)

However, Casals and Martinez (2013) adopted a mixed model building approach developed by Pinheiro and Bates (2000). A stepwise approach was used to develop the linear regression model, firstly beginning with a model without any covariates. Individual action variables were then added using the Akaike information criterion (AIC) to measure model fit. AIC is the residual deviance plus twice the number of parameters in the model (Akaike, 1998). The addition of 'twice the number of parameters' acts as a penalty for larger models with more action variables and hence more parameters to be estimated. Individual action variables were added one at a time. If the action variable's inclusion within the model resulted in the production of a lower AIC, the action variable was retained. The process was repeated in a sequential nature until the AIC did not reduce, indicating the best model. When developing the generalised linear regression model, a backwards stepwise approach was used; beginning with a full model and removing action variables if the AIC increased until an adequate and statistical significant model was developed. However, Cheung and Skitmore (2006) found that although the forward selection or backwards elimination approaches were a thorough modelling method, the resultant models could vary. As a result, Cheung and Skitmore (2006) proposed conducting a stepwise regression approach, thus testing the model building approach using a forward selection followed by a backwards elimination approach and then selecting the model with the lowest AIC.

Although Casals and Martinez (2013) developed a valid linear regression model and a generalised linear regression model, which indicated that minutes played and usage percentage had the largest impact on the player, the action variables used did not provide a holistic insight into the overall performance of an individual. Gómez *et al.* (2014), Mertz *et al.* (2016) and Sampaio *et al.* (2010) also combined individual on-ball action variables into a single action variable or used individual on-ball action variables within their linear regression model in an attempt to accurately predict an individual's performance. However, the discrete action variables used in these studies did not allow the various decisions a player has available to them during a game to be considered (Hristovski *et al.*, 2012; Sweet and Grace-Martin, Karen, 2012). In addition, the findings of the research provide evidence of the desired frequencies and percentages an individual has to achieve at the end of a game but what the findings do not identify is how and why an individual can achieve these desired levels. Furthermore, the reliability procedures outlined by Gómez *et al.* (2014) are deemed incorrect, and therefore the findings of the study cannot be deemed reliable.

Logistic regression modelling, on the other hand, is an "efficient technique of predicting group membership of a dichotomous dependent variable if the independent variables are metric, nominal, or a mix of both, and the assumptions about the distribution of independent variables are not satisfied" (Verma, 2016, p.294). Thus logistic regression modelling can provide coaches, athletes and support staff with an objective insight into optimal outcomes for a given situation and thus the data-driven approach can be used to inform decisions during training and games (Baker and Kwartler, 2015).

Within basketball, logistic regression modelling has been used recently to explore the key determinates of success associated with momentum streaks (LaRow, Mittl and Singh, 2015), ball possession effectiveness (Gómez, Lorenzo, *et al.*, 2013), fast break effectiveness (Conte *et al.*, 2017) and shooting effectiveness (Gómez, Alarcón and Ortega, 2015). In developing a logistic regression model to explore shooting characteristics from the 2010 Basketball World Cup, Gómez, Alarcón and Ortega (2015) analysed 510 shots regarding the shot location, the duration of ball possession and the number of passes completed prior to the shot, the previous action completed by the shooting player and the defensive pressure sustained on the player taking the shot. The sequential nature of recording the actions leading up to and during the shot along with the interaction between the offensive player and the defensive players have similarities with the characteristics related to DST outlined by Gréhaigne and Godbout (2014). In addition, the study adopted a two-stage process for developing the logistic regression model, which consisted of a descriptive analysis test to identify significant action variables followed by a forward selection approach. In contrast to Casals and Martinez (2013) linear regression modelling approach, the shooting data were not subjected to a statistically underpinned validation process. Furthermore, the reliability of the data had not been subjected to intra-observer or inter-observer testing to explore the accuracy of the data. Therefore, the model's predictability is unknown because neither the data's reliability nor the logistic regression model's validity was explored or confirmed.

However, in a previous study completed by Gómez *et al.* (2013) the accuracy of the data was explored, when exploring the key determinants of team success, through the completion of an intra-observer and inter-observer test. The action variables that were developed align with the characteristics associated with DST. However, neither Gómez *et al.* (2013) or Gómez, Alarcón and Ortega (2015) outlined the stages undertaken to develop the action variables and therefore the action variables used to explore ball effectiveness and shooting effectiveness may not be valid. Despite this acknowledgement, the reliable data was subjected to the same two-stage logistic regression modelling process, which had been used by Gómez, Alarcón and Ortega (2015). However, the predictability of the logistic regression model was not explored, and thus, irrelevant to how reliable the data are, the model cannot be used to predict ball possession effectiveness. Despite the issues surrounding the validity of the action variables and the logistic regression model, some of the action variables which were used demonstrated statistical significance and thus potentially provided an insight into the key determinants associated with ball possession effectiveness but not the magnitude of the effect.

In contrast to the logistic regression modelling work completed by Gómez *et al.* (2013) and Gómez, Alarcón and Ortega (2015), Conte *et al.* (2017) most recently adopted a four-stage model building process to explore fast break actions in

Italian men's basketball. The modelling approach built on the methods used by Gómez *et al.* (2013) and Gómez, Alarcón and Ortega (2015). Following the descriptive analysis testing, the action variables were subjected to univariate analyses and testing of collinearity. These two additional stages explored the relationship between each action variable and the probability of winning a game as well as ensuring action variables were not correlated or associated with each other. However, no statistical evaluation of the relationships between action variables was presented. Assuming no collinearity or homoscedasticity existed between action variables, a forward selection approach was conducted to build the model. However, additional models using either a backwards elimination or stepwise approach were not developed, which Cheung and Skitmore (2006) proposed would have been one means of exploring a model's predictability. The action variables, which were recorded for this study, were categorised into three successive tempo phases of basketball (initiation, advance and completion). In addition, the number of players involved in each interaction (for example 1v1 or 3v1) during each fast break possession was recorded and thus the establishment of the action variables seems to be supported by DST. Although the establishment of these action variables was not outlined explicitly in relation to the methods proposed by James, Mellalieu and Jones (2005), the recording of the information regarding each fast was shown to be collected in a reliable manner. However, only one action variable was found to be statistically significant ($p < 0.05$) in relation to exploring fast break effectiveness and therefore the inclusion of non-statistical significant variables and the model's predictability has to be questioned.

LaRow, Mittl and Singh (2015) validated the logistic regression model developed to predict scoring streaks in the NBA from the 2000-01 to the 2014-15 season by splitting the data into an 80-20 training-testing data set. The 80 per cent training dataset was used to develop a logistic regression model, whereas, the 20 per cent testing data set was used to explore the accuracy of the logistic regression model. The splitting of the data into a training and testing sample ensured an honest assessment of the final model's predictability could be gained

(Reitermanova, 2010). Despite the detailed model building process in the work, only a backwards elimination approach was adopted. The adoption of only one model building approach, instead of a forward selection, backwards selection and a stepwise approach, did not determine if a model with greater predictability could have been developed. In addition, LaRow, Mittl and Singh (2015) did not test for multicollinearity and therefore did not examine if any variables were correlated or associated with each other. Furthermore, the reliability of the data were not examined and therefore potential discrepancies within each possession could have existed. However, when the training data set was validated against the testing data set a high success rate of the model's ability to randomly predict scoring streaks was observed. As a result, LaRow, Mittl and Singh (2015) concluded that the model which was developed was assumed to successfully predict scoring streaks in the NBA. However, according to Hosmer and Lemeshow (2000), a model which achieves an AUC value rate of 0.787 can only be considered acceptable at accurately predicting scoring streaks. Although, through splitting the data LaRow, Mittl and Singh's (2015) work is the only regression-based basketball study which validated the regression model's predictability through using a subset of the original data and thus can be claimed to have developed a logistic regression model that successfully predicted scoring streaks in the NBA.

Despite the above limitations of linear regression and generalised linear regression modelling, the modelling process enables the relationship between the dependent action variable (e.g. efficiency) and the independent action variables (e.g. the number of successful free-throw attempts) to be identified. The modelling process helps to linearise the nonlinear function, highlighting the impact of each independent action variable on the dependent variable (Kvam and Sokol, 2006). However, the logistic regression modelling method can be argued to be superior to the linear regression modelling approach, which relies on pure percentages that have typically been presented in SPA research. A logistic regression model can be used to compare the predicted combinations to the actually achieved combinations of action variables in specific categories, highlighting the optimal combination to achieve success (Clark, Johnson and Stimpson, 2013). The logistic regression model building approach should therefore follow the proposed steps outlined in Table 2-3, with a training and validation data set as well as the use of pseudo r-squared values (Hodeghatta and Nayak, 2017), a ROC curve and an AUC value (Muschelli, Betz and Varadhan, 2014) to determine the accuracy of future developed regression models. As a result, the probabilities of each action variable's effect on the dependent action variable can be calculated from the logistic regression model to identify the key determinants of success, predict performance and thus optimal game and playing strategies. Coaches, players and support staff can use the objective evidence gained from understanding the impact of each action variable and combination to make data-driven adjustments to specific training sessions tailoring the content, which has been shown to have the highest probability of success. Coaches and players can also use the data-driven approach to inform the in-game decisions, understanding the optimal combinations that are associated with a higher probability of achieving success (Gonzalez-Rodenas *et al.*, 2015). The logistic regression modelling approach, which involves grouping action variables into categories to identify the optimal sequence of events to establish success, could be useful in identifying the key technical and tactical determinants of success within wheelchair basketball.

2.6 Evaluating the impact of SPA data and information

The SPA infrastructure, regarding technology and the ability to collect large quantities of objective data, has increased significantly during the past decade (Davenport, 2014). Particular focus has been paid to identifying the key technical and tactical determinants of success in individual and team sports (Hughes, 2008; O'Donoghue, 2013, 2014). Currently, SPA has adopted positivist and reductionist approaches attempting to test hypotheses and reduce the highly complex and multi-faceted components into constituent elements represented as a mathematically articulated pitcutre of performance (McLean *et al.*, 2017). These current SPA processes highlight a disconnect between research and the application of SPA data and information into practice (Sarmento *et al.*, 2012;

Sarmento, Marcelino, *et al.*, 2014). As alluded to by Jayal *et al.* (2018) an alternative approach could be found by exploring the sociotechnical systems, through shifting towards an interpretivist perspective, to provide a more efficient and effective SPA process and information. The complex systems and interacting factors would be represented in a contextually-rich and situational specific manner, enabling greater understanding and learning to be achieved regarding how SPA data and information can be used to aid the coaching process and inform practice (Carling *et al.*, 2014; Wright, Carling and Collins, 2014). To support this shift, researchers have begun to explore the every-day use of SPA from a socio-cultural perspective (Groom and Nelson, 2013; Carling *et al.*, 2014; Mackenzie and Cushion, 2014). Since Blaze *et al.* (2004) first examined the perceptions of coaches and support staff towards the use of SPA, 18 studies have attempted to build on this work. The interpretive studies have endeavoured to generate rich accounts of how coaches, players or support staff understand SPA and the relationships involved within the SPA process in an attempt to make sense of the social dynamics which are evident in the SPA process. Subsequently, researchers have elected to focus on one specific group of individuals; either gaining an insight into players' opinions (Groom and Cushion, 2005; Francis and Jones, 2014; Nelson, Potrac and Groom, 2014; Tay*lor et al*., 2017), the coaches' perspectives (Groom, Cushion and Nelson, 2011; Butterworth, Turner and Johnstone, 2012; Williams and Manley, 2014; Booroff, Nelson and Potrac, 2015; Vinson *et al.*, 2017) or the performance analysts' viewpoint (Wright *et al.*, 2013; Butterworth and Turner, 2014; Huggan, Nelson and Potrac, 2015).

In contrast to the above-mentioned studies, Bampouras, Cronin and Miller (2012) focused on the perspectives of an athlete, a coach and a performance analyst towards SPA. Despite the participants having no connections and being involved in three different sports, their varied perspectives regarding the process provided a rich and detailed insight into the multiple social processes that were/are involved in SPA and presented suggestions on how to improve the provision. Reeves and Roberts (2013) expanded further, examining coaches', players' and analysts' perceptions of SPA who were associated with one English Premier League Academy association football team. Unfortunately, many of these studies used a variety of research designs and tools and there was no attempt to interpret the individuals' narrative through any theoretical lens, potentially disguising the power that these studies had on enhancing new knowledge in SPA.

2.6.1 Appraising qualitative research design for capturing coach, player and analyst perspectives of SPA

Researchers have recently begun to explore the thoughts and opinions of the individuals involved in the SPA process and how the data and information are used to inform the decision-making process and affect behaviour change. The researchers have elected to use questionnaires, interviews and reflective diaries to capture the participant's thoughts and opinions. Groom and Cushion (2005), for example, asked ten under-17 professional youth football players to complete a learning style inventory (Felder and Soloman, 1991) and a semi-structured questionnaire following the exposure to ten SPA sessions. The research explored the benefits of SPA in relation to learning, reflection, timing, mental components and overall usefulness of the session; providing an overview of the players' perceptions towards the SPA provision. Specifically, the results indicated a range of preferred learning styles emerged, video-assisted in identifying individual and team strengths and weaknesses, and developing an understanding of the team and unit shape.

Interestingly, the phenomena of learning styles have been debunked in the more recent literature (Riener and Willingham, 2010; Cuevas, 2015; Willingham, Hughes and Dobolyi, 2015), suggesting that placing learners into specific categories fails; as there is no evidence to prove an improvement in learning occurs. Simarliliy, asking players to categories there experiences through multiple choice questions restricts players to express their own perspectives through a limited number of available responses (Azzara, 2010). One of the questions in Groom and Cushion's (2005) work was regarding the length of time for SPA sessions; the question restricted the player's response to either 'about right', 'short' or 'too long'. Thus players were required to provide an average perspective rather than reflecting on each individual session as well as lacking the context for their response. Additionally, participants have shown a reluctance to use extreme values (Azzara, 2010). Within this research, the options of selecting that the session was either 'too long' or ' too short' could result in participants not wanting to offend the researcher or in this case the coaches.

To capture the experiences and the role of performance analysts, Wrigh*t et al*. (2013) devised a questionnaire comprising of 32 closed answer questions. The research team perceived the use of closed answer questions facilitated the ability to make comparisons across clubs. This process could enable attitudes, concepts and opinions relating to engagement to be compared (Hartley, 2014), however, respondents were asked to complete several different scales in the questionnaire. Research which requests different terminology when answering scale questions could reduce the validity due to the respondents not always noticing the shift in language (Betts and Hartley, 2012). Furthermore, the exact content of the questionnaire and the processes undertaken were not presented. Despite these issues, the study provided an insight into the role of performance analysts, specifically with regards to the post-match feedback process within elite academy and first-team football. However, Yorke (2009) argued that the use of Likert-style scaling questionnaires should only be used on large participant numbers, over 150. Research conducted with a large number of responses enable parametric analyses and sub-group comparisons, unlocking meaningful insights. The small sample size used by Wright *et al.* (2013) could explain why any academy analyst versus first team analyst statistical comparisons was not conducted, despite displaying clear numerical differences in the summary tables.

Likewise, the issues in terms of sample size, statistical comparisons and sub-group analyses could also be found in research conducted by Francis and Jones (2014). The researchers attempted to gain the experiences of elite rugby union players from two different clubs. Yorke (2009) also highlighted that when two small sub-groups were compared, respondents came with differing prior experiences. This typically has been shown to produce a variation in the responses which are extremely difficult to identify and analyse. Thus in an attempt to overcome the limitations of Likert-scale questionnaires Francis and Jones (2014) elected to also use semi-structured interviews to delve deeper into the players' perceptions.

The use of semi-structured interviews, in addition to questionnaires, allowed real-life examples to be drawn out and assisted the researchers with gaining a detailed understanding of why the respondents had developed their perception towards SPA (Francis and Jones, 2014). Blaze *et al.* (2004) also elected to use a Likert-scale questionnaire to complement the data gained from semi-structured interviews. The researchers decided to use interviews following the collection of quantitative data to obtain greater depth regarding a number of responses. The use of semi-structured interviews to complement the Likert-scale data has often been shown to generate positive levels of agreement, however, it could be argued that researchers are less likely to publish studies that discredit their questionnaires and interviews (Salmons, 2012; Wideman *et al.*, 2016). Blaze *et al.* (2004) used additional personnel in the form of assistant managers, coaches and support staff to complete the interview, but these individuals had not completed the questionnaire. The decision to use different participants for the interviews could be seen as a research limitation by some and a strength by others. The use of different participants has been shown to restrict the ability to make generalisations across the participant's responses and narratives. Although, by using different participants it could be argued that the data collected from two different tools could complement each other, overcoming individual methodological limitations (Park, Hwang and Gutman, 2017).

The use of these two data collection tools has been highlighted to enable patterns to be identified (questionnaires) and more in-depth insights regarding the participants' attitudes, beliefs and opinions (interviews) (Kendall, 2008). However, the two data collection tools are often used in mixed methods studies to generate generalisable results despite differences in philosophical perspectives, methodological design, analyses and interpretation. Harris and Brown (2010, p. 1) reported that the differences typically result in poor alignment, and can be attributed to "(i) differences in data collection procedures, (ii) the complexity and instability of the construct being investigated, (iii) difficulties in making data comparable, (iv) lack of variability in participant responses, (v) greater sensitivity to context and seemingly emotive responses within the interview, (vi) possible misinterpretation of some questionnaire prompts, and (vii) greater control of content exposure in the questionnaire".

Interviews, according to Hammersley and Atkinson (2007a), have advantages over questionnaires. Largely, context is provided by the interaction between the researcher and interviewee (DiCicco-Bloom and Crabtree, 2006). Importantly, face-to-face interviews enable the researcher to acknowledge social cues in the form of body language, intonation, tone ect., providing additional information to the verbal response (Opdenakker, 2006). Furthermore, the synchronous communication gained through a face-to-face interview has been shown to enable the interviewee to respond without an extended reflection (Iacono, Symonds and Brown, 2016). Interviewees can ask for clarification, explain their point of view in their own words and clarify certain points, however, an interviewer can lead or manipulate the responses through questioning (Park, Hwang and Gutman, 2017). Self-reporting issues have also been associated with interviews resulting in intentional or accidental inaccurate recall (Harris and Brown, 2010), subsequently resulting from the limited recall ability of specific events or situations by humans (Wright and Davies, 2008).

Interviews, despite the above-mentioned limitations, are the most commonly used data collection method in qualitative research (King and Horrocks, 2010; Mann, 2016). This is due to the fact the interviewees will have "a pretty good idea of the kind of encounter they are agreeing to" and the nature of questions that will be asked (King and Horrocks, 2010, p.1). The data collection method has been shown to enable the capture of rich and detailed narrative from the participant's actual experiences, overcoming the alignment issues identified when using interviews and questionnaires together to answer a research question (Galletta, 2013). This is due to the fact that the purpose of interviews is to clarify an individual's experiential life. Individuals engage "directly in a conversation with the researcher in order to generate deeply contextual, nuanced and authentic accounts of participants' outer and inner worlds, that is, their experiences and how they interpret them" and thus interviews are distinguished from other data collection tools (Schultze and Avital, 2011, p.1) providing a better way to interpret the participant's perspectives. They enable an interactional exchange between the interviewer and interviewee to be captured, the exploration of a number of themes and issues designed around a fluid and flexible structure, and the generation of situated knowledge by bringing relevant contexts into focus (Edwards and Holland, 2013).

To contextualise meaningful knowledge, Groom, Cushion and Nelson (2011) conducted interviews with 14 association football coaches who worked with the English national team over a 12-month period. The researchers examined the participants' views towards the delivery processes of video-based SPA within their practice. By using a purposive sampling technique, the participants' narratives enabled situational-specific concepts and theory to emerge, assisting in developing new knowledge to inform applied practice (Corbin and Strauss, 2014). Greater sensitivity to the theoretical relevance of the emerging themes was also achieved through this sampling technique (Salmons, 2012; Holt, 2016) and the researcher's previous knowledge of the participants and experience of SPA assisted in building rapport with the interviewees (Gray, 2013). Prior knowledge of the individuals or of the processes has been raised as a potential point of bias, whereby the researcher guides the interviewee towards a specific theme (Galdas, 2017). Access to elite sports participants is notoriously difficult and thus typically gained by the researcher fulfilling a secondary or consultancy support role (Williams and Kendall, 2007). Subsequently, by adopting an expert-systems approach (Côté *et al.*, 1995) and using elite level coaches, Groom, Cushion and Nelson's (2011) study allowed for the perspectives of the coaches to be captured.

The interviews, in Groom, Cushion and Nelson's (2011) work, collected rich empirical data that provided an insight into the interlinked process of delivering SPA in a cyclical manner to inform future practice. In particular, this highlighted importance regarding the tailoring of feedback to the target audience as well as considering the presentation format, session design and delivery approach. If the researchers had elected to use questionnaires to construct new knowledge, information-rich cases that would yield insightful data relevant to understanding the phenomena under investigation would not have been achieved (Cresswell, 2009; Groom, Cushion and Nelson, 2011). Thus, the methodological approach adopted enabled the collection of more realistic representation of current practice and offered a greater insight to inform the future use of SPA in football and coach education, in comparison to previous research (Groom and Cushion, 2005; Cushion, 2007a, 2007b; LeUnes, 2007).

Without capturing the individuals who received the video-based SPA provision and feedback, the potential findings to inform future practice could be argued to be onesided; a potential limitation of Groom, Cushion and Nelson's (2011) work. Reeves and Roberts (2013) acknowledged this limitation by interviewing five academy players, one academy coach and two academy performance analysts in association youth football. Open-ended questions specifically focusing on how SPA had impacted upon individual and team performance were used to explore all of the participants involved in the SPA process. The ability to collate multiple perspectives from individuals within a multitude of roles assisted in obtaining information-rich data to build on the existing knowledge of the phenomena. Specifically, the participant's perceived SPA had the potential to (i) benefit team and individual performance through identifying areas of weaknesses, (ii) encourage self-evaluation and self-reflection, and (iii) act as a motivational tool to reinforce good performances. However, the average length of the interviews was 20 minutes, suggesting the interviewer did not use follow-up questions effectively and thus potentially limiting the quantity and quality of the data (West and Blom, 2017).

The length and the richness of the interview data obtained by Groom, Cushion and Nelson (2011), however, could suggest that the participants' in Reeves and Roberts' (2013) work were unwilling to be open and expand on their responses due to the interviewer's relationship with the participants. Alternatively, researchers have suggested the interviewer's experience, gender and age can affect the effectiveness of interviews (West and Blom, 2017), and thus provide potential evidence to explain the shorter interview lengths. Purdon, Campanelli and Sturgis (1999) and Blom, de Leeuw and Hox (2011) also found that more experienced and successful interviewers obtained richer data through longer discussions due to increased cooperation being displayed by the interviewee. Whereas Blohm, Hox and Koch (2007) discovered that women and older interviewers achieved higher contact rates. Matching the demographics of the interviewer with the interviewee, however, tended to result in longer interviews (Durrant *et al.*, 2010), although, Schultze and Avital (2011) argued that longer interviews may not always result in richer data. However, it is the topic of interest that is more pertinent and the recruitment of individual's who are able to provide a thick first-person account of their own experiences within their world (Ponterotto, 2006).

More recently, Booroff, Nelson and Potrac (2015) examined a head coach's (Terry) perceptions of the use of SPA through a series of observations, field notes and semi-structured interviews. The researchers specifically focused on how SPA was deployed by Terry to facilitate a number of coaching goals that were perceived to be expected of his role as an academy football coach. During the period of the study, Booroff, the lead researcher, worked as Terry's performance analyst. Thus, access to the participant through personal connections ensured information-rich accounts of the coach's perceptions and views were collected. Similarly to Groom, Cushion and Nelson's (2011) study, the recruitment of participants through purposive sampling was found to add further credence to the topic that was being explored and allowed for concepts and theory to emerge (Salmons, 2012; Corbin and Strauss, 2014; Holt, 2016). Booroff, Nelson and

Potrac (2015) were careful to note in their work that Booroff had held the position as the team's performance analyst prior to conducting the research, reiterating the data was credible due to the developed rapport between researcher and participant.

Booroff, Nelson and Potrac (2015) observed the head coach in-practice, made fieldnotes during these sessions and conducted a series of semi-structured interviews, to overcome the limitations of combining questionnaires and interviews (Harris and Brown, 2010). Observations and field notes have been used by researchers to document contextual information (Phillippi and Lauderdale, 2018). The notes made during observations can assist in gaining information regarding pertinent events, drawing further questions, developing new ideas and establishing new knowledge. Walford (2009) highlighted that fieldnotes typically contain very personal and idiosyncratic perspectives, and thus a one-sided perspective could be presented. Fieldnotes, however, aid in the construction of thick, rich descriptions of a specific context, encounter and/or informal conversation and are widely regarded as a standardised criterion for qualitative research (Emerson, Fretz and Shaw, 2011; Maanen, 2011; Phillippi and Lauderdale, 2018). Within Booroff, Nelson and Potrac's (2015) work, observations and field notes were used to raise further questions. In this manner, the observations and field notes, in addition to the interview questions, "not only helped to confirm much of what had been discussed but allowed for a richer understanding of his practices to be generated" (Booroff, Nelson and Potrac, 2015, p.118).

The series of semi-structured interviews that were conducted enabled specific points in time to be discussed during the interview. This ensured the participant was able to recall the event and allowed for a nuanced understanding of how the coach's perceptions of SPA changed over time (Carduff, Murray and Kendall, 2011). The time in which the phases of observation and interviews were conducted was not explicitly highlighted, however, it can be inferred that the data collection period was completed over a period in excessive of 10 weeks; as

Booroff, Nelson and Potrac (2015) referred to the collection and analysis of the data as an on-going cycle.

Exploring a phenomenon through the data collection tools used by Booroff, Nelson and Potrac (2015) and over a longer period of time was shown to develop an understanding of what change happens and the associated reasons of how and why (Holland, Thomson and Henderson, 2006; Edwards and Holland, 2013). Additionally, the longitudinal design enabled the interplay between time and the cultural dimensions of social life to be captured (Neale and Flowerdew, 2003). The researchers, Booroff, Nelson and Potrac (2015), were able to identify that Terry's use of SPA was far from apolitical but constrained by his relationship with others in the club. The coach made use of SPA to assist players that he perceived to have the greatest chance of progressing into the first team; due to SPA being identified to assist the learning and decision-making processes of individuals (Francis and Jones, 2014). Feedback was provided through SPA to highlight what the players were doing well and what they needed to work on to improve. The releasing of players was an additional key responsibility of Terry, and he made use of SPA to highlight why a player was being released after their two-year academy contract. The findings from this study could be particularly relevant for understanding the experience of a new SPA provision and how coaches make use or do not use SPA to assist the development of players.

Longitudinal qualitative research studies, however, are complex due to the number of variables to consider in the research design (Calvey, 2004). For example, the ability to conduct a series of interviews over a period is difficult to organise, especially in high performance sport (Williams and Kendall, 2007). To overcome this issue, researchers in sports sociology (e.g. Edwards, Molnar and Tod, 2017) have made use of timelines within an in-depth semi-structured interview to enable participants to recall specific events that have occurred. Such an approach could assist in overcoming access to participants involved in high performance environments but still provide information-rich cases by sharing the participant's thoughts, reasons and interpretations of events. However, despite the work of Booroff, Nelson and Potrac (2015) providing a useful insight into SPA, the perspectives of the players and other members of staff, a strength of Reeves and Roberts' (2013) work, have not been captured.

Regardless of some of the methodological flaws within the research presented within this section, the benefits of SPA, as a learning tool, have been highlighted by coaches in association football, basketball, field hockey, netball, rugby league and rugby union (Bampouras, Cronin and Miller, 2012). It has been found that a longitudinal qualitative case study would provide the ability to understand how change has happened over time within a specific context. This is important to consider as Francis and Jones (2013) discovered a coach can be sceptical of new information, especially if it is too complex or contradicts their way of thinking. Thus, if data is collected over a shorter period of time, important information and insights may not be collected. Observations, fieldnotes and semi-structured interviews have been shown to enable researchers to collect information-rich cases that assist in making sense of the complex and messy realities of delivering SPA in high performance sport. While these studies are exploratory in nature and begin to provide new knowledge, there is a need to collate the perspective of each user within the SPA process. Currently, the critical understanding of SPA and the means in which it is deployed is embryonic at best, especially in sports that have not used SPA. This is due to the continual application of the data being presented in a largely technical and unproblematic manner. Thus, additional work is needed to acknowledge the socio-cultural contexts within which coaches, players, and support staff use SPA.

2.6.2 Interpreting and contextualising coach, player and analyst perspectives of SPA

Researchers have attempted to answer these calls to acknowledge the socio-cultural contexts of using SPA by turning to the work of Kelchtermans and Ballet (2002a, 2002b), Bourdieu (1977) or Raven (1992, 1993, 2001, 2008) to help interpret the participants’ narratives and experiences. For example, Huggan, Nelson and Potrac (2015) provided a detailed account of a performance analyst

(Ben) as the individual attempted to navigate through the early stages of his career working in elite association football. To interpret Ben's narrative of the authoritarian management cultures that were experienced, Kelchtermans and Ballet's (2002a, 2002b) and Kelchtermans' (2005, 2009a, 2009b, 2011) micropolitical works were principally used to understand how Ben learnt to behave (micro)politically. Central to Kelchtermans' socio-political analysis is that individuals hold beliefs regarding the 'optimal' working conditions that will enable them to undertake their professional activities effectively. These beliefs operate as *professional interests*, comprising of *cultural-ideological interests* (i.e. "normative values and ideals about 'good'" practice in the environment, p.110), *material interests* (i.e. "availability and access to…materials, funds, infrastructure and structural time facilitates", p.110), *organisational interests* (i.e. "issues concerning roles, positions or formal tasks", p.110), *self-interests* (i.e. "issues of professional identity and its social recognition", p.110), and *social-professional interests* (i.e. "issues on the quality of interpersonal relations" within the environment, p.110) (see Kelchtermans and Ballet, 2002b). An individual's *professional interests* assist them when entering a new environment. They begin to read, learn and write themselves into the micropolitical landscape. The individual is attempting to establish themselves as a professional and develop the 'optimal' working conditions to ensure they can fulfil their aims (*micropolitical literacy*) (Kelchtermans and Ballet, 2002a, 2002b). During their employment, they will attempt to develop, maintain and protect their 'optimal' working conditions, by engaging in *micropolitical action*. Or to restore their previously established conditions if those are threatened or removed. The core component to the establishment of these 'optimal' working conditions is the individual's understanding of themselves, their task perceptions and their professional self-esteem (Kelchtermans and Ballet, 2002a).

Kelchtermans and Ballet's (2002a, 2002b) micropolitical theoretical lens helped Huggan, Nelson and Potrac (2015) interpret how Ben understood his new working environment and the political and power relationships that existed in it. Over time Ben undertook additional responsibilities, increasing his worth and value to the coach (*organisational interests*), developing relationships with stakeholders (*social-professional interests*) and establishing his worth through increasing his visibility by travelling with the team to away games (*cultural-ideological interests*). The increasing exposure allowed Ben to build rapport and trust with key stakeholders. Consequently, Ben was able to influence the players, coaches and board to invest in his personal agenda by engaging in the above *micropolitical action*. His success could be attributed to his ability to navigate his way through the micropolitical landscapes, investing time and energy to establish relationships to secure his position as he moved between clubs and fulfil his aims (*micropolitical literacy*). The interpretation of Ben's narrative through a micropolitical lens provided an insight into the socio-political realities that exist in the context of SPA in association football and allowed for key messages in terms of improving future practice to be learnt.

Similarly, Booroff, Nelson and Potrac (2015) also used Kelchtermans' socio-political analysis (Kelchtermans and Ballet, 2002a, 2002b, Kelchtermans, 2005, 2009b, 2009a, 2011) to provide a political insight into how Terry made use of SPA technology to protect his position. Terry's actions were "influenced by his understandings of the contextual opportunities and constraints of his working environment" (Booroff, Nelson and Potrac, 2015, p.121), aligning his actions to his *professional interests* in an attempt to protect his position at the club (Kelchtermans and Ballet, 2002a). Through engaging in *micropolitical literacy* (Kelchtermans and Ballet, 2002a, 2002b), he developed the grammatical knowledge to see, interpret and understand the existing micropolitical undercurrents that were apparent in the environment. Furthermore, his decision to focus his feedback on the most gifted players, to support their development of becoming professionals and resolve the club's financial issues, illustrated Terry's ability to engage in *micropolitical action* (Kelchtermans and Ballet, 2002a); implementing strategies which would actively influence and protect his working environment (Kelchtermans, 2005).

The use of Kelchtermans and Ballet's (2002a, 2002b) work provided a useful lens to interpret the micropolitical underbelly that was apparent in Ben’s and Terry’s narratives. It provided a productive role in strengthening the theoretical understanding of this topic and the landscape of high performance sport. The narratives and lens that were used emphasised the importance of acknowledging the social and political dynamics between individuals to introduce change, specifically whilst attempting to navigate through the various environments they entered. However, as Leftwhich (2005) highlighted wherever there are political agendas, power balance and imbalances will also surface. Booroff, Nelson and Potrac (2015) also perceived the actions completed by Terry illustrated he was neither totally free nor constrained by his role as the head coach in academy association football (Jones, Armour and Potrac, 2004). He was thus continuously engaged in a battle to establish, secure and maintain power. Undoubtedly, his actions and the practices he completed were influenced by his previous socialisation experiences, the awareness of the club’s culture and demands from the sport’s national governing body regarding SPA provision. However, he still had some level of freedom regarding how he chose to implement a provision to aid his practice and ensure his end goals were achieved. Booroff, Nelson and Potrac (2015) thus interpreted Terry’s actions to not be solely “the deterministic consequences of the role expectations” (Callero, 1994, p. 239). Instead, they perceived he engaged in structural improvisation (Bourdieu, 1977) to fulfil his own expectations and his perceptions of the organisation’s expectations.

Booroff, Nelson and Potrac's (2015) also used Bourdieu's (1977, 1984, 1986, 1988, 1989, 1990, 1991) work as a pivotal foundation for understanding and unpacking the power relations that existed as Terry attempted to survive as an academy association football coach. Bourdieu (1977, 1989) believed the formation of power relies on an individual’s ability to acquire knowledge through drawing on previous experiences to guide and shape their future behaviour, thinking and practice. His perspective attempted to outflank “the agency-structure debates, micro-macro linkages and the freedom and determinism dichotomy” that have bedevilled social research, “focusing on the ‘dialectical’ relationship between objective structures and subjective phenomenon" (Jarvie and Maguire, 1994, p,184). Thus, to assist in the reorientation of the sociological perspective of power and knowledge, Bourdieu devised several thinking tools that illustrated his key concepts of habitus (i.e. how an individual's cultural and sociological history are used to influence and structure their understanding and knowledge (Gouanvic, 2005)), field (i.e. how the location in which an individual and their social positions find themselves influence their understanding and knowledge), and capital (i.e. how an individual used their ability to exert power to control their own future, as well as the future of others).

Bourdieu (1986) held a perspective that capital does not present in a single form but could appear in various forms; economic (i.e. the immediate and/or direct conversion to money, attributing to owning items such as a house, car, boat, holiday home, etc.), cultural (i.e. "in the form of long-lasting dispositions of the mind and body" or "cultural goods (pictures, books, dictionaries, instruments, machines, etc.)" or "a form of objectification" (Bourdieu (1986, p.241)), social (i.e. 'made up of social obligations ('connections'), which is convertible, in certain conditions, into economic capital (Bourdieu (1986, p.243)) or symbolic (i.e. a kind of advance, a credence, that only the group's belief can grant" (Bourdieu, 1990, p.120)). These various forms of capital contribute to the formal and informal social hierarchy between individuals within a group. Cushion (2001) identified these various forms of capital existed between coaches and athletes when either attempted to introduce new ideas and concepts. It could be argued that cultural, social and symbolic capital are the most relevant when working with SPA, due to individuals attempting to use SPA as a tool to achieve success, relying on the buy-in of others to the process, to protect their position. However, it is important to remember an individual's position and relationship within a field are dependent upon the interplay between their habitus and capital (Asimaki and Koustourakis, 2014). Bourdieu (1986) located the various forms of capital as a fundamental part of the structuring process of habitus and argued that individuals use these, as a tool within the relative field that they are located in, to gain power and dominance over others. Therefore, specific power struggles are evident in each field because individuals attempt to establish, impose or improve upon their position by employing a variety of strategies (Gaventa, 2003). Thus, this relationship between the three components as (habitus x capital) + field = practice (Bourdieu, 1984, p.101).

Booroff, Nelson and Potrac (2015) thus perceived Terry's role as both enabled and limited by the role he fulfilled as the coach within academy football and how his use of SPA and interactions with the players illustrated elements of agency in the structural social positions and the broader subcultural expectations in which he was placed. Therefore, Terry's beliefs and opinions, regarding how SPA could be used to advance his own political agenda, drew parallels to Bourdieu's notion of field, habitus and capital (Bourdieu, 1977, 1984, 1986).

Butterworth and Turner's (2014) work also referred to Bourdieu's (1984) field theory (habitus, field and capital) to aid the interpretation of their own experiences as a performance analyst and a lecturer, and the challenges they faced navigating themselves through their careers. Butterworth felt 'like a fish out of water', experiencing a sense of disconnection, as he attempted to establish, improve and secure his position as a performance analyst. Through entering a new field, as his career progressed from assisting at the London 2012 Olympic and Paralympic Games to becoming the England Netball analyst, he initially struggled to improve or change his position within the new environments and introduce new ideas and concepts to assist the athletes and coaches. However, over time he drew on previous experiences (habitus) to underpin his decisions, ensuring his actions and behaviours contributed to success. These positive contributions to the team and individual player performance at various competitions raised his symbolic capital and the feeling of misrecognition was declined. Butterworth's previous work and achievements as a performance analyst were acknowledged by other sports and he was subsequently provided with new opportunities.

Bourdieu's (1984) work provided an approach for exploring the process of change and interpreting Butterworth and Turner's narrative. The theory also revealed the potential power-struggles that have been rendered invisible by habitus and misrecognition (Navarro, 2006). Bourdieu's (1989) theoretical perspective helped to make sense of the everyday, dynamic social process where one action, process or situation "is not recognised for what it is because it was not previously 'cognised' within the range of dispositions and propensities of the habitus of the person(s) confronting it" (James, 2015, p.100). Bourdieu's (1977, 1984, 1986, 1988, 1989, 1990, 1991) works have provided a useful platform for exploring the phenomena of power in SPA and the interplay between habitus, field and capital. However, within Butterworth and Turner's (2014) work, there are no attempts made by Butterworth to elaborate on the power strategies he used to introduce or improve his position, subsequently limiting his interpretation of his own journey through the various landscapes.

Alternative theories regarding specific power strategies have been applied to a SPA context. For example, Groom, Cushion and Nelson (2012) applied Raven's (1992, 1993, 2001, 2008) work to interpret the 'coach-athlete' dialogue and the power strategies adopted by a coach during SPA sessions. The multidimensional power/interaction model of interpersonal influence proposed by Raven (1992) addressed the methodological limitations and a single measurement of each power base in French and Raven's (1959) original typology of power (Podsakoff and Schriescheim, 1985; Koslowsky and Schwarzwald, 2001). The revised model assumed an individual's decision to apply an available base of power is chosen through a rational decision, whilst being influenced by situation and personal variables (Koslowsky and Schwarzwald, 2001). The individual with superior power is also required to acknowledge the motive of the individual with inferior power, electing to either comply or resist (Koslowsky, Schwarzwald and Ashuri, 2001). Within a sporting scenario, a player could acknowledge the need to work with an analyst and a coach to enhance their performance, despite both the analyst and the coach having a superior position of power. Raven subsequently began referring to the individual with a superior position of power as the *influencing agent,* whilst the individual with an inferior position of power was referred to as the *target agent* in his work. To illustrate this revised perspective, Raven's (1992, 1993) new theoretical perspective of power included 14 power bases in comparison to the original six bases (French and Raven, 1959; Raven, 1965) (See Figure 2-2**Error! Reference source not found.**).

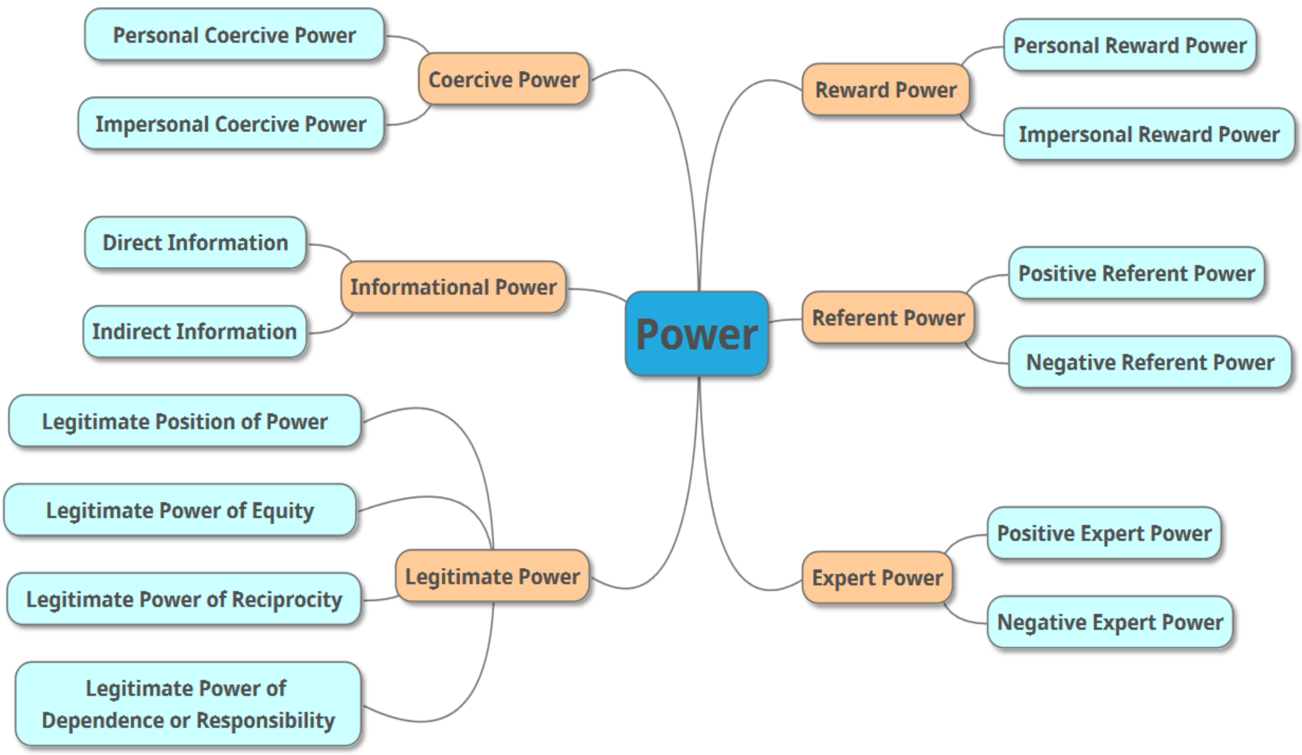


Figure 2-2: Schematic diagram illustrating French and Raven's (1959) six bases of power in orange and Raven's (1992; 1993) new theoretical perspective of power including 14 power bases in blue.

Referring back to Groom, Cushion and Nelson's (2012) interpretation of the power and interactions between the coach and the players, the coach engaged in forms of preparatory work. Through building on his position as the coach, he provided the players with some background information at the start of the session (establishing informational power), used video as a tool to punish an individual to set an example (intimidation), flattered other players (ingratiation), emphasised the work he had completed preparing the team (favour-doing to establish legitimate reciprocity) and explained the amount of time it took to prepare for each session (self-promotion) (Raven, 2008). Thus, Groom, Cushion and Nelson

(2012) perceived the coach exerted positive expert power, legitimate power of responsibility and direct informational power (Raven, 1992, 1993, 2001, 2008).

Through these bases of power, the coach was able to persuade the players that their actions were incorrect and his way of thinking and how the players should have behaved on the pitch was correct. If a disagreement between opinions arose, the coach demonstrated institutional authority to retain power and restore control over the players' interactions. On a number of occasions, the coach demonstrated personal coercive power, forcing the players to re-watch a specific event. The researchers deemed the coach's actions to be an attempt to present himself as the expert in an attempt to reinforce his social basis of power (Raven, 1992, 1993). Adopting this approach of social power could have unintended consequences in terms of loss of respect and trust (Elias, 1956), resulting in potential player resistance to the coach and non-learning (Nelson, Potrac and Groom, 2014). Raven's (1992, 1993) revised perspective of power provided a useful theoretical lens to explore the 'talk in action' conversation acknowledging the power strategies and the subsequent effects on the players' reactions and buy-in to the session (Groom, Cushion and Nelson, 2012).

These previous qualitative studies and the theoretical lenses used have highlighted the importance of acknowledging and understanding the intertwining components of power and micropolitics. The theoretical lenses of Bourdieu (1977, 1984, 1986, 1988, 1989, 1990, 1991), Raven (1992, 1993, 2001, 2008) and Kelchtermans and Ballet (2002a, 2002b) have been shown to assist in making sociological sense of how individuals have engaged in an SPA provision. Additionally, the researchers have been able to capture the participants' narratives and gain a contextually deep insight into how the SPA provision was perceived and how improvements could be made to assist in providing contextual and situational-specific information. The capturing of perceptions of those who have been directly involved in the SPA process has been shown to help develop the existing knowledge regarding the complex and sometimes messy socio-political realities that are implicit in sport and assist when introducing new concepts and ideas regarding the utilisation of SPA as a tool to assist the learning, decision-making and performance of individuals and the team.

2.7 Summary

The literature review has critically explored the use of SPA within research and has increased knowledge of the application and the processes involved in SPA, and more specifically in wheelchair basketball. Despite such a body of knowledge existing in SPA, the review has highlighted that some investigations were methodologically flawed, lacked clarity and used inadequate procedures. Therefore, to ensure a vigorous and objective approach has been adopted towards analysing wheelchair basketball performance, a number of issues need to be considered.

The developments in computerised technology and the integration of video footage, through the creation of bespoke SPA software, have led to systems that are easier to use and obtain the required data more quickly than previous hand notation methods (Jayal *et al.*, 2018). These software packages enable operators to develop bespoke templates capable of recording specific events and actions in a sequential nature. Within wheelchair basketball, the current reliance on the CBGS to provide individual and team insights does not allow coaches, players and support staff to gain a complete picture of the entire performance which takes into consideration the dynamic and fluctuating nature of team sport. Whilst Gómez *et al.* (2014) outlined that the findings within their work could be used to inform practice, this review has highlighted that it is unclear whether these findings provided contextual and situation-specific information to present accurate and meaningful information that could enhance the coaching process and feedback.

In relation to contextually relevant performance data, previous SPA research has historically analysed the discrete actions of team performance over time (e.g. Lorenzo *et al.*, 2010). To understand the complex and unstable nature of team sports, it has been argued in this review that it is important to identify valid variables that follow DST principles and provide an insight into the relationships between interactions during different situations of a game. Recent studies both in wheelchair basketball and other invasion sports have still continued to collect performance data in isolation. The move towards context and situational-specific variables would enable more meaningful, sport-specific and even team specific data to be collected and used within the coaching process to further enhance learning and the decision-making skills of coaches, players and support staff.

In addition, it has been highlighted that the processes undertaken to develop sport-specific action variables and explore the accuracy of analysts, researchers or operators to obtain this data has differed. A standardised process for creating valid action variables and exploring the reliability of a system or analyst to capture performance data does not currently exist. For example, the following differ in the process of ensuring validity: (i) how an initial list is developed, (ii) how and when operational definitions have been established, and (iii) the methods used to establish content validity. The review has highlighted that the percentage error and Weighted Kappa statistics could provide an insight into an individual's ability to observe individual actions and behaviours in an accurate and consistent manner. If a template's validity and reliability were explored and fall within the agreed limits, the objective performance data could be used by coaches, players and support staff to provide accurate feedback to enhance learning and performance.

Considering that presenting the frequencies or percentages of discrete actions continues to be the adopted approach in wheelchair basketball, the findings, therefore, do not provide any explanation as to the reasons how and why a team or an individual produced a successful or unsuccessful outcome. Passos *et al.* (2008) believed that it is pertinent to explore the sequential passages of play to help provide contextually relevant performance data. Additionally, research that includes how the actions of the attackers are influenced and affected by the actions and behaviours of the defenders and fellow team members helps within this process (Gréhaigne and Godbout, 2014). Within the context of this thesis and wheelchair basketball, it is important to not only take into consideration the defender's actions but the effect of the interaction between both the attackers and defenders in any given situation in an attempt to answer how and why an action occurred.

Considering the ability of computerised systems to collect large quantities of performance data, the SPA discipline has witnessed a recent shift (Hutchins, 2016). Performance analysts and coaches are beginning to use previous performance data to develop linear and logistic regression models to make objectively informed predictions regarding certain situations and events. These predictions are now being used to inform decisions within the planning and delivery of training sessions throughout competitive performances (Heazlewood, 2006). However, due to the limited valid and reliable performance data within wheelchair basketball and the methodologically flawed attempt by Gómez *et al.* (2014) to develop a linear regression model, no valid regression models have been developed that accurately predict future performance. The logistic regression modelling approach, which involved grouping action variables into categories to identify the optimal sequence of events to establish success, could be useful in identifying the key technical and tactical determinants of success within wheelchair basketball.

A further concern highlighted within the research is that coaches can be sceptical of new information and new ways of thinking (Francis and Jones, 2013). This is despite other researchers and coaches acknowledging the wider benefits SPA can bring to enhancing an athlete's learning within team sports (Wright, Atkins and Jones, 2012; Wright, Carling and Collins, 2014; Vinson *et al.*, 2017). The use of SPA is a relatively new concept within wheelchair basketball and as a result, the interpretation and application of key performance data by coaches, player and support staff within wheelchair basketball are unknown. Further exploration is therefore required to understand how the objective data can be used to enhance learning, development and performance.

Accordingly, this review highlighted a need for a comprehensive and holistic data capture, measurement and interpretation tool within nearly all team sports, in particular, wheelchair basketball, to assess and model performance. Through the identification of valid and reliable action variables and performance indicators, it is possible to begin to collect accurate performance data that can provide the initial platform to model wheelchair basketball performance. Through gaining an objective understanding of the key components that contribute to the success and how to deliver the information to the end user, it is important to explore how a SPA provision can impact overall team performance in elite men's wheelchair basketball.

Subsequently, the aim of this thesis was to advance knowledge of the key tactical actions and variables attributed to success in elite wheelchair basketball and interpret the impact of a SPA provision that was provided to one elite men's wheelchair basketball team during the Rio de Janeiro Paralympic Games cycle (2013-2017) using a mixed methods case study approach.

Chapter 3 Assessing team performance in wheelchair basketball

3.1 Overview

Within this chapter, the workings employed to develop a valid and reliable performance analysis template for analysing team performance are presented. The chapter opens with a discussion regarding the validity and reliability procedures undertaken in previous wheelchair basketball SPA studies before addressing the need for developing a new template. Within the SPA research that was highlighted in Chapter Two, validity referred to the degree to which a variable represented the concept of performance being measured (Larkin, O'Connor and Williams, 2016). Reliability of a variable in SPA is the level of consistency with which the measurement procedure can be replicated by independent operators achieving the same result (O'Donoghue, 2010). However, a variable that is deemed unreliable, due to errors in the measurement process, cannot be valid. The stages undertaken to develop the valid SPA template are outlined. These build on the work of James *et al.* (2005) involving the use of experienced coaches to identify performance indicators. Furthering Thomson, Lamb and Nicholas' (2013) work, the sequential events recorded, through observing a full game of wheelchair basketball on two separate occasions, were subjected to an intra-observer reliability test to explore my ability to accurately record events within the template. Through scrutinising the two observations, an agreed observation was formulated. The agreed observation was then used to calculate the level of inter-observer reliability by comparing an observation of the same game completed by a coach and a performance analyst intern. The intra-observer and inter-observer results are presented and discussed.

3.2 Introduction

Feedback provided to athletes regarding their performance should be constructed through the utilisation of valid and reliable performance data and information (Liebermann *et al.*, 2002; Lames and McGarry, 2007). Traditional coaching approaches have involved the use of subjective observations and conclusions formulated through the coach's own perceptions and previous experiences (Robinson, 2010). However, Franks and Miller (1986, 1991) and Laird and Waters (2008) found coaches' subjective opinions can often be inaccurate and unreliable. These studies highlighted coaches could accurately recall only 30 per cent to 59 per cent of a performance during a post-game assessment. The inaccuracies observed in the coaches' ability to recall information highlighted the limitations of the human brain in storing and retrieving information, however, this inability to recall information can result in inaccurate and unreliable information being fed back to athletes (Wright and Davies, 2008). The information gained through observing a performance is used to plan and implement upcoming training sessions, and inform in-competition decisions. Evidently, the use of a coach's subjective opinion is not sufficient to instigate and inform performance change, thus an alternative method is required to effectively provide more valid and reliable performance information (Ali, 2011). The increasing advancements in SPA could provide an alternative method for collecting valid and reliable performance data (Maslovat and Franks, 2015).

Wheelchair basketball SPA research studies (critically evaluated in Chapter Two), have inherently questionable validity and reliability These studies have relied on box score data, with no consideration of its validity or reliability and the (modified) comprehensive basketball grading system (CBGS) to provide an 'objective' means of evaluating individual player performance. The CBGS was originally developed for use in running basketball and from a very small sample of games at a specific level of competition (Mullens, 1978), making it invalid for use in the wheelchair game.

Researchers attempted to include wheelchair basketball specific variables in the modified-CBGS (Byrnes and Hedrick, 1994), however, the sport-specific variables were removed due to definitional errors identified as a result of the operators' experience (Vanlandewijck *et al.*, 2003, 2004). The CBGS and modified-CBGS data were also found to be highly correlated with one another. Reliability of these studies was assessed by inter-observer reliability procedures using a Pearson's R Correlation, which has been criticised due to presenting miss-leading results as it is an assessment of relationship, not agreement (Liu *et al.*, 2016). Despite this, researchers have elected to use this ‘evidence’ to determine the quality of players’ games and made comparisons between functional classification groups, identifying that higher classified players achieved higher CBGS scores.

Furthermore, researchers have also claimed the findings from individual box score data can be used to provide an insight into team performance. Neither version of the CBGS, however, capture contextual and situational relevant data regarding team performance. Araújo and Davids (2016) argued that it is important to consider the interactive behaviours of players over time and recording these on a continuous or sequential basis. Researchers have identified the performance relationship between game status (e.g. Sampaio et al. 2010), line-up rotations (e.g. Clay and Clay 2014) and the offensive-defensive dyads involved in sports (García *et al.*, 2013), and thus by capturing these data it could be possible to provide meaningful objective augmented feedback (Araújo, 2017; Jayal *et al.*, 2018). Passos (2008) also argued that the collection of discrete variables, as is the case with the (modified) CBGS, does not provide a true insight into an entire performance. Additionally, the seven studies did not mention how the action variables were established. Therefore, if the process of establishing the action variables is not outlined and the secondary box score data has been shown to be potentially incorrect, the data collected should not be used by coaches, players and support staff to inform decisions regarding team aspects of performance (Ziv, Lidor and Arnon, 2010). The (modified) CBGS is not suitable for measuring team performance in elite men’s wheelchair basketball.

Considering the above concerns within the discipline and specifically in wheelchair basketball regarding reliability, there is a need for a new valid and reliable sports performance analysis template to assess a team’s performance in wheelchair basketball. The template is required to correctly identify and record the actions that occur during a game in a consistent manner, thus providing coaches, players and support staff with meaningful performance data to inform future decision making. The variables that are analysed in the study can contribute to the players' learning, thus increasing the likelihood of wheelchair basketball teams achieving performance success. As such, an adequate methodological process for quantifying action variables in elite men's wheelchair basketball was required. Therefore, the aims of this chapter were to (i) develop a valid performance analysis template in elite men's wheelchair basketball and (ii) assess its intra-observer and inter-observer reliability.

3.3 Method

To meet the aims of this chapter, the methodological approaches used by James, Mellalieu and Jones (2005) and Thomson, Lamb and Nicholas (2013) were followed as an initial framework. The framework was adapted, due to the limited pre-existing research in wheelchair basketball and the limited number of available wheelchair basketball staff. The framework for this research followed nine distinct phases (See Figure 3-1), with phase one to six pertaining to the validation process, phase seven involved developing the SPA template and phase eight and nine related to the reliability process. Before any of the research phases were conducted, ethical approval was granted by the University of Worcester's Ethics and Research Governance Committee.

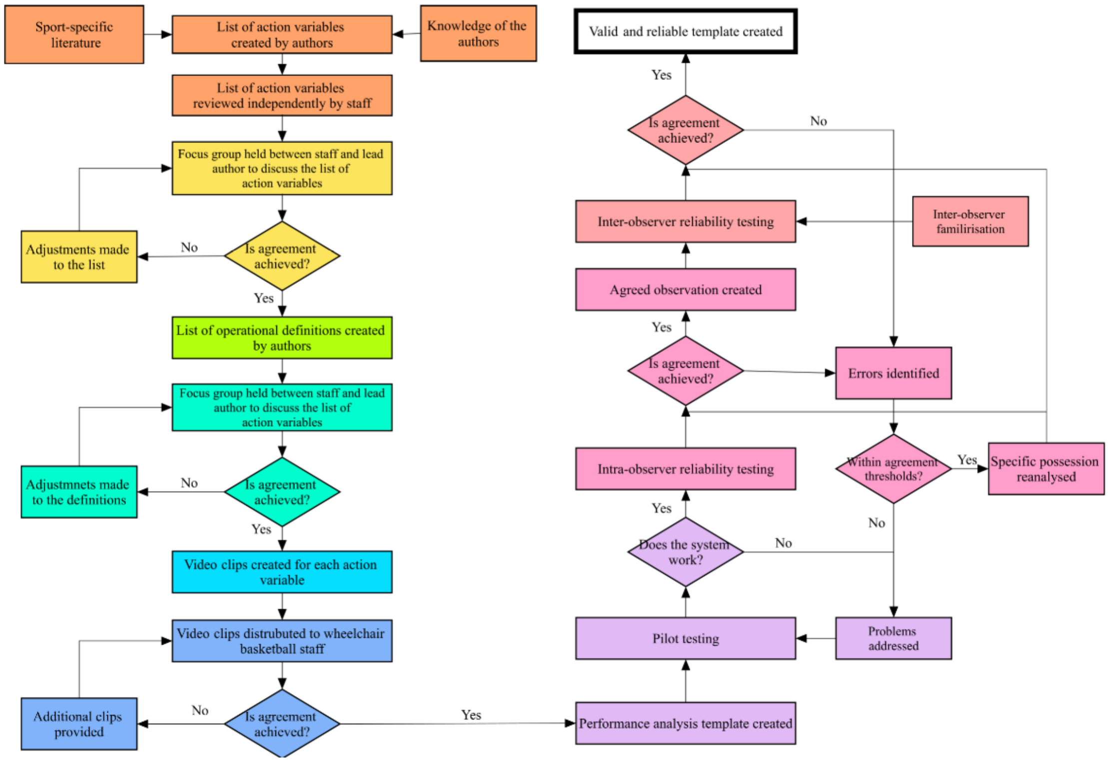


Figure 3-1: Diagram showing the systematic research process for developing a new SPA template (adapted from James, Mellalieu and Jones (2005) and Thomson, Lamb and Nicholas (2013)).

3.3.1 Validation process

The classification of action variables and operational definitions were identified as measures of team performance in six stages. Firstly, a list of action variables was developed from previous wheelchair basketball literature and the knowledge gained from working with a wheelchair basketball team since 2012. The action variables were grouped into 16 categories: Time, Game Status, Away Team Player Number, Away Classification, Home Team Player Number, Home Classification, Offence - Starter, Offence - End, Offence - Shot, Offence – Shot Clock, Offence – Shot Location, Defence - System, Defence - End, Defence, Defence - Efficiency and Defence - End Possession (See Table 3-1). The action variables within each category were not an exhaustive list of behaviours that could occur but merely the key behaviours which help towards understanding the sequential nature of a successful possession.

The list was then circulated to a group of four elite wheelchair basketball staff. The four staff members consisted of three elite wheelchair basketball coaches

(Coach one: 20 years' experience; Coach two: 19 years' experience; Coach three: 19 years' experience) and a member of support staff for an elite wheelchair basketball team (three years' experience). The group was provided with information regarding the study, including the number of focus groups they were required to attend, and completed an informed consent form prior to being presented with the list. Each member was provided with an electronic and hard copy of the list and given one week to scrutinise the information. During the week, the staff were asked to review the list and provide their opinions as to whether the categories and variables would provide an objective insight into understanding the sequential nature of a successful possession. The staff made annotated notes on the list and sent the list back prior to the commencement of a focus group with the four staff members.

Table 3-1: Original list of action variables created and shown to the wheelchair basketball staff (developed from previous literature and personal knowledge).

Categories	Action Variables											
Quarter	Q1	Q2	Q3	Q4								
Game Status	Winning	Drawing	Losing									
Away Team Player Number	4	5	6	7	8	9	10	11	12	13	14	15
Away Classification	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5				
Home Team Player Number	4	5	6	7	8	9	10	11	12	13	14	15
Home Classification	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5				
Offence - Starter	Inbound – Baseline	Inbound – Endline	Sideline – Front	Sideline – Back	Free Throw	Other Start	Turnover					
Offence - End	Foul Received	Foul Drawn	Violation Received	Violation Drawn	Defensive Rebound	Offensive Rebound	Turnover	Other				
	Out of Bounds – Lost	Out of Bounds – Maintained	Handling Error – Lost	Handling Error – Maintained								
Offence - Shot	Shot	1 Point S	1 Point U	2 Point S	2 Point U	3 Point S	3 Point U					
Offence - Shot Clock	6 – 0 seconds	12 – 7 seconds	17 – 13 seconds	24 – 18 seconds								
Offence - Shot Location												
Defence - System	Press	Highline	Zone	Fast Break								
Defence - End	Foul Received	Foul Drawn	Violation Received	Violation Drawn	Defensive Rebound	Offensive Rebound	Opposition Basket	Turnover				
	Other	Out of Bounds – Lost	Out of Bounds – Gained	Handling Error – Lost	Handling Error – Gained							
Defence	Pick Back											
Defence - Efficiency	Successful Defence	Unsuccessful Defence										
Defence - End Possession	Possession Gained	Possession Lost										

The aim of the first focus group, which lasted 55 minutes, was to clarify the list of action variables. During the focus group, changes or alterations were made to the categories and accompanying action variables. The wheelchair basketball staff highlighted the variables within the Offence – End and Defence – End categories would be highly correlated and therefore the two categories were amalgamated into a category entitled End of Possession. During the establishment of this new category, the action variables within the Defence – Efficiency and Defence – End Possession were adjusted and the categories rephrased (Defensive Outcome and Possession). The sole action variable within the Defence category (pick back) was adjusted to form a category entitled Man Out Offence, which comprised of two action variables: Equal Numbers, Numbers Advantage. Further to this, the Offence – Shot category was divided into three categories: Shot Taken, Shot Point and Shot Outcome. The Offence – Shot Clock was reworded to clarify the category: Shot Clock Remaining. However, if the Shot Taken was No Shot, additional action variables were added to the Shot Point, Shot Outcome and Shot Clock Remaining categories to represent the sequential nature of No Shot being taken. In addition, action variables were added to the Defence – System category to illustrate the number of players pressing. The final list after the first focus group, therefore, resulted in 17 categories and 109 action variables being identified.

Following the completion of the first focus group, operational definitions were developed for each of the 116 variables using various resources (Frogley, 2010; Federation International Basketball Association, 2014; International Wheelchair Basketball Federation, 2014b). The revised list of action variables and operational definitions was circulated to each of the wheelchair basketball staff members in an electronic and hard copy version (See Appendix 2). The staff members were given one week to analyse and make comments on the list prior to a second focus group.

The emphasis of the second focus group was to critically evaluate the provided definitions and enable any required amendments to the definitions to be made. However, due to time constraints of the wheelchair basketball staff, only the action variables and operational definitions within the following categories were debated: Quarter, Game Status, Away/Home Team and Classification, Start of Possession, Man Out Offence, Shot Taken, Shot Point, Shot Outcome, Shot Clock Remaining and Shot Location. The action variable 6-0 Seconds in the Shot Clock Remaining category was amended to 6-0.1 seconds because a shot taken when the ball is released from the player's hands when the clock is displaying 0 seconds is not counted as a shot attempt. The action variables and operational definitions within the End of Possession, Defensive System, Defensive Outcome and Possession categories were explored one week later in a third focus group. The definitions for Zone and Highline Defensive System were discussed and amended to add further clarity. The two action variables, within the Defensive Outcome category, were debated regarding what constitutes a successful outcome before a final definition was established. The wheelchair basketball staff members were subsequently presented with a final version of the action variables and operational definitions and asked to examine the list and provide any additional comments (See Appendix 2). No additional amendments were suggested. The three focus groups were recorded digitally on a hand-held recording device and transcribed verbatim in Microsoft Word.

Following confirmation of the operational definitions for the 109 action variables, video clips with overlaying text were created illustrating the action variables within each possession. The clips were circulated to the wheelchair basketball staff using external hard drives. Each member was given one week to watch the clips and ensure the overlaying text represented the operational definitions for each action variable. One staff member requested a further clip to illustrate the different types of Defensive System when a team were playing a Highline defence. The clip was circulated to the staff members. After watching the additional clip, the staff members confirmed the provided video clips represented the overlaying text and no additional clips or amendments to the operational definitions were undertaken.

3.3.2 Template development and reliability process

Following the validation process, a SPA template was created in SportsCode Elite Version 10 (SportsTec Inc., Australia) (See Figure 3-2). One game of elite male international wheelchair basketball was selected at random from the 2015 European Wheelchair Basketball Championships and a copy of the live-streamed video recordings acquired from the host nation. The recording was imported into SportsCode Elite Version 10 and converted into a 'SportsCode Project'. The video recordings were analysed post-event and generally viewed at normal playback speed (15 keyframes per second). If necessary, the playback speed was permitted to be adjusted to ensure events were observed and recorded accurately. Multiple actions within a category could be recorded. For example, if the player was fouled in the act of scoring a successful basket then the End of Possession category would automatically record "Basket Scored" and "Foul For". In addition, the home and away team player numbers were checked against the official tournament website (www.euro2015.uk) to ensure the numbers in the template represented the competing teams. The players' classifications were also verified on the official tournament website (www.euro2015.uk) and the IWBF player database (www.ecmw.eu). If required, the home classification and away classification activation links were adjusted to enable a player's number to be selected and automatically activate their classification.

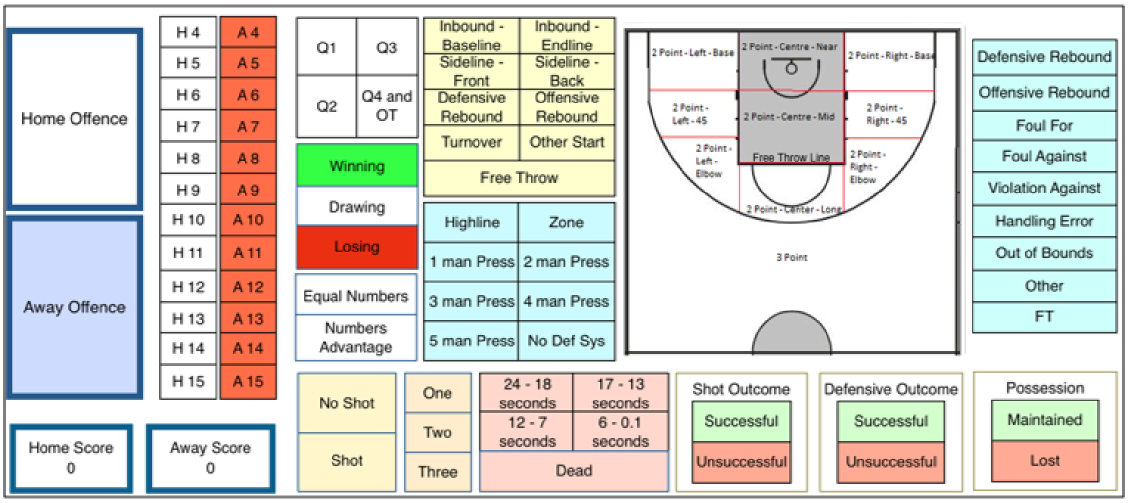


Figure 3-2: Team SPA template for coding wheelchair basketball performance.

3.3.3 *Intra-observer and inter-observer reliability test*

To ensure acceptable reliability was achieved, intra-observer and inter-observer reliability tests were both used to explore the levels of agreement with Weighted Kappa coefficients (Cohen, 1968) and percentage error values (Bland and Altman, 1999) being calculated for each category. The concept of percentage error enabled the identification of errors and determined if these were random, or if one observer recorded values differently from other observers (McHugh, 2012). Whilst Weighted Kappa tests were selected to evaluate the agreement between the operators when the action variables were exported out on ordinal or nominal scales as well as acknowledging that in some instances no operator could be sure of the action to record (McHugh, 2012). Weighted Kappa tests have been typically used for exploring inter-observer reliability, however, there are cases when it has also been used for determining intra-observer reliability in previous research (O'Donoghue and Ingram, 2001; Tenga *et al.*, 2009)

For intra-observer procedures, 100 Home Offence and 100 Away Offence possessions were analysed on two occasions with a period of four weeks (Ross *et al.*, 2016) between the two observations to ensure operators were unable to recall the previously observed events. The two observations were exported as categorical variables from SportsCode Elite Version 10, using the 'Sorter' function, into Microsoft Excel. The 400 rows of data were transferred into a CSV file and imported into R (R Core Team 2015). Weight Kappa coefficients and percentage error values were calculated for each category to determine intra-observer agreement levels between the two observations. Where categories did not demonstrate perfect agreement or established a zero per cent error, the source of the discrepancy was identified and the specific possession was re-observed to create an agreed observation. Previously, researchers have used the first observation from an intra-observe reliability test as a baseline, however, this observation could include disagreements. Thus, through the establishment of an agreed intra-observer reliability observation potential disagreements between the inter-observer reliability test have been minimised.

Following the establishment of an agreed observation, a wheelchair basketball coach and a performance analysis intern completed an observation of the same game, enabling the completion of an inter-observer reliability test. The wheelchair basketball coach, who had 19 years of sport-specific experience, was involved in the classification of action variables and had a year of experience using a similar performance analysis software programme (Dartfish TeamPro, Switzerland). The performance analysis intern had limited knowledge of wheelchair basketball (nine months) and was not involved in the first phase of the research but had three years of experience as a performance analyst in rugby union and using SportsCode Elite.

The coach and performance analyst intern were provided with the action variables, operational definitions and the accompanying video clips two weeks prior to conducting the observations to help familiarise themselves with the specific behaviours they were required to record. In addition, the coach and the intern were allowed to code a pre-tournament game between the two competing nations to assist with learning the SPA template and the software. Familiarisation varied in time for the two operators, with the coach completing four sessions of two hours over a five day period and the intern undertaking an additional two-hour session before both individuals felt they were able to complete the reliability test (O'Donoghue, 2014). The testing was conducted one day after they had completed their final familiarisation session. The coach and the intern focused on observing the entire game, which equated to 200 possessions. Weighted Kappa and percentage error were calculated for each category to determine inter-observer agreement levels with the agreed observation being firstly compared against the coach's observation and secondly against the performance analyst intern's observation. The coach's, performance analyst intern's and the agreed observation were triangulated and expressed as Weighted Kappa coefficients and percentage error values. Categories which did not demonstrate perfect agreement or establish zero per cent error were discussed and the source of the discrepancy identified.

3.4 Results

3.4.1 Intra-observer agreement

Cohen's Weighted Kappa demonstrated perfect agreement (k1.000) for 12 categories and almost perfect agreement (k 0.987-0.994) for the remaining five categories between the first (Ob1) and second observation (Ob2) (See Table 3-2). Percentage error reported zero error for the same 12 categories and below the five per cent acceptable error percentage for the remaining five categories. Categories that reported perfect agreement or zero error demonstrated the same actions were recorded in the two observations (See Table 3-2). The Start of Possession category produced a Weighted Kappa coefficient of 0.981 and 1.50 per cent error (See Table 3-2). Upon exploring the two observations further, singular discrepancies were apparent between the following action variables: "Inbound-Baseline" and "Inbound-Sideline", "Defensive Rebound" and "Offensive Rebound", and "Sideline – Front" and "Sideline – Back". The Shot Location category reported a Weighted Kappa coefficient of 0.988 and a 1.00 per cent error with a single discrepancy occurring between the "2 Point – Left – Base" and "2 Point – Left – 45" action variables.

The Defensive System category produced a Weighted Kappa value of 0.980 and 1.50 per cent error with singular discrepancies being observed between the "1

Man Press" and "1 Man Press", "2 Man Press" and "3 Man Press", and the "Highline" and "Zone" action variables. The Shot Clock Remaining category produced a Weighted Kappa value of 0.980 and a 1.50 per cent error, in contrast to the single discrepancies between action variables within the other categories, the two observations recorded three differences between the "17 – 13 seconds" and the "12 – 7 seconds" variables. In addition, the End of Possession reported a similar Weighted Kappa and percentage error value (K0.981; 1.50%) to the Shot Clock Remaining category, with the two observations recording three discrepancies when recording a behaviour as a "Defensive Rebound" or an "Offensive Rebound".

Table 3-2: Intra-observer agreement reported using Cohen's Weighted Kappa (K) and percentage error between the first observation (Ob1) and the second observation (Ob2).

	Quarter	Home Team Player Number	Home Classification	Away Team Player Number	Away Classification	Game Status	Start of Possession	Man Out Offence	Shot Taken	Shot Point	Shot Outcome	Shot Location	Shot Clock Remaining	End of Possession	Defensive System	Defensive Outcome	Possession
Ob1 v Ob2	K1.000	K1.000	K1.000	K1.000	K1.000	K1.000	**K0.981**	K1.000	K1.000	K1.000	K1.000	**K0.988**	**K0.980**	**K0.981**	**K0.980**	K1.000	K1.000
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**1.50%**	0.00%	0.00%	0.00%	0.00%	**1.00%**	**1.50%**	**1.50%**	**1.50%**	0.00%	0.00%

3.4.2 Inter-observer agreement

Weighted Kappa coefficients and percentage error values were calculated for each category to determine inter-observer agreement levels with the agreed observation (Ob3) being compared against the coach's observation (Ob4) and then against the performance analyst intern's observation (Ob5). Inter-observer agreement levels were then triangulated between the coach's observation (Ob4), the performance analyst intern's observation (Ob5) and the agreed observation, and expressed using Weighted Kappa coefficients and percentage error values (See Table 3-3).

Agreed observation versus the coach's observation.

The agreement between the agreed observation and the coach's observation demonstrated perfect agreement (k1.000) and zero percentage error for nine categories and almost perfect agreement (k 0.974-0.993) and within the acceptable percentage error threshold (0.50%-1.50%) for the remaining seven categories (See Table 3-3). The Man Out Offence category recorded the lowest Weighted Kappa coefficient (k0.974) but almost a zero percentage error value (0.50%) when comparing the frequency counts for each action variable between the two observations. No behaviour was recorded for one possession by the coach resulting in the singular discrepancy.

The Start of Possession and Shot Clock Remaining categories both recorded a Weighted Kappa coefficient of 0.981 and a percentage error value of 1.50%. Within the Start of Possession category, two discrepancies occurred where the coach reported the possession starting as an "Offensive Rebound" whereas the researcher's agreed observation recorded the possession starting as a "Defensive Rebound", and vice versa, in addition, the coach also recorded a possession as starting from an "Inbound – Baseline" whereas the researcher agreed the possession started as an "Inbound – Endline". Three discrepancies also occurred when comparing the coach's observation to the agreed observation within the Shot Clock Remaining category surrounding recording shots taken when there were "17-13 seconds" remaining.

Table 3-3: Inter-observer agreement reported using Cohen's Weighted Kappa (K) and percentage error between the agreed observation (Ob3), the coach’s observation (Ob4) and the performance analyst intern’s observation (Ob5).

	Quarter	Home Team Player Number	Home Classification	Away Team Player Number	Away Classification	Game Status	Start of Possession	Man Out Offence	Shot Taken	Shot Point	Shot Outcome	Shot Location	Shot Clock Remaining	End of Possession	Defensive System	Defensive Outcome	Possession
Ob3 v Ob4	**K0.993**	K1.000	K1.000	K1.000	K1.000	K1.000	**K0.981**	**K0.974**	K1.000	**K0.992**	K1.000	**K0.994**	**K0.981**	K1.000	**K0.993**	K1.000	K1.000
	0.50%	0.00%	0.00%	0.00%	0.00%	0.00%	**1.50%**	**0.50%**	0.00%	**0.50%**	0.00%	**0.50%**	**1.50%**	0.00%	**0.50%**	0.00%	0.00%
Ob3 v Ob5	K1.000	K1.000	K1.000	K1.000	K1.000	K1.000	**K0.994**	K1.000	K1.000	K1.000	K1.000	**K0.983**	**K0.981**	**K0.987**	**K0.993**	K1.000	K1.000
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.50%**	0.00%	0.00%	0.00%	0.00%	**1.50%**	**1.50%**	**1.00%**	**0.50%**	0.00%	0.00%
Ob3 v	**K0.996**	K1.000	K1.000	K1.000	K1.000	K1.000	**K0.987**	**K0.983**	K1.000	**K0.995**	K1.000	**K0.988**	**K0.974**	**K0.991**	**K0.991**	K1.000	K1.000
Ob4 v Ob5	**0.50%**	0.00%	0.00%	0.00%	0.00%	0.00%	**1.50%**	**0.50%**	0.00%	**0.50%**	0.00%	**1.50%**	**3.00%**	**1.00%**	**1.00%**	0.00%	0.00%

Agreed observation versus performance analyst intern's observation.

The performance analyst intern's observation, when compared with the agreed observation, demonstrated perfect agreement (k 1.00) and zero percentage error with 11 categories and almost perfect agreement (k 0.981-0.993) and within the five per cent error limit (0.50-1.50%) with five categories (See Table 3-3). The Shot Clock Remaining category recorded the lowest Weighted Kappa coefficient (K 0.981) and highest error percentage (1.50%), within the two observations the agreed observation and the intern's observation disagreed over three possessions. One of the disparities within the two observations resulted from the intern recording a shot being taken with "17-13 seconds" remaining whereas the agreed observation indicating the shot was taken with "6-0.1 seconds" remaining. Through exploring the Weighted Kappa coefficient (k 0.983) and percentage error (1.50%) for the Shot Location category, a discrepancy existed between the two observations regarding three shots. The agreed observation recorded two shots as being taken in the "2 Point – Centre – Near" variable whereas the intern perceived the shots to have been taken in the "2 Point – Centre – Mid" variable. An additional discrepancy was observed when the agreed observation indicated a shot being taken in the "2 Point – Left – 45" variable whereas the intern recorded the same shot to be taken in the "2 Point – Left – Base" variable.

Triangulation of coach's, performance analyst intern's and agreed observation

Through reporting the Weighted Kappa coefficients and percentage error values of the 17 categories, eight categories demonstrated perfect agreement and zero percentage error, and eight categories produced almost perfect agreement (K0.974-0.996) and within the five per cent error threshold (0.50%-3.00%). Three categories, Shot Location, Start of Possession and Shot Clock Remaining, reported the largest number of discrepancies amongst the variables within each action variable. The Shot Location (K 0.988; 1.50%) and Start of Possession (K 0.987; 1.50%) categories recorded three discrepancies whereas Shot Clock Remaining recorded six discrepancies (K 0.974; 3.00%) between the three observations and hence produced the lowest Weighted Kappa coefficient and the highest percentage error value. Although the triangulation results for the Shot

Location category highlight the category is the most susceptible to producing errors, the Weighted Kappa coefficient and percentage error values are still within the acceptable thresholds for agreement levels (Cohen, 1968; Bland and Altman, 1999).

3.5 Discussion

This chapter set out to develop a unique valid and reliable performance analysis template for wheelchair basketball. To achieve this aim, the methodological procedures to develop a template completed by James, Mellalieu and Jones (2005) and Thomson, Lamb and Nicholas (2013) were adapted. This involved completing a nine-stage methodological process, which included a validation process, template development and reliability assessment.

To address the limitations of the (modified) CBGS, it was necessary to employ the knowledge of sport-specific staff to assist in identifying contextually relevant action variables as well as drawing on the existing sport-specific literature. The four members of staff that were used in the chapter provided a qualitative contribution through focus groups to further enhance the final list of 109 action variables and operational definitions. The time in the season in which the study and the focus groups were conducted restricted the access to a larger number of elite wheelchair basketball coaches and support staff. In an attempt to enhance the content validity procedures, video clips were created to ensure the written action variables and operational definitions visually represented the specific team behaviours which were established.

Studies in basketball have included passing and the number of players involved in a possession when analysing team performance (e.g. Mavridis *et al.*, 2009). In this study, however, the coaches were asked to only include key behaviours which distinguish between successful and unsuccessful possessions, as had been the case in James, Mellalieu and Jones' (2005) work. The wheelchair basketball staff were asked during the first focus group if they thought it was relevant, however, they deemed it was not, with one coach stating:

"Within wheelchair basketball, only two or three of the players are typically involved in handling the ball. The Dutch team, for example, has two main ball handlers in each possession who handle the ball down the court and normally distribute the ball straight into the player who shoots. So I don't think it's relevant and we can look at the box score data from each match to work out who made the last pass before a shot. So I don't think it is key" Coach One

In addition to this topic being debated, the focus groups highlighted a number of adjustments to the list of action variables and operational definitions. For example, the extra detail added to the Defensive System category regarding the specific types of press defence. Hughes and Bartlett (2002) and Lames and McGarry (2007) highlight the most important behaviours regarding a performance cannot be 'teased out' by a researcher or by a lone individual, instead, a combined holistic approach must be used to remove individual biases and ensure important aspects are not overlooked. The focus groups used in this study, allowed the five individuals' knowledge and perspectives, regarding the key behaviours of team performance, to be combined. This collaborative approach formulated the finalised list of action variables and operational definitions.

Following the agreement of the action variables and operational definitions, the 109 variables were used to develop a team-specific SPA template. Whilst the number of action variables developed is relatively high, resulting in the observation process potentially becoming lengthy in comparison to other team studies (Jones, James and Mellalieu, 2008), the collected data would enable an in-depth picture of team performance to be created (Hutchins, 2016). One of the benefits of using SportsCode Elite V10 computerised SPA software is the activation links. This allowed action variable buttons to be hidden within the template but still record when a specific sequential behaviour occurred. For example, if the observers recorded the Shot Outcome as "Successful" this also automatically recorded the End of Possession as "Basket Scored". Through utilising this function, the quantity of objective information gained from the 17 categories per possession is maintained, whilst reducing the number of times the observer must record specific behaviours during each possession, helping to contextualise each possession and answer the important performance questions of how and why.

The template was developed to be used post-event, with the ability to extract data as total frequency counts or as successive, discrete possessions. The development of the template built on Cooper, Hughes, O'Donoghue, & Nevill's (2007) idea of dividing an observation into specific time cells. It also agreed with Thomson, Lamb and Nicholas' (2013) work that this process was a sufficient method for assessing test-retest analysis. However, rather than dividing the observed performance into two minute or 10-second time cells, each possession, which could last up to 24 seconds, was used. As outlined above, within each possession, irrelevant of the duration, each observer collected information pertaining to 17 categories.

The template's intra-observer and inter-observer reliability were explored through analysis of one game of elite men's wheelchair basketball on two occasions and by a wheelchair basketball coach and a performance analyst intern on one occasion. Intra-observer and inter-observer reliability tests highlighted that the accuracy of all observations was excellent for the notation of all 109 action variables and 17 categories with inter-observer reliability slightly lower than intra-observer reliability. The coach's observation achieved the lowest Weighted Kappa coefficient for the Shot Clock Remaining category whilst the performance analyst intern achieved the lowest Weighted Kappa coefficient for the Man-Out Offence category.

Previous research has identified that it is not unexpected for the level of inter-observer reliability to be inferior to intra-observer reliability (Thomson, Lamb, and Nicholas 2013), but all observations fell within the adequate levels of reliability. It is clear, however, that an adequate period of template piloting, familiarisation and training was key to obtaining these excellent levels of reliability. The small disagreements identified between the observations could be due to the dynamic nature of the sport whereby observers are attempting to record action variables quickly and thus could incorrectly click on a closely related button rather than missing an action at all. Examples of this were identified when the coach coded the possession starting as an “Offensive Rebound” whereas the agreed observation coded the possession starting as a “Defensive Rebound”. It could also be argued that whilst operational definitions should be clear to distinguish between the two rebound types, they share a number of characteristics and thus could explain the disagreement.

The use of two reliability statistical approaches, Weighted Kappa coefficients (Cohen 1968) and percentage error values (Bland and Altman 1999), provided a useful cross-checking method for determining the reliability of the template. The concept of percentage error allowed directed comparisons of agreement to be made irrespective of the scaling between observers (Hopkins 2000). Thus, it enabled the identification of errors and determined if these were random (McHugh, 2012). However, the percentage error statistic did not exhibit construct validity and could have hidden important disagreements (Choi, O’Donoghue and Hughes, 2007). Whilst the Weighted Kappa tests acknowledged that in some instances no operator could be sure of the action to record (McHugh, 2012) and provided credit when two observers recorded adjacent values, for example, in the Shot Location category. By using both measures, a consensus estimate can be gained allowing for a comprehensive picture of the template’s intra-observer and inter-observer reliability to be established (Stemler, 2004). Therefore, the use of both percentage error and weighted kappa statistics to assess intra-observer and inter-observer is recommended in the development process of a performance analysis template.

The benefits of utilising two different agreement measures and the triangulation of the three observations within this study were highlighted in the Man Out Offence category (See Table 3-3). The use of percentage error only reported a value of 0.50% as there was only one frequency count difference between the observations, however, the Weighted Kappa coefficient reported a lower coefficient (K0.983) in comparison to other singular disagreements (K0.996). By exploring the lower Weighted Kappa coefficient, it was identified that the observer did not record an action variable within this category. Weighted Kappa acknowledged the discrepancy was not due to a definitional or observational error, but was due to an operational error and thus assigned a lower coefficient. Although Weighted Kappa assigned the discrepancy with a lower coefficient in comparison to another singular discrepancy, a discrepancy within the observations is still a discrepancy irrespective of whether it was an incorrect labelling or a missing label (Butlewiski *et al.*, 2015). However, missing a value in comparison to inputting an incorrect value would result in a larger skew of information within a larger data set (Wielenga, 2007). Despite the discrepancies between the observations, the high Weighted Kappa coefficients and low percentage error values achieved for 17 categories highlight a valid and reliable SPA template was developed.

It is important to note, however, that this template was developed for post-event analysis, and thus changes would be required if the goal was to use the template in real-time analysis. The action variables included within the template were carefully considered to ensure meaningful and contextually-relevant information was captured. Additional action variables could be added to the template to assist in strengthening the profile of an elite team's performance, however, this would likely increase the time taken to analyse the wheelchair basketball performance and interpret the data. Subsequently, if additional modifications were made to the action variables, operational definitions, categories or template, further reliability assessment would be required. Nevertheless, the current template provided the grounding for future attempts to identify the key tactical determinants of team success in elite wheelchair basketball and the processes undertaken to produce the template provided a framework for the development of future templates in this thesis.

3.6 Conclusion

The chapter has presented an improved systematic and robust methodological process to establish a valid and reliable wheelchair basketball SPA template that produced accurate observations of key team performance behaviours in a sequential nature within elite male wheelchair basketball. Applied knowledge was combined with that of wheelchair basketball staff and supporting literature to determine a comprehensive list of key team performance action variables and operational definitions. Two reliability measures were used to assess the level of agreement between an intra-observer and inter-observer reliability test. The 109 action variables, which were placed into 17 categories, demonstrated perfect or almost perfect agreement (<K0.900) and low percentage error values (<5.00%) confirming the template can be reliably used as a collection tool by different trained observers for analysing elite male wheelchair basketball games.

The developed template has enabled the collection of most actions that occur in a wheelchair basketball possession whilst also recording the actions of the opposition, allowing for a context-specific insight to be gained. It has also highlighted that the template can be used by wheelchair basketball coaches, analysts and non-wheelchair basketball analysts to collate valid and reliable team performance data. The notion of utilising three observers with a range of experiences built on the work of Thomson, Lamb and Nicholas (2013). In addition, the process of requesting the coach to undertake a reliability observation was seen as an education process and an opportunity to validate the operational definitions that he had created. As the template is deemed valid and reliable, it is now up to the analyst and coach to decide how much data are required to develop a performance profile and begin comparing profiles, modelling performance and predicting future performances (Hughes, 2004b). The process of the coach undertaking a reliability test would hopefully assist in understanding the data and information that would be presented in the future. As the template has been underpinned with DST, coaches, players and support staff would be able to contextually how and why certain behaviours occurred in each possession.

The method used to extract the data allowed singular possessions to be compared. This work built on Cooper *et al.'s* (2007) idea of dividing an observation into specific time cells. It also agreed with Thomson, Lamb and Nicholas' (2013) work that this process was a sufficient method for assessing test-retest analysis. However, rather than dividing the observed performance into two minute or 10-second time cells, each possession, which could last up to 24 seconds, was used. As outlined above, within each possession, irrelevant of the duration, each observer was collecting information pertaining to 15 categories. Thus, providing a sufficient measure of an observer's ability to accurately note the actions or behaviours of the team in and out of possession as well as providing the end user with contextual rich data.

The use of a percentage error and Cohen's Weighted Kappa to explore the observer's ability to accurately observe events can also be deemed as a beneficial means to highlight discrepancies between observers. Percentage error allowed for the magnitude of the error to be identified whereas Cohen's Weighted Kappa accounted for missing data, i.e. non-random observer error, as well as the inaccuracies within the observations. Comparing both statistical methods also allowed the degree of chance to be factored into the observation, because percentage error does not acknowledge that observations can occur by chance (McHugh, 2012). Other reliability statistical methods could have been used, such as Krippendorff's Alpha (2011) or Cohen's Kappa (1960), however, these methods were critically evaluated in Chapter Two and deemed unsuitable. Therefore, this work recommends that future reliability tests within the discipline of SPA should use percentage error and Cohen's Weighted Kappa statistical tests to measure test-retest.

Despite the work presented in the chapter, it could be argued that a larger sample size was needed to conduct the reliability testing. Although, it can be debated that the results presented above suggest action variables have been recorded on a suitable number of occasions. Thus, it can be concluded that the research presented in this chapter is the first and only valid and reliable SPA template that assesses team performance in elite male wheelchair basketball. The current template should now be used by wheelchair basketball coaches, analysts and researchers to collect valid and reliable performance data to help identify the key tactical determinants of team success and subsequently to underpin both performance enhancing training and within-game practices.

Chapter 4 Modelling the components of team success

4.1 Overview

Building on the work completed in the previous chapter, this chapter aims to identify the key determinants of team success. The chapter begins by exploring how a valid and reliable SPA template can be used to identify reoccurring patterns and trends in the performances of successful teams. Through the identification of these patterns, the key action variables that contribute to success can be recognised. The developed template was used to collect data from performances at the 2015 European Wheelchair Basketball Championships to identify sequential action variables which are associated with team success. These were then used to develop a binary logistic regression model that was able to quantify the impact of each sequential action variable as a predictor of the probability of team success. The impact of the findings on practice are critically discussed and areas of further exploration are outlined.

4.2 Introduction

The wheelchair basketball studies that were critically evaluated in Chapter Two relied on discrete action variables to record and evaluate a team's performance (Vanlandewijck *et al*., 2003; Molik *et al*., 2009; Skucas *et al*., 2009; Gómez, Molik, *et al*., 2015). The discrete action variable data in these studies were combined and used to objectively evaluate the contributions made by each athlete, to provide an overview of a team's performance in a game. According to Gómez *et al.* (2014), the data and calculations have the potential to evaluate a team's performance and inform the decisions coaches are required to make during games. However, the use of discrete action variables does not provide insight into how or why an individual's or team's action occurred. If coaches are relying on data collected from individual player discrete action variables to inform their team decisions, the information is one-dimensional and does not provide a valid insight into how a team can be effective. Subsequently, this collected discrete action variable data were argued to be both inaccurate and unreliable to inform future team strategic actions (Ziv, Lidor and Arnon, 2010).

The template that was developed in Chapter Three enabled the collection of sequential action variable data. These data have enabled analysts and performance staff to contextualise a performance, answering the question of how and why a behaviour or specific action occurred (Clemente, Martins and Mendes, 2016). Within a team context, Garganta (2009) found that players only have a set number of available options to them in any given situation, which is influenced by the interactions and actions of the opposing team. Therefore, it is possible to record these patterns and identify reoccurring trends to enhance the understanding of a team's tactics (Perl, Grunz and Memmert, 2013).

Within wheelchair basketball, the actions and subsequent changes in the offensive and defensive strategies can be recorded to identify reoccurring patterns. The sequential data, that included situational action variables, such as the state of the game or which players are on the court, enables a greater understanding of the actions within a possession to be gained in relation to the Game Outcome. For example, if the offensive team have been shown to advance the ball towards the basket quickly following a turnover, when there are two 2.0 or 2.5 players on the court, then the defensive team's coaches can address this and inform their players to unsettle the offensive team by adjusting the defensive system when a turnover occurs. The change in the defensive system, which would attempt to slow the offensive team's advancement, could be measured in relation to the offensive team's adjustments. It is these decisions and adjustments by the offensive and defensive team that can be collated, analysed and interpreted in relation to the outcome of the game. Thus, the findings can be used to inform future decisions by exploring how and why a specific incident occurred (Kubatko *et al.*, 2007).

Through the utilisation of modelling techniques, which were critically discussed in Chapter Two, the effect of each sequential action variable on the odds of the Game Outcome can be calculated. For example, Gómez *et al.* (2013) used binary logistic regression modelling to identify the key action variables associated with achieving success in basketball and quantified the effect of each action variable on the Game Outcome. The insights gained from this type of modelling can be used to assist coaches, players and members of support staff with the decision making processes; specifically regarding the planning and delivery of training sessions as well as informing in-game decisions through exploiting performance factors which are most highly associated with success (Petersen *et al.*, 2007; Passos, 2017). The use of binary logistic regression modelling in wheelchair basketball could, therefore, enhance the understanding of the coaches, players and support staff regarding the key requirements of the game and provide an objective insight into the effect of an individual action variable on the odds of the Game Outcome.

By collecting, analysing and modelling performance data in this way, reoccurring themes and trends within a team's performance could be identified. The new SPA template developed in Chapter Three has the potential to collect data concerning the interaction between offensive tactics (e.g. taking a shot within six seconds of being in possession) and defensive tactics (e.g. Press vs. Highline vs. Zone defence) on the outcomes of possession (e.g. shooting opportunities) throughout the course of a single game or across multiple games. If significant trends are discovered, the data have the potential to identify the key components of success, the impact each action variable has on success can be quantified and used to inform the decision-making of coaches, players and support staff (Busemeyer and Pleskac, 2009). Therefore, this chapter (i) identifies the key variables associated with team success in elite men's wheelchair basketball and (ii) explores the impact of each key action variable upon the outcome of a performance through the use of binary logistic regression modelling.

4.3 Data handling

This chapter's analysis employed the SPA template developed in Chapter Three to analyse video recordings from men's games during the 2015 European Wheelchair Basketball Championships (See Figure 3-2). The wheelchair basketball staff involved in the development and validation processes in Chapter

Three requested that only games which involved a team that had qualified for the 2016 Paralympic Games were analysed. The coaches made this request to gain an objective insight into future upcoming opponents. The European Zone were given five qualification spots for the 2016 Paralympic Games and these were given to Germany, Great Britain, Netherlands, Spain and Turkey (European Wheelchair Basketball Championships, 2015).

During the 2015 tournament, a total of 46 games were played; and of those, 31 games involved the top five teams mentioned above (See Figure 4-1). These 31 games were analysed over a two-month period at the end of 2015, spending an average of two hours to analyse each game, using the SPA template developed in Chapter Three. On any given day, a maximum of two games were analysed in an attempt to reduce errors and a five-minute break was taken at the end of each quarter (Liu, Jaramillo and Vincenzi, 2015). Periodic assessment checks were conducted in an attempt to limit the overall loss of accuracy (Kazdin, 1977). Following the analysis of every five games, 10 randomly selected possessions were re-observed to identify any discrepancies. No adjustments to the analysed data were necessary.

Pool Games

Group A

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Pool Game 1 **Great Britain (92)** v Czech Republic (42)	Pool Game 4 France (69) v **Spain (76)**	Pool Game 9 **Spain (61)** v Czech Republic (42)	Pool Game 15 **Germany (89)** v **Great Britain (55)**	Pool Game 23 France (42) v **Germany (79)**	Pool Game 30 **Germany (66)** v **Spain (58)**
	Pool Game 6 Czech Republic (32) v **Germany (92)**	Pool Game 11 **Great Britain (80)** v France (46)	Pool Game 17 **Spain (82)** v Poland (81)	Pool Game 25 **Great Britain (70)** v **Spain (58)**	
	Pool Game 7 Poland (85) v **Great Britain (73)**	Pool Game 12 Poland (72) v **Germany (78)**			

Group B

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
	Pool Game 3 **Netherlands (46)** v **Turkey (52)**	Pool Game 8 **Turkey (59)** v Sweden (48)	Pool Game 16 **Turkey (70)** v Italy (63)	Pool Game 21 Sweden (55) v **Netherlands (57)**	Pool Game 28 **Netherlands (51)** v Italy (58)
		Pool Game 13 Israel (46) v **Netherlands (92)**	Pool Game 18 **Netherlands (70)** v Switzerland (49)	Pool Game 24 Switzerland (52) v **Turkey (79)**	Pool Game 29 **Turkey (79)** v Israel (52)

Quarter Final Games

Quarter-Final 1
Great Britian (77)
v
Italy (48)

Quarter-Final 2
Turkey (63)
v
Spain (54)

Quarter-Final 3
Netherlands (63)
v
Poland (56)

Quarter-Final 4
Germany (75)
v
Israel (54)

Semi-Final Games

Semi-Final 1
Turkey (69)
v
Netherlands (50)

Semi-Final 2
Germany (68)
v
Great Britain (77)

Ranking Games

Ranking 1
Italy (55)
v
Spain (86)

Ranking 2
Spain (56)
v
Poland (47)

Medal Games

Gold Medal Match
Great Britain (87)
v
Turkey (66)

Bronze Medal Match
Germany (74)
v
Netherlands (56)

Figure 4-1: Games analysed from the 2015 European Wheelchair Basketball Championships with the qualified teams for the 2016 Rio de Janeiro Paralympic Games being shown in bold (and the number of points scored being placed within the brackets).

Following data collection in SportsCode, the data were exported into Microsoft Excel using the ‘Sorter’ function in SportsCode. The 31 games resulted in 6,126 rows of data, each of which related to a single ball possession consisting of 17 columns (See Tables 3.3 and 3.9). The possession number and game information (Offensive Team, Defensive Team, Game Outcome and Stage of Competition) were added to the data, making the dataset consist of 22 columns. Each row was subjected to data cleaning to identify any discrepancies within the data. If any missing or duplicated data were identified, the game and possession were identified and re-analysed. In total, four possessions were re-analysed to input missing data.

Two categories from the SPA template that were recorded within the Excel dataset were renamed; Home Classification was amended to Offensive Classification Unit and Away Classification was amended to Defensive Classification Unit. The Away Classification data were switched with the Home Classification data when the away team were in possession of the ball to ensure the two categories comprised of the team’s classification combinations when they were in offence and defence. Through making this adjustment, the data could be used to explore whether there is an optimum unit combination that could be used dependent upon the opposition’s line-up unit. The recorded data for these two categories was displayed as a 10-digit code to reflect the classifications of the five players on the court at the time, such as for example, ‘1.0 2.0 3.0 4.0 4.0’ and ‘4.0 1.0 3.0 2.0 4.0’. However, these two example codes refer to the same line-up combinations, although the process in which the player numbers were inputted affected the format due to the use of activation links. These action variables were therefore reformatted and displayed in numerical order (1.0 through to 4.5) so that the two examples shown above then reflected the same line-up.

Following checking and sorting of the data set, the following columns were removed, Home Team Player Number, Away Team Player Number, Offensive Team, Defensive Team and Possession Number, therefore leaving a data set which consisted of 17 columns:

- Defensive Outcome
- Defensive System
- Defensive Classification Units
- End of Possession
- Game Status
- Man Out Offence
- Offensive Classification Units
- Possession
- Quarter
- Shot Clock Remaining
- Shot Location
- Shot Outcome
- Shot Point
- Shot Taken
- Stage
- Start of Possession
- Game Outcome (Dependent Variable)

The title of each of the columns (apart from Game Outcome) will now be referred to as a Categorical Predictor Variable (CPV), however, the action variables within each CPV will continue to be referred to as action variables. The Excel file was converted into a CSV file, analysed using R (R Core Team 2015) and subjected to a five-stage data modelling process (The University of Sydney, 2010).

4.4 Data modelling process

4.4.1 Exploratory data analysis

Two CPVs presented issues related to low-frequency counts. Firstly, for the CPV, Time, 38 possessions occurred in Over Time whereas the number of possessions within the other four quarters exceeded 1,400. Out of the 31 games that were analysed, only a single game was drawing at the end of the four quarters and therefore only one period of Over Time was required to determine a winner. The 38 possessions within the “Over Time” variable were therefore combined with the “Q4” possession into a new action variable called “Q4 & OT”.

Throughout the 31 games, the Offensive Classification Unit and the Defensive Classification Unit CPVs comprised of 47 and 49 different classification combinations respectively (See Appendix 3 and Appendix 4). These illustrated the variation in the frequencies with which each classification unit was used. Offensively, the “1.0 1.5 3.0 3.5 4.5” classification unit was only used in three possessions whereas the unit “1.0 2.5 3.0 3.0 4.5” was used in 960 possessions. When exploring the frequency counts of each Offensive Classification Unit, 32 of the 47 unit combinations were used in fewer than 100 possessions. A similar variation in the number of possessions each classification unit was used was also evident regarding the Defensive Classification Unit. Defensively, the “1.0 1.5 3.0 3.0 4.0” classification unit was only used in a single possession and the unit “1.0 2.5 3.0 3.0 4.5” was used during 812 possessions. Of the 49 different Defensive Classification Unit CPV, 35 unit combinations were used in fewer than 100 possessions.

To reduce the number of different classification unit combinations used, the Offensive Classification Unit and Defensive Classification Unit CPV data were re-coded into four new CPVs: Offensive Unit 3.0 or 3.5, Offensive Unit 4.0 or 4.5, Defensive Unit 3.0 or 3.5 and Defensive Unit 4.0 or 4.5 (See Table 4-1). For example, the offensive “1.0 1.5 3.0 3.0 4.0” classification unit comprised of two 3.0 players and one 4.0 player. Therefore, the action variable within the Offensive Unit 3.0 or 3.5 CPV was “Two” and the action variable within the Offensive Unit 4.0 or 4.5 CPV was “One”. A 3.0, 3.5, 4.0 or 4.5 classified player appeared in the observed possessions. Although, due to the low-frequency counts of possessions comprising of three or four 3.0 or 3.5 players, the two action variables were amalgamated to form the action variable “Three or More”. In addition, due to the low-frequency counts of possessions comprising of zero or one 4.0 or 4.5 players, the two action variables were combined to create an action variable entitled “Zero or One”. As a result of the 14-point on-court classification rule (International Wheelchair Basketball Federation, 2014b), the number of additional unit combinations reduced as teams played the majority of the time with at least a single 1.0 or 1.5 classification player. For instance, at least a 1.0 or a 1.5

classified player appeared in 5,722 out of 6,126 possessions whilst in offence and 5,654 out of 6,126 possessions in defence. Therefore, the number of 2.0 or 2.5 players or 1.0 or 1.5 players was not recorded due to the ability to predict the classifications of the remaining players.

Table 4-1: Illustrating the four new CPVs for the classification units within each possession and the associated action variables.

Categorical Predictor Variable	Action Variable (No. Of Players)
Offensive Unit 3-0 or 3.5	Zero
	One
	Two
	Three or More
Offensive Unit 4-0 or 4.5	Zero or One
	Two
	Three
Defensive Unit 3-0 or 3.5	Zero
	One
	Two
	Three or More
Defensive Unit 4-0 or 4.5	Zero or One
	Two
	Three

The dataset now consisted of Game Outcome as the dependent variable and 18 CPVs: Defensive Outcome, Defensive System, Defensive Unit 3-0 or 3.5, Defensive Unit 4-0 or 4.5, End of Possession, Game Status, Man Out Offence, Offensive Unit 3-0 or 3.5, Offensive Unit 4-0 or 4.5, Possession, Quarter, Shot Clock Remaining, Shot Location, Shot Outcome, Shot Point, Shot Taken, Stage and Start of Possession (See Appendix 5).

4.4.2 Univariable analyses

Chi-square tests were used to identify significant associations between Game Outcome and each individual CPV. Significant associations ($p < 0.05$) were identified for 15 out of the 18 CPVs (See Table 4-2). Man Out Offence, Quarter and Shot Taken were found to be non-significant ($p < 0.05$) and were removed from further analyses. The CPV with the largest chi-square value ($\chi^2 = 803.49$)

and lowest p-value ($p < 0.001$) was Game Status. The CPVs which were statistically significant ($p < 0.05$) were shortlisted as potential predictor variables in the model and so subjected to assessments of multicollinearity with each other.

Table 4-2: Chi-square tests of association with Game Outcome and each individual CPV.

CPV	χ^2	df	p-value
Defensive Outcome	39.58	1	< 0.001
Defensive System	37.94	7	< 0.001
Defensive Unit - 3.0-3.5	182.36	3	< 0.001
Defensive Unit - 4.0-4.5	20.03	2	< 0.001
End of Possession	53.84	10	< 0.001
Game Status	803.49	2	< 0.001
Man Out Offence	0.06	1	0.801*
Offensive Unit - 3.0-3.5	104.77	3	< 0.001
Offensive Unit - 4.0-4.5	69.12	2	< 0.001
Possession	50.78	3	< 0.001
Quarter	0.81	3	0.848*
Shot Clock Remaining	14.14	4	< 0.001
Shot Location	43.91	10	< 0.001
Shot Outcome	10.40	2	0.005
Shot Point	26.14	3	< 0.001
Shot Taken	0.51	1	0.473*
Stage	76.09	4	< 0.001
Start of Possession	65.91	8	< 0.001

*: Denotes a CPV that was non-significant ($p < 0.05$).

4.4.3 Assessments of multicollinearity

The action variables, Shot Point “One”, Shot Point “Two” and Shot Outcome “Unsuccessful”, demonstrated perfect collinearity. Shot Point “One” was perfectly associated with the Start of Possession “Free Throw”, as a free throw attempt can only result in a “One” point Shot Point. As a result, the Shot Point CPV was removed due to the lower chi-squared value and a lower r-squared value when a singular logistic regression model was created between the two CPV (Midi, Sarkar and Rana, 2010). The removal of this CPV could have affected the remaining action variables within the CPV: Shot Point “Two” and Shot Point “Three”. However, through the Start of Possession and Shot Location CPV, the shooting value of a shot could be calculated. In addition, Shot Outcome "Unsuccessful" aligned perfectly with a number of the action variables within the End of Possession CPV. The Shot Outcome CPV was removed in favour of maintaining the End of Possession CPV due to the larger p-value (Crawley, 2007).

The 'car' package (Companion to Applied Regression (car): Fo*x et al*. (2018)) and the *vif* function (Variance Inflation Factors (VIF)) in R were used to measure the potential for multicollinearity of the 13 CPVs that remained for consideration in the model building process. If the CPVs are highly associated with the other CPVs, the standard errors of the regression coefficients for each action variable will be inflated, resulting in a destabilisation of the coefficients and thus the coefficients become difficult to interpret. VIF values for two CPVs fell above the threshold of 10 (Myers, 1990) and were therefore excluded from multivariable analyses: Possession and Defensive Outcome (See Table 4-3). These two CPV were removed due to the high level of association between the two categories. For example, when the Defensive Outcome was recorded as being Successful that automatically resulted in the offensive team Losing Possession. Following the testing of multicollinearity, 11 CPVs were shortlisted for multivariable analyses.

Table 4-3: VIF for the 13 CPVs that remained for consideration in the model.

CPV	VIF	df
Defensive Outcome	3346.07*	1
Defensive System	1.16	7
Defensive Unit 3.0 or 3.5	1.45	3
Defensive Unit 4.0 or 4.5	1.72	2
End of Possession	2.93	10
Game Status	1.07	2
Offensive Unit 3.0 or 3.5	1.48	3
Offensive Unit 4.0 or 4.5	1.78	2
Possession	153.39*	2
Shot Clock Remaining	1.57	4
Shot Location	1.20	10
Stage	1.04	4
Start of Possession	1.23	8

*: Denotes a VIF value above 10.

4.4.4 Model development

The dataset was randomly split using the 'createDataPartition' function in the 'caret' package in R (Classification and Regression Training (caret): Kuhn *et al.* (2018)) into a 70 per cent data training sample (4,282 possessions) and a 30 per cent data testing sample (1,844 possessions). The split was calculated utilising the percentage of observation equation:

$$p\% = \frac{1}{\sqrt{\max k}}.100\%$$

Equation 1: Percentage of observation equation **(Deppa, 2015)**

The term "$\max k$" represented the largest number of CPVs that had been shortlisted for multivariable analyses. In this case, $\sqrt{\max k} = 3.3606$ and $p\% = 29.757\%$. Thus, suggesting a 70:30 split should be adopted for the available data set. The training sample was first subjected to a manual forward selection process to build a model. This process used the residual deviance, which is a measure of the unexplained variation in game outcomes that are not explained by the model. Models which have lower residual deviances are considered to be better models. Hence initially, the CPV with the lowest residual deviance in a model on its own as a single CPV was included in the model; which in this case was Game Status. Then with this CPV retained in the model, the additional one CPV which reduced the residual deviance the most when added as a second CPV in the model was then retained in the model. This process continued retaining additional CPVs which produced the lowest residual deviance. However, if the addition of a CPV to the model decreased the residual deviance by less than one then that CPV was not included and the manual forward selection process stopped. In addition, the reduction in the residual deviance with the addition of each CPV was more formally compared with the value from a chi-squared distribution table. The reduction in the residual deviance was greater than one and also greater than or close to the associated chi-squared values for all stages except the addition of the "Defensive Unit – 4.0-4.5" CPV. Therefore, "Defensive Unit – 4.0-4.5" CPV was not added to the model during the forward selection process at the last stage (See Table 4-4). Following this manual forward selection approach, ten CPVs were incorporated into the model.

Table 4-4: Residual deviance values for the manual forward selection process.

Number of CPV in Model	Game Status	Defensive Unit - 3.0-3.5	Offensive Unit - 4.0-4.5	Stage	Start of Possession	Defensive System	End of Possession	Shot Location	Shot Clock Remaining	Offensive Unit - 3.0-3.5	Defensive Unit - 4.0-4.5
One	5228.6*	5628.2	5728	5731.6	5738.7	5765.1	5755.1	5750.8	5776.1	5710.9	5764.2
Two (including Game Status)		5074.9**	5105.0	5159.3	5202.2	5207.1	5206.4	5202.8	5224.0	5125.4	5166.4
Three (including Game Status + Defensive Unit - 3.0-3.5)			4983.2	5020.3	5051.6	5071.5	5056.8	5053.0	5074.0	4999.8	5050.4
Four (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5)				4936.1	4959.9	4957.1	4967.6	4962.8	4979.2	4968.2	4981.0
Five (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage)					4912.4	4912.6	4919.4	4913.4	4932.3	4923.1	4935.4
Six (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage + Start of Possession)						4886.1	4894.4	4894.5	4910.2	4900.4	4911.4
Seven (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage + Start of Possession+ Defensive System)							4868.6	4868.6	4882.8	4873.2	4885.6
Eight (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage + Start of Possession+ Defensive System + End of Possession)								4851.7	4865.2	4855.6	4867.8
Nine (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage + Start of Possession+ Defensive System + End of Possession + Shot Location)									4846.8	4867.8	4851.0
Ten (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage + Start of Possession+ Defensive System + End of Possession + Shot Location + Shot Clock Remaining)										4833.7	4846.0
Eleven (including Game Status + Defensive Unit - 3.0-3.5 + Offensive Unit - 4.0-4.5 + Stage + Start of Possession+ Defensive System + End of Possession + Shot Location + Shot Clock Remaining + Offensive Unit – 3.0-3.5)											4833.1***

* Game Status enters the model first with the lowest residual deviance

** Defensive Unit – 3.0-3.5 enters next as the CPV that with Game Status produces the lowest residual deviance

*** Including Defensive Unit -4.0-4.5 at Step Eleven would reduce the residual deviance by 0.6 from 4883.7 to 4833.1 and so was not added to the model and the process ends.

One common measure of model fit is the Akaike Information Criterion (AIC) which is the residual deviance plus twice the number of parameters in the model. The addition of twice the number of parameters acts as a penalty for larger models with more CPVs (Akaike, 1998). Hence acknowledging that when more parameters are added, and the model increases in size, the AIC value will also increase. In other words, the AIC is a measure of the relative distance between the observed data and the fitted model, with a lower value indicating a 'better' predicting performance of the model (Anderson and Burnham, 2002). The manual forward selection model, obtained at Stage Ten above, had a residual deviance of 4,833.70 and included a total of 54 parameters and so gave an AIC value of 4,833.70 + 2 x 54 = 4,941.70.

The above model was then compared to other candidate models that can be derived using automated forward selection, backwards elimination and stepwise approaches to develop the final model. The model derived using the forward selection approach produced a model with an AIC estimate of 4,935.65 and included eight CPVs, eliminating End of Possession and Shot Clock Remaining from the manually developed model above. The backwards elimination approach produced a model with an even lower AIC estimate of 4,933.16 and included seven CPVs, eliminating End of Possession, Shot Clock Remaining and Shot Location. The stepwise approach produced the same model as the backwards elimination approach (AIC estimate of 4,933.16 with the same seven CPVs), however, the order in which the CPVs entered the model was different. The final model was chosen using the automated stepwise approach due to the lower AIC estimate (See Table 4-5).

Table 4-5: Summary of the AIC values using the four modelling approaches.

	Manual Forward Selection	Automated Forward Selection	Automated Backwards Elimination	Automated Stepwise
CPV within the model	Game Status Defensive Unit - 3.0-3.5 Offensive Unit - 4.0-4.5 Stage Start of Possession Defensive System End of Possession Shot Location Shot Clock Remaining Offensive Unit – 3.0-3.5	Game Status Defensive Unit - 3.0-3.5 Offensive Unit - 4.0-4.5 Stage Shot Location Offensive Unit – 3.0-3.5 Defensive System Start of Possession	Game Status Defensive Unit - 3.0-3.5 Offensive Unit - 4.0-4.5 Stage Start of Possession Defensive System Offensive Unit – 3.0-3.5	Game Status Defensive Unit - 3.0-3.5 Offensive Unit - 4.0-4.5 Stage Offensive Unit – 3.0-3.5 Defensive System Start of Possession
AIC	4,941.70	4935.65	4933.16	4933.16

To specify the final model mathematically, the outcome of the game relating to possession was denoted i in the data set as y_i, such that y_i = 1 if the game outcome was a win or y_i = 0 if the game outcome was a loss. The model can then be specified as the logarithm of the odds of winning as follows:

$$Loge\left[\frac{P(y_i = 1)}{P(y_i = 0)}\right] = \alpha + X_i\beta.$$

Equation 2: Logarithm of the odds of winning (Field, Miles and Field, 2012).

The term $P(y_i = 1)$ represented the probability of winning the game and $P(y_i = 0)$ represented the probability of losing the game {=1- $P(y_i = 1)$}, so that $\frac{P(y_i=1)}{P(y_i=0)}$ represented the odds of winning the game. The model was specified in this way since the logarithm of the odds could then be related to the CPVs using a linear model as shown above. The term α represented an intercept term that provided the log-odds of winning for possessions which reflected "baseline" or "reference" action variables. The term X_i denoted the relevant data (action variables) from the CPVs for possession i which were combined with the vector of regression coefficients given by β.

To explore the individual contributions of each action variable within the final model, the estimated regression coefficients and their standard error values along with their p-values and Odds Ratio (OR) values are presented in Table

4-6. The estimated regression coefficients demonstrated the action variables' contribution to the prediction of the outcome (game success), with a positive estimated regression coefficient improving the ability to win the game. ORs are also presented in Table 4-6 to assist with the interpretation of the logistic regression model.

The estimated intercept of 1.214 reflects the log-odds of winning the game where the possession includes the "baseline" or "reference" action variables: Game Status – "Drawing", Defensive Unit – 3.0-3.5 – "Zero", Offensive Unit – 4.0-4.5 – "Zero or One", Stage – "Pool", Start of Possession – "Defensive Rebound", Defensive System – "1 Man Press" and Offensive Unit – 3.0-3.5 – "Zero". The OR is the exponential of the log-odds and so its value of 3.366 {=exp(1.214)} reflects the odds of winning the match when the action variables associated with the possession are as listed above. This suggested that teams that adopted possessions according to the above "baseline" or "reference" action variables would win the game with probability = odds/(1+odds) = 3.366/4.366 = 0.7709 or a 77.09% chance of winning.

The ORs for the remaining CPVs indicate the multiplicative change in the odds of the outcome of winning the game, resulting from a change in an action variable from the "baseline" or "reference" action variables. Therefore, if an action variable is included in the model and has an OR greater than one, the odds of winning the game increases. For example, should Game Status have been "Winning" instead of "Drawing", then the odds of ultimately winning the game would be multiplied by 2.137 and hence more than doubled, whereas should Game Status have been "Losing" instead of "Drawing", then the odds of ultimately winning the game would be multiplied by 0.365 and hence be reduced significantly.

Table 4-6: Final model illustrating the estimated regression coefficients, standard errors, p-values and ORs for the intercept variable and for each action variable in a CPV.

		Estimate	Std. Error	*p*	OR
(Intercept)		1.214	0.340	< 0.001	3.366
Game Status	Drawing	Included in intercept*			
	Losing	-1.009	0.164	< 0.001	0.365
	Winning	0.759	0.165	< 0.001	2.137
Defensive Unit – 3.0-3.5	Zero	Included in intercept*			
	One	-0.624	0.096	< 0.001	0.536
	Two	-0.920	0.092	< 0.001	0.398
	Three or More	-0.093	0.180	0.607	0.911
Offensive Unit – 4.0-4.5	Zero or One	Included in intercept*			
	Two	-0.240	0.206	0.244	0.787
	Three	-1.358	0.278	< 0.001	0.257
Stage	Pool	Included in intercept*			
	Quarter Final	-0.491	0.111	< 0.001	0.612
	Ranking	-0.634	0.149	< 0.001	0.531
	Semi-Final	-0.189	0.155	0.223	0.827
	Medal Game	-0.554	0.143	< 0.001	0.575
Offensive Unit – 3.0-3.5	Zero	Included in intercept*			
	One	-0.203	0.106	0.056	0.816
	Two	0.070	0.229	0.760	1.072
	Three or More	0.502	0.274	0.067	1.653
Defensive System	1 Man Press	Included in intercept*			
	2 Man press	0.320	0.224	0.153	1.377
	3 Man Press	0.370	0.228	0.104	1.448
	4 Man Press	0.258	0.266	0.331	1.294
	5 Man Press	0.112	0.282	0.690	1.119
	Highline	0.472	0.213	< 0.05	1.603
	Zone	-0.052	0.192	0.785	0.949
	No Defensive System	-0.088	0.261	0.735	0.915
Start of Possession	Defensive Rebound	Included in intercept*			
	Free Throw	0.675	0.216	< 0.01	1.965
	Inbound – Baseline	-0.038	0.094	0.689	0.963
	Inbound - Endline	0.300	0.199	0.131	1.350
	Offensive Rebound	0.476	0.156	< 0.01	1.609
	Other Start	0.384	0.482	0.426	1.467
	Sideline - Back	0.228	0.172	0.186	1.256
	Sideline - Front	0.260	0.148	0.079	1.297
	Turnover	0.335	0.169	< 0.05	1.398

*: Denotes the reference group that is used to calculate the estimated coefficient for the intercept model, which is the mean value of the outcome variable.

4.4.5 Model diagnostics

The model's ability to predict performance was evaluated using pseudo r-squared values (Hodeghatta and Nayak, 2017), a ROC curve and an AUC value (Muschelli, Betz and Varadhan, 2014). Pseudo r-squared values were calculated to compare the maximum likelihood of the final model against a null model. McFadden (McFadden, 1974), Cox and Snell (Cox and Snell, 1989), and Nagelkerke (Nagelkerke, 1991) pseudo r-squared values are shown for this model in Table 4-7. The pseudo r-squared values presented below suggest the model does explain at least a reasonable amount of the variation in game outcomes. These values do have an upper limit of 1 when the model would explain nearly all the variation but these pseudo r-squared values are well known for very rarely attaining values near this upper limit, even for well-fitting models (Heinzl and Mittlböck, 2003). The values achieved for a comparison between the final model and the null model, however, are fairly low. Although, the achieved figures indicate that the final model better fits the outcome data than the null model.

Table 4-7: Pseudo r-squared values comparing the final model to the null model.

Pseudo r-squared for logistic regression	
McFadden r-squared	0.158
Cox and Snell r-squared	0.192
Nagelkerke r-squared	0.260

To obtain a different "view" of the model's ability to accurately predict, a ROC curve was used to calculate the sensitivity and specificity of the final model against the 30 per cent out of sample testing data (1,844 possessions). The ROC curve was used to illustrate how well the model separated the possessions being tested into those that led to a winning performance and those which resulted in a losing performance (See Figure 4-2). The accuracy of the model was measured by the area under the ROC curve with an area of one representing a perfectly accurate model through to a value of zero representing a perfectly inaccurate model (Hosmer and Lemeshow, 2000). The area under the ROC curve value indicated the probability of the model correctly predicting the outcome of the event or stimuli (Hanley and McNeil, 1982). An

AUC value of 0.749 was established for the model when subjected to the sample testing data and is considered acceptable (Hosmer and Lemeshow, 2000) at accurately predicting win probabilities in elite men’s wheelchair basketball.

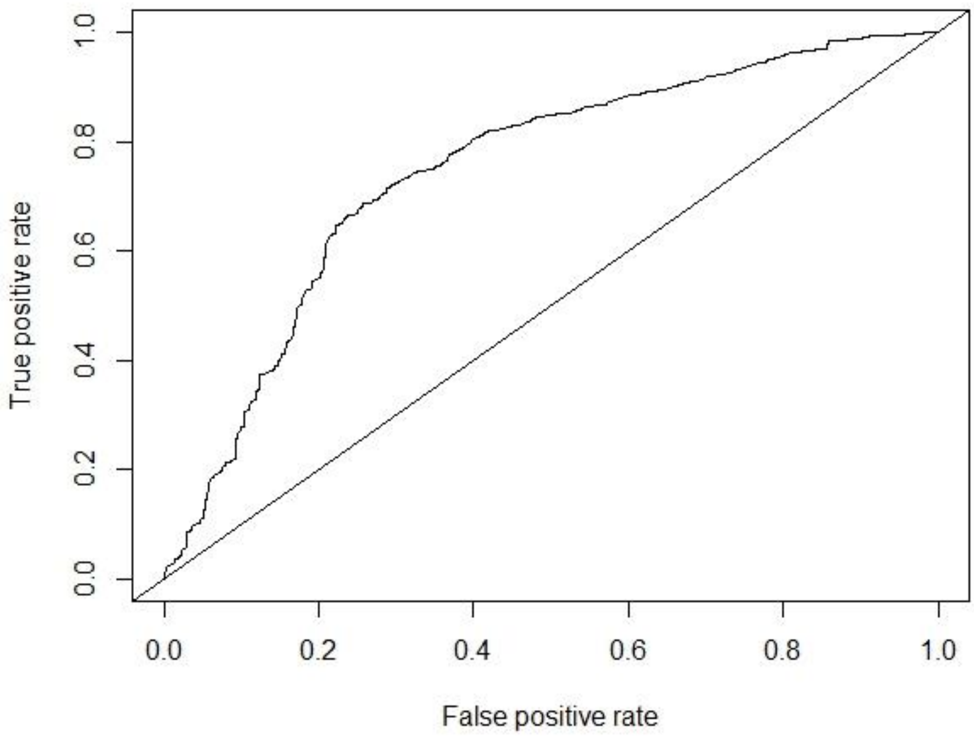


Figure 4-2: ROC curve illustrating the team model’s performance against the 30 per cent testing data sample.

4.5 Application of model

To interpret and apply the model (see Equation 2), the log-odds estimated from the regression coefficients presented in Table 4-6 were converted into probabilities by using Equation 3. The change in probability from the intercept was then calculated by subtracting the probability after a change in the action variables within a CPV from the intercept probability. The change in probability, due to a change of an action variable within a CPV, was explored next.

$$\text{probability} = \exp(log - odds) /(1 + exp(log - odds))$$

Equation 3: Equation used to calculate the probability of an event occurring through converting logits (Field, Miles and Field, 2012).

4.5.1 *Change in Game Status*

The ORs in Table 4-6 indicate the odds of winning are more than doubled (multiplied by 2.137) when the state changes from “Drawing” to “Winning”, but more than halved (multiplied by 0.365) if the state changes from “Drawing” to “Losing”. Further clarification of these effects is illustrated in Table 4-8, which shows how the probability of winning a game is dependent upon the current Game Status (columns) and the influence of additional CPVs (rows). The percentage changes, as shown in Table 4-8, emphasise by how much the chances of winning are affected by a change in Game Status.

Table 4-8: Change in the chance of winning due to Game Status CPV and additional CPVs (percentages in bold indicate the inclusion of the action variable improves the chance of winning the game from the intercept chance of 77.1%).

CPV		Game Status		
		Winning	Drawing	Losing
Defensive Unit – 3.0-3.5	Zero	**87.6%**	77.1%	55.1%
	One	**79.4%**	64.3%	39.7%
	Two	74.1%	57.3%	32.9%
	Three or More	**86.8%**	75.4%	52.8%
Offensive Unit – 4.0-4.5	Zero or One	**87.6%**	77.1%	55.1%
	Two	**85.0%**	72.6%	49.1%
	Three	64.9%	46.4%	24.0%
Stage	Pool	**87.6%**	77.1%	55.1%
	Quarter Final	**81.5%**	67.3%	42.9%
	Ranking	**79.2%**	64.1%	39.4%
	Semi-Final	**85.6%**	73.6%	50.4%
	Medal Game	**80.5%**	65.9%	41.4%
Offensive Unit – 3.0-3.5	Zero	**87.6%**	77.1%	55.1%
	One	**85.5%**	73.3%	50.1%
	Two	**88.5%**	**78.3%**	56.8%
	Three or More	**92.2%**	**84.8%**	67.0%
Defensive System	1 Man Press	**87.6%**	77.1%	55.1%
	2 Man Press	**93.4%**	**86.9%**	70.7%
	3 Man Press	**87.4%**	76.4%	54.2%
	4 Man Press	**90.7%**	**82.0%**	62.4%
	5 Man Press	**92.1%**	**84.4%**	66.4%
	Highline	**91.4%**	**83.2%**	64.3%
	Zone	**90.3%**	**81.4%**	61.4%
	No Defensive System	**90.0%**	**80.9%**	60.7%
Start of Possession	Defensive Rebound	**87.6%**	77.1%	55.1%
	Free Throw	**91.0%**	**82.5%**	63.2%
	Inbound – Baseline	**90.8%**	**82.3%**	62.8%
	Inbound – Endline	**91.2%**	**83.0%**	64.0%
	Offensive Rebound	**90.3%**	**81.3%**	61.4%
	Other Start	**89.0%**	**79.0%**	57.9%
	Sideline – Back	**92.0%**	**84.4%**	66.3%
	Sideline – Front	**86.8%**	75.5%	52.9%
	Turnover	**87.2%**	76.2%	53.8%

4.5.2 Change in offensive and defensive classification units

The ORs presented in Table 4-6 indicated that compared to playing with “Zero or One” Offensive Unit - 4.0-4.5 players, playing with three such players significantly reduces the odds of winning (OR = -0.257, p<0.001). Table 4-9 then showed, for example, that the model-estimated chances of winning fall to 64.9% if “Three” Offensive Unit - 4.0-4.5 players are used, compared to an 87.6% chance if “Zero or One” such players were used. Note that Table 4-6 suggested that there is no statistically significant effect (p=0.244) on the chances of winning if “Two” Offensive Unit - 4.0-4.5 players were on the court in comparison to using “Zero or One”. Hence it seems that using “Three” Offensive Unit - 4.0-4.5 players has a detrimental impact on the chances of winning, compared to any other line-up selection policy.

Table 4-6 suggested that the impact of changing the number of Offensive Unit - 3.0-3.5 players on the chances of winning was less clear and mixed. For example, compared to playing with “Zero” such players, the use of “One” player decreased the odds of winning (OR = 0.816), whilst playing with “Three or More” players increased the odds of winning (OR = 1.653). However, in both cases, these effects were actually borderline non-significant (p=0.056 and 0.067 respectively). Furthermore, Table 4-6 suggested that the odds of winning significantly reduced (p<0.001) when the offensive team were being defended by a team that comprised of “One” Defensive Unit - 3.0-3.5 player (OR =0.536) or “Two” Defensive Unit - 3.0-3.5 players (OR = 0.398). However, the odds of winning reduce by the smallest amount when “Three or More” Defensive Unit - 3.0-3.5 players were playing, although this case is non-significant (p=0.607).

Table 4-9 indicated that the optimal defensive line-up would be to play with “Zero” Defensive Unit - 3.0-3.5 players but to employ a “2 Man Press” in the Defensive system. Whereas, it could be argued that the optimal offensive line-up for a team to use would be “Three or More” Offensive Unit - 3.0-3.5 players and “Zero or One” Offensive Unit - 4.0-4.5 players. However, Table 4-6 suggested that the number of Offensive Unit - 3.0-3.5 players used in relation to the chances of winning is non-significant, less clear and mixed.

Table 4-9: Change in the chance of winning due to Defensive Unit - 3.0-3.5, Offensive Unit - 3.0-3.5, Offensive Unit - 4.0-4.5 CPV and additional CPVs.

CPV		Defensive Unit - 3.0-3.5 (Assuming Offensive Unit – 3.0-3.5 is "Zero" and Offensive Unit – 4.0-4.5 is "Zero or One")				Offensive Unit - 3.0-3.5 (Assuming Defensive Unit – 3.0-3.5 is "Zero" and Offensive Unit – 4.0-4.5 is "Zero or One")				Offensive Unit - 4.0-4.5 (Assuming Defensive Unit – 3.0-3.5 is "Zero" and Offensive Unit – 3.0-3.5 is "Zero"		
		Zero	One	Two	Three or More	Zero	One	Two	Three or More	Zero or One	Two	Three
Game Status	Losing	55.1%	39.7%	32.9%	52.8%	55.1%	50.1%	56.8%	67.0%	55.1%	49.1%	24.0%
	Drawing	77.1%	64.3%	57.3%	75.4%	77.1%	73.3%	**78.3%**	**84.8%**	**77.1%**	72.6%	46.4%
	Winning	**87.8%**	**79.4%**	74.1%	**86.8%**	**87.8%**	**85.5%**	**88.5%**	**92.2%**	**87.8%**	**85.0%**	27.8%
Stage	Pool	77.1%	64.3%	57.3%	75.4%	77.1%	73.3%	**78.3%**	**84.8%**	77.1%	72.6%	46.4%
	Quarter Final	67.3%	52.5%	45.1%	65.3%	67.3%	62.7%	68.9%	68.9%	67.3%	54.2%	61.9%
	Ranking	64.1%	48.9%	41.6%	61.9%	64.1%	59.3%	65.7%	64.1%	64.1%	52.2%	50.7%
	Semi-Final	73.6%	59.9%	52.6%	71.7%	73.6%	69.5%	74.9%	73.6%	73.6%	59.6%	63.0%
	Medal Game	65.9%	50.9%	43.5%	63.8%	65.9%	61.2%	67.5%	76.2%	65.9%	60.4%	33.2%
Defensive System	1 Man Press	77.1%	64.3%	57.3%	75.4%	77.1%	73.3%	**78.3%**	**84.8%**	77.1%	72.6%	46.4%
	2 Man Press	**86.9%**	**78.0%**	72.5%	**85.8%**	**86.9%**	**84.4%**	**87.6%**	**91.6%**	**86.9%**	**83.9%**	63.0%
	3 Man Press	76.4%	63.5%	56.4%	74.7%	76.4%	72.6%	**77.7%**	**84.3%**	76.4%	71.8%	45.5%
	4 Man Press	**82.0%**	70.9%	64.4%	**80.6%**	**82.0%**	**78.8%**	**83.0%**	**88.3%**	**82.0%**	**78.2%**	53.9%
	5 Man Press	**84.4%**	74.4%	68.3%	**83.2%**	**84.4%**	**81.6%**	**85.3%**	**90.0%**	**84.4%**	**81.0%**	58.2%
	Highline	**83.2%**	72.6%	66.3%	**81.8%**	**83.2%**	**80.1%**	**84.1%**	**89.1%**	**83.2%**	**79.5%**	55.9%
	Zone	**81.4%**	70.1%	63.5%	**79.9%**	**81.4%**	**78.1%**	**82.4%**	**87.8%**	**81.4%**	**77.5%**	52.9%
	No Defensive System	**80.9%**	69.4%	62.8%	**79.4%**	**80.9%**	**77.5%**	**81.9%**	**87.5%**	**80.9%**	76.9%	52.1%
Start of Possession	Defensive Rebound	77.1%	64.3%	57.3%	75.4%	77.1%	73.3%	**78.3%**	**84.8%**	77.1%	72.6%	46.4%
	Free Throw	**82.5%**	71.6%	65.2%	**81.1%**	**82.5%**	**79.3%**	**83.5%**	**88.6%**	**82.5%**	**78.7%**	54.7%
	Inbound – Baseline	**82.3%**	71.3%	64.9%	**80.9%**	**82.3%**	**79.1%**	**83.3%**	**88.5%**	**82.3%**	**78.5%**	54.4%
	Inbound – Endline	**83.0%**	72.3%	66.0%	**81.6%**	**83.0%**	**79.9%**	**83.9%**	**89.0%**	**83.0%**	**79.3%**	55.6%
	Offensive Rebound	**81.3%**	70.0%	63.5%	**79.9%**	**81.3%**	**78.1%**	**82.4%**	**87.8%**	**81.3%**	**77.4%**	52.8%
	Other Start	**79.0%**	66.9%	60.0%	**77.4%**	**79.0%**	75.5%	**80.2%**	**86.2%**	**79.0%**	74.8%	49.2%
	Sideline – Back	**84.4%**	74.3%	68.3%	**83.1%**	**84.4%**	**81.5%**	**85.3%**	**89.9%**	**84.4%**	**80.9%**	58.1%
	Sideline – Front	75.5%	62.3%	55.1%	73.7%	75.5%	71.6%	76.8%	**83.6%**	75.5%	70.8%	44.2%
	Turnover	76.2%	63.1%	56.0%	74.4%	76.2%	72.3%	**77.4%**	**84.1%**	76.2%	71.5%	45.1%

When the offensive and defensive classification unit combinations were compared (See Table 4-10), the findings highlighted the importance of playing with a greater number of Offensive Unit – 3.0-3.5 players on the court when “Zero” or “One” Offensive Unit – 4.0-4.5. This trend was observed regardless of the number of Defensive Unit – 3.0-3.5 players on-court when “Zero or One” Offensive Unit – 4.0-4.5. Although, when the Offensive Unit – 3.0-3.5 comprised of “Three or More” players the chances of winning has the lowest fluctuations dependent upon the defensive unit combinations that are used (86.6% to 96.0%). This contrasts to when “Zero” Offensive Unit – 3.0-3.5 players were used where the chances of winning have higher fluctuations dependent upon the defensive unit combinations that were used (28.0% to 75.0%). The results also showed that as the number of Offensive Unit – 3.0-3.5 players and Defensive Unit – 3.0-3.5 players increased, when “Zero or One” Offensive Unit – 4.0-4.5 players were on the court, the chances of winning increased from 28.0% to 96.0%. However, the inverse effect was observed when the number of Offensive Unit – 4.0-4.5 players increased from “Two” or “Three” (87.0% to 36.0%). Finally, playing with “Three” Offensive Unit – 4.0-4.5 and “Zero” Offensive Unit – 3.0-3.5 decreased the likelihood of winning from between 61.0% to 36.0% dependent upon the number of Defensive Unit – 3.0-3.5 players.

Table 4-10: Change in the chance of winning due to an action variable change in the Defensive Unit - 3.0-3.5, Offensive Unit 3.0-3.5 and Offensive Unit 4.0-4.5 CPVs.

		Defensive Unit - 3.0-3.5			
Offensive Unit - 4.0-4.5	Offensive Unit - 3.0-3.5	Zero	One	Two	Three or More
Zero or One	Zero	28.0%	73.0%	50.8%	75.0%
Zero or One	One	**79.0%**	68.9%	45.0%	71.7%
Zero or One	Two	**93.0%**	**89.0%**	76.6%	**90.7%**
Zero or One	Three or More	**96.0%**	**94.4%**	**86.6%**	**95.0%**
Two	Zero	**87.0%**	**79.7%**	60.1%	**81.8%**
Two	One	**84.0%**	76.0%	55.0%	**78.0%**
Three	Zero	71.0%	59.0%	36.0%	62.0%

4.5.3 Change in Stage

Within the Stage CPV, the odds of winning the game were shown to significantly decrease as a team progressed from the "Pool" stages to the knock-out stages of the competition (See Table 4-6). Table 4-11 shows the magnitude of this change during the various knock-out stages of the tournament in comparison to the "Pool" stages. The chances of winning the game decreased from 77.1% during the Pool stage to 67.3% during the "Quarter-Final" stages ($p<0.001$). The chances of winning the game during the "Ranking" stage decreased further to 64.1% ($p<0.001$). However, the chances of winning the game during the "Semi-Final" stage were the highest of the knock-out stage games (73.6%). Although this stage of the competition was found to be non-significant ($p=0.223$) and could be explained by the points difference in both "Semi-Final" games (Great Britain 77 v Germany 68; Turkey 69 v Netherlands 50). The final two games of the tournament ("Medal Game"), found that the chances of winning the games during this stage of the tournament were 65.9% ($p<0.001$). Hence it seems that the chances of winning a game during the knock-out stages of the 2015 European Wheelchair Basketball Championships were more testing than winning a "Pool" stage game.

Table 4-11: Change in the chance of winning due to an action variable change in the Stage CPV.

	OR	Chance of Winning	Change from Intercept
Pool	3.366	77.1%	
Quarter Final	0.612	67.3%	-9.8%
Ranking	0.531	64.1%	-13.0%
Semi-Final	0.827	73.6%	-3.5%
Medal Game	0.575	65.9%	-11.2%

4.5.4 Change of Defensive System

Table 4-6 also showed that the effect of changing the Defensive System from a "1 Man Press" was found to be non-significant, apart from the use of a "Highline" Defensive system where the odds of winning increased (OR = 1.603, $p<0.05$). The effect of the choice of Defensive System on the chances of winning a game is presented in Table 4-12. These results highlighted that when the defending team is operating a "Highline" defensive system, the offensive team's chance of winning the game were likely to increase by 7.3%, in comparison to when the defensive team elected to use a "1 Man Press".

Table 4-12: Change in the chance of winning due to an action variable change in the Defensive System CPV.

	OR	Chance of Winning	Change from Intercept
1 Man Press	3.366	77.1%	
2 Man Press	1.377	82.3%	**5.2%**
3 Man Press	1.448	83.0%	**5.9%**
4 Man Press	1.294	81.3%	**4.2%**
5 Man Press	1.119	79.0%	**1.9%**
Highline	1.603	84.4%	**7.3%**
Zone	0.949	76.2%	-0.9%
No Defensive System	0.915	75.5%	-1.6%

4.5.5 Change of Start of Possession

Table 4-6 indicated the odds of winning the game decreased only when a possession started from an "Inbound – Baseline", although this finding was found to be non-significant. Possessions that started with a "Free Throw", "Offensive Rebound" and "Turnover" were found to be the only statistically significant action variables attributed to increasing the odds of winning a game. The results indicated the probability of winning a game when starting a possession in the team's own half is lower than a possession starting in the opponent's half. Although this could be intuitive, as when the possession starts in the opponent's half they are closer to the basket, however, the space available for the offensive players is reduced and could, therefore, be argued that it is easier to defend.

The magnitude of this change is illustrated in Table 4-13 and highlighted that if a possession started underneath the defensive team's basket or was an unchallenged possession, the team had the highest probability of eventually winning the game. Although this finding is again intuitive if a team's possession began from an "Offensive Rebound" their chances of achieving success increased by 7.3% whereas if the start of possession was from an "Inbound –

Endline" the chances of winning only increased by 4.9%. The differences displayed between these two starts of possessions could be explained by the defensive team's ability to organise and structure their defensive system. Prior to an "Inbound – Endline" the clock stopped and enabled both teams to organise their systems whilst from an "Offensive Rebound" the clock resets and play continued.

Table 4-13: Change in the chance of winning due to an action variable change in the Start of Possession CPV.

	OR	Chance of Winning	Change from Intercept
Defensive Rebound	3.366	77.1%	
Offensive Rebound	1.965	84.4%	**7.3%**
Inbound - Baseline	0.963	76.4%	-0.7%
Inbound - Endline	1.350	82.0%	**4.9%**
Sideline - Back	1.609	80.9%	**3.8%**
Sideline - Front	1.467	81.4%	**4.3%**
Free Throw	1.256	86.9%	**9.8%**
Turnover	1.297	82.5%	**5.4%**
Other Start	1.398	83.2%	**6.1%**

4.6 Discussion

The aim of this chapter was to identify the key variables associated with team success in elite men's wheelchair basketball and to explore the impact of each key variable upon the outcome of a performance through the use of binary logistic regression modelling. Chi-square analyses identified statistical significance ($p < 0.05$) relationships between 15 out of the 18 CPVs in relation to Game Outcome. Following assessment of multicollinearity and a process of model building, the final logistic regression model consisted of seven CPVs and was deemed to be acceptable (Hosmer and Lemeshow, 2000) at accurately predicting win probabilities in elite men's wheelchair basketball. The model demonstrated the sequential action variables within the classification units CPVs, Defensive System CPV and Game Status CPV had the largest impact on predicting Game Outcome. The Stage of the competition was also found to be an important factor, but this simply seemed to be explained by the fact that during the later stages, the teams that eventually won dominated possession less during the games as the quality of opposition increased. The findings from this chapter largely support previous research regarding stage of competition (van Rooyen, Lombard and Noakes, 2008; van Rooyen, Diedrick and Noakes, 2010; O'Donoghue *et al.*, 2016), defensive structure (Gómez, Tsamourtzis and Lorenzo, 2006; Tenga *et al.*, 2010) and in-game status (Lago-Peñas and Dellal, 2010; Marcelino, Mesquita and Sampaio, 2011; Almeida, Ferreira and Volossovitch, 2014) in relation to the importance of game outcome. Thus, the final model offers practical insight to coaches, players and support staff with greater utility and the capacity to devise training and game strategies to enhance their likelihood of winning based on the accumulation of optimal CPV sequences.

Findings from previous wheelchair basketball studies have highlighted the importance of 4.0 and 4.5 classification players in relation to achieving higher CBGS scores and assisting towards a positive game outcome (Vanlandewijck *et al*., 2004; Gómez, Molik, *et al.*, 2015), however, the findings in this chapter regarding classification challenge these. The findings around player classification identified the chance of winning is reduced if "Three" 4.0 or 4.5 players were used during a possession by odds of 0.257. Playing with the above combination of players restricts the classification of each of the remaining two players on-court to 1.0 in order to stay within the 14-point total team classification score. Players who are classified as 1.0 players have been found to regularly achieve low or negative CBGS scores (Skucas *et al.*, 2009), albeit through an unreliable data collection tool. These players have limited trunk function in the forward plane and no active rotation which significantly impairs balance in both forward and sideways directions, impairing their ability to push, dribble, pass and shoot the ball (Perriman, 2014). The players typically fulfil the role of a screen as they are reliant on the wheelchair for support in all planes of movement and are susceptible to losing the ball (Vanlandewijck, Spaepen and Lysens, 1995). Thus, having two of these 1.0 classified players on the court at the same time negatively impact team performance due to the impairment of handling, pushing and shooting as identified through the produced odds ratio in the model.

In contradiction to the work of Molik *et al.* (2009) who found similarities between low class players (classification 1.0-3.0) and low game efficiency, the model demonstrated that playing with “One” or “Three or More” Offensive Unit – 3.0-3.5 players on the court improves Game Outcome (borderline significance: $p = 0.056$; $p = 0.067$). Subsequently, the limitations of physical movement associated with 1.0 players can be overcome by a combination of players with the following classification: 2.0, 2.5, 3.0 or 3.5. Boyd *et al.* (2016) indicated cerebral football players with similar lower classifications had no differences in terms of time-motion analysis, however, this study explored cardiovascular and locomotive demands and not technical or tactical demands. Within wheelchair basketball, players with either a 2.0, 2.5, 3.0 or 3.5 classification have partial or full volume of action in the forward and vertical planes enabling them to hold the ball outstretched without inclining the head or trunk, return to an upright position with minimal effort when pushing and rotate the upper trunk to receive a pass from behind. They are also able to lean forward when shooting to propel the ball towards the basket, and thus have a similar functional ability (Perriman, 2014). As a result, the ability to have some form of partial control in the forward and vertical planes could be argued to make them superior players to those with a 1.0 classification (Gil-Agudo, Del Ama-Espinosa and Crespo-Ruiz, 2010). However, both these classification groups have limited sideways plane movement and are unable to incline to one side, unlike 4.0 or 4.5 players. Although, Gómez *et al.* (2014, 2015) identified that similar performances are observed for players between adjacent classes, in particular around the mid-class players. Molik *et al.* (2009) were also unable to identify any significant differences between class 2 and class 3 players, thus supporting the argument.

Furthermore, playing with a greater number of Offensive 3.0-3.5 players than Offensive 4.0-4.5 players could be due to the 3.0 players being able to sit 5cm higher in the chair in comparison to 3.5, 4.0 and 4.5 players and thus having a superior height advantage when being defended in the act of shooting or rebounding (International Wheelchair Basketball Federation, 2014b). Santos *et al.* (2014) highlighted the importance of trunk stability and movement when completing faster movement directions in the frontal plane when rebounding. Thus, having a superior seating position could assist in compensating for any potential instability in the trunk. Recently, the superior seating position has also been found to negatively impact their turning ability (van der Slikke *et al.*, 2016). Although, increasing the number of 3.0-3.5 players in both offence and defensive line-ups within this chapter reduced the likelihood of losing, as the limited shooting expertise and ball handling skills of 1.0-1.5 classification are replaced by higher classified players.

In addition, the ability of higher classification players (class 2.0, 2.5, 3.0 and 3.5 players) to propel the chair has been found to be superior in both straight-line speed and weaving than low-class players (class 1.0 and 1.5) (Crespo-Ruiz, Del Ama-Espinosa and Gil-Agudo, 2011), therefore supporting the notion that class 1.0 and 1.5 players could be redundant in the game; further identifying that the IWBF classification system may not be fit for purpose (Gómez *et al.*, 2014). The odds ratios produced for different line-ups can be used to highlight the benefits of a team comprising of more 3.0-3.5 players than 4.0-4.5 players and using these players in the on-court five in relation to game outcome. These findings provide useful information for coaches to carefully consider the line-up configurations of players acknowledging the strengths and limitations of certain classifications in order to identify an optimum line-up. Of course, this information also adds further debate around the classification system in wheelchair basketball and the potential need to be supported by scientific analyses. Consideration, therefore, needs to be taken regarding the individual's technical player characteristics as well as anthropometric data that could impact their mobility and subsequently could challenge some of the findings and interpretations around classification and line-up configurations.

The model also illustrated the chances of winning a game during the knock-out stages of the 2015 European Wheelchair Basketball Championships were more testing than winning a "Pool" stage game. O'Donoghue *et al.* (2016) found as teams advanced through a competition the points difference between the two teams decreased along with the probability of winning. Gómez *et al.* (2015) also observed this trend in wheelchair basketball because the quality of opposition increased during each stage of the tournament. The researchers found that players in teams that finished in the top four teams achieved higher shooting efficiencies and CBGS scores than other players in lower ranked teams. Although, in the present study only games that involved a team that finished in the top five were included in the analyses. If all 46 games were included, there could be greater insight into the determinants of success within European wheelchair basketball. However, previous research has shown including lower ranked teams in a data set exploring the determinants of success may distort the results and it is useful to remove these teams when playing against another lower ranked team (Rampinini *et al.*, 2009; Lago-Peñas and Lago-Ballesteros, 2010; García-Rubio *et al.*, 2015). Thus, teams that did not progress during the knock-out stages of the tournament were removed due to previous studies identifying significant differences between those that progress and those that do not advance (Gómez, Ortega and Jones, 2016).

In addition, the 10-day wheelchair basketball tournament may have affected the probability of winning due to players becoming fatigued and thus leading to a reduction in skill execution. Montgomery *et al.* (2008) found this occurred during a three-day basketball tournament, reporting small to moderate impairments in players' performance due to physical fatigue. Lertwanich (2009) also found 1.0 players were susceptible to becoming physically fatigued at a quicker rate than amputees due to the impairement of sweating and vasomotor control. These findings, therefore, reiterate the importance of line-up combinations and minimising the use of 1.0 players in an attempt to maintain consistent performances, especially in the later stages of a tournament. However, without recording the cardiovascular and locomotion demands of these players during the tournament it is unknown whether fatigue affected the odds ratios achieved. Thus, future international tournaments should incorporate cardiovascular and locomotion demands in addition to the SPA to collate a broader picture of performance, subject to the agreement of the IWBF. However, the results of this study have clearly indicated that Stage, and thus the quality of opposition, affect Game Outcome.

The ability to score more points, and thus win a game, was also found to be affected by the defensive system operated by the opposition in this research. The tighter and more structured the defensive system the offensive team were trying to break down, the harder it was to score and thus the chances of winning the game decreased. Research surrounding DST confirmed this interpretation of the results in this chapter. Gómez, Tsamourtzis and Lorenzo (2006) found within Spanish basketball Playoffs' series, the losing team found it difficult to break down a Zone defensive system and convert possession into points. By operating a zonal defensive system the attacker-defender dyads are closer and thus the available space is less. Therefore, restricting the ability of the attackers to create an open shot, which has been found to increase the shooting efficiencies of players (Zhang *et al*., 2017). In addition, Gómez, Tsamourtzis and Lorenzo (2006) found the winning teams were able to breakdown pressing systems but took a longer duration to attempt a shot. With operating a pressing system, the attacker-defender dyads are further away and by changing pace and direction players are able to progress towards the basket in a less pressurised situation (McGarry *et al.*, 2002; Bourbousson, Sève and McGarry, 2010). However, due to the nature of team sport, it is difficult to control and devise how humans attempt to exploit space to beat defenders. Recent technology advancements in terms of radio-frequency-based indoor (Rhodes *et al.*, 2015), Bluetooth-based systems (Figueira *et al.*, 2018) or artificial intelligence (Kristan *et al.*, 2009) could allow for more objective data in relation to defensive systems and attacker-defender dyads to be collected that could inform future practice. Despite these ideas for future exploration, what the results from this analyses indicate is that the defensive system, space and pressure are important factors for coaches to consider in training and when devising game strategies to prevent opponents from scoring and capitalising on disorganised defensive systems to outscore opponents.

The chi-squared tests and binary logistic regression model illustrated Game Status was the most significant CPV in relation to Game Outcome. The results demonstrated if a team are in a state of winning when the possession started the probability of winning the game increases. Simiarly, Gómez, Gasperi and Lupo (2016) identified that the starting quarter score in the fourth quarter was significantly related to final points differential in the NBA. The researchers found that teams who were ahead during the first possession of the fourth quarter were almost twice as likely to win the game (OR: 1.75). Although this point could seem obvious in relation to Game Outcome, the odds of winning the game utilising the wheelchair basketball data were double if the team started a possession in a state of "Winning". Therefore, suggesting that the game winner can be predicted in wheelchair basketball earlier in the game in comparison to basketball. This could be as a result of the NBA being a much closer contest competition with longer breaks in between games (Horowitz, 2018), allowing for mental and physical recovery, than wheelchair basketball tournaments. Thus, according to Gómez, Gasperi and Lupo (2016), teams in the NBA attempt to solve the issue of beginning the fourth quarter ahead on the scoreboard and maintain a lead throughout this period of the game by making better shot selections during these the ball possessions. However, it can be argued that elite wheelchair basketball players will always be making the best shot selection in a given scenario.

The increasing odds of winning the game, both in basketball and in wheelchair basketball highlight the importance of shooting effectiveness, however, no shooting related CPVs were presented in the final model. Despite this, Shot Location was included in the model developed using the automated forward selection approach and thus indicates it is potentially an important CPV. The ability of a team to establish a lead and maintain the lead has been explored in a number of team sports in relation to the concept of momentum (see Hughes *et al.*, 2015). To establish a lead in wheelchair basketball, a player must make a successful shot attempt and prevent the opposition from making a successful shot. The findings of this chapter agree with the work of Gómez, Gasperi and Lupo (2016), whereby the importance of capitalising on each ball possession and ensuring individual players are able to convert under pressure shooting opportunities into points affects the final outcome. Thus, the findings presented in this chapter regarding Game Status, classification, Defensive System and Stage highlight the importance of direct practical applications when designing training tasks and game strategies to assist the players' learning and decision-making skills.

4.7 Key applied messages

As a result of the findings within this chapter, wheelchair basketball, coaches, players and support staff should consider three key messages regarding components of team performance:

1. The data demonstrated that playing with a greater number of Offensive Unit – 3.0-3.5 players on the court than "Zero or One" Offensive Unit – 4.0-4.5 players, regardless of the number of Defensive Unit – 3.0-3.5 players on-court, would increase the chances of winning. In addition, coaches should refrain from playing "Three" Offensive Unit – 4.0-4.5 as the likelihood of winning decreases. In some cases, coaches could be restricted by the number of available players in each classification group and the IWBF total team classification points. Therefore, coaches need to consider player selection in particular offensive and defensive advantages and disadvantages of their own players, in addition to those of the opposition when selecting starting units and making in-game rotations. Furthermore, coaches should consider how they utilise their players in each stage of the tournament, in relation to physical demands and rest periods, with the knowledge that as the team progresses through the tournament the strength of the opposition increases.

2. The team should attempt to limit the use of the "Highline" or pressing defensive system as the data have shown that the offensive team are more likely to win the game when they face a team who operate this particular defensive system. Operating these two defensive systems creates greater

distances between attacker-defender dyads and players are less likely to prevent an opponent from scoring. The data found that a “Zone” Defensive System is associated with most effectively limiting the shooting ability of opponents. Drawing on these data, plans should be devised that exploit the opposition when they adopt a “Highline” defensive system as well as how to effectively shoot under greater pressure. Hence making sure wheelchair basketball teams are restricting the use of a “Highline” Defensive System and exploiting the opposition when they run this system due to a significant relationship being identified in regards to achieving a “Winning” game outcome.

3. If the team are in a state of “Winning” when they start a possession their chances of winning the game double in comparison to starting a possession when equal on the scoreboard. Hence making sure a team are in a status of “Winning” when starting a possession appeared to be the most important issue to achieve a winning game outcome. Therefore, coaches should attempt to improve an individual’s shooting effectiveness during training sessions to assist them early on in a game and maintain the lead throughout.

4.8 Conclusion

The chapter has identified the key determinants of team success in elite men’s wheelchair basketball that contributed to a game-winning performance by using chi-squared tests and developing a binary logistic regression model. The model indicated that the ability to have the optimal line-ups on the court who can score and prevent an opponent from scoring by creating defensive pressure is a key component in predicting winning odds in elite men’s wheelchair basketball. In addition, consideration is required regarding the defensive system operated by wheelchair basketball teams as reducing the space between the attacker-defender dyads and the basketball was associated with lower shooting efficiencies. However, the most significant and important finding from the model is regarding game status and maintaining a winning margin on the scoreboard.

The application of these findings emphasises the importance of key tactical and technical abilities of the players regarding the on-court decision making processes in the act of shooting.

This chapter has presented some limitations and delimitations related to the key determinants of team success in elite wheelchair basketball. From the outset of this thesis, a focus was undertaken on male European wheelchair basketball teams and there are opportunities to now explore the key determinants of success within female wheelchair basketball using the SPA template developed in Chapter Three. Previous wheelchair basketball research has identified individual performance differences between male and female players (Gómez *et al*., 2014), thus highlighting a need for future research into the female game. The analyses have also focused on the 2015 European Wheelchair Basketball Championships and thus different nations' playing styles during different international competitions require exploration. The advancements in technology can be incorporated in further analysis to provide further objective insights into the holistic performances of teams. Despite shooting being highlighted of importance, shooting CPVs were not included within the final model and the current existing knowledge around shooting in wheelchair basketball is limited to free-throw shot attempts. Therefore, further research is required to explore the key determinants of field goal shooting in wheelchair basketball taking into consideration the attacker-defender dyads. Despite the limitations, delimitations and recommendations for future research, this chapter is the first team wheelchair basketball study to have identified the key variables associated with team success and explored the impact of each key action variable upon the outcome of a performance through the use of binary logistic regression modelling. These findings could now be used to assist coaches, players and support staff with planning training and game strategies within elite male wheelchair basketball as well as beginning further in-depth analyses regarding the key tactical and technical demands of specific wheelchair basketball skills.

Chapter 5 Modelling field-goal shooting success

5.1 Overview

The binary logistic regression model developed in Chapter Four found the odds of winning a wheelchair basketball game increased when a team started a possession in a state of winning in comparison to drawing or losing. As a result, being successful from shot attempts is even more important, especially early on in the game. Despite this finding, to date previous peer-reviewed research has only explored the key determinants of free-throw shooting in wheelchair basketball (e.g. Schwark, Mackenzie and Sprigings, 2004). Therefore, this chapter aims to identify the key determinants of field-goal shooting success in wheelchair basketball. The chapter critically examines previous shooting studies in basketball and wheelchair basketball, due to the limited existing research regarding the topic, to establish an initial understanding of the determinants of success. The same wheelchair basketball staff members, who were used in Chapter Three, were recruited to develop a valid and reliable SPA template for analysing field-goal shooting performance in elite men's wheelchair basketball. At the request of the BWB coaching staff, the shooting-specific SPA template was used to analyse the shooting performance of the top five teams when playing another top-five team at the 2015 European Wheelchair Basketball Championships. Action variables and CPVs, which are associated with shooting success, were then used to develop a binary logistic regression model that quantifies the impact of each action variable as a predictor of the probability of shooting success. The impact of the model's findings on practice is critically discussed and areas of further exploration are outlined.

5.2 Introduction

Shooting has been highlighted as one of the fundamental technical skills required by elite wheelchair basketball players (Zwakhoven *et al.*, 2003; Zacharakis *et al.*, 2012). Previous shooting research in wheelchair basketball has focused solely on free-throw shooting exploring the optimal release conditions regarding the ball release height, projection angle, speed of release (Malone, Gervais and

Steadward, 1999, 2002) as well as identifying the optimal shoulder and trunk inclination angle (Goosey-Tolfrey, Butterworth and Morriss, 2002) and the orientation angle of the hand to ball segment and forearm to upper arm (Schwark, Mackenzie and Sprigings, 2004). The four previous peer-reviewed studies identified similarities within the ball release angle (53.8°-59°), the height of release (1.57-1.84m) and the speed of release (7.0-7.6 m/s) regardless of the ability level of the participants being tested, but fluctuations in metrics were dependent on player classification.

Despite the importance of free-throw shooting separating stronger teams from weaker teams in wheelchair basketball (Gómez, Molik*, et al*., 2015), previous research in wheelchair basketball has not explored the key technical and/or tactical components of effective field-goal shooting. Field-goal shot attempts equate to the largest number of shot attempts during a wheelchair basketball game. Gómez *et al.* (2014) identified an average of 56.95 field-goal attempts were taken per game in comparison to 16.01 free-throw attempts during men's wheelchair basketball games at the 2008 Beijing Paralympics and the 2010 World Championships. However, during the 2015 European Wheelchair Basketball Championships, games involving the top five teams averaged a lower number of free-throw attempts per game (12.12) but a higher number of field-goal attempts per game (64.19). Whilst at the 2016 Rio de Janeiro Paralympic Games, teams averaged 12.11 free-throw attempts and 61.17 field-goal attempts per game. The figures suggest over the eight-year period (2008-2016), a decline in the number of free throw attempts per game and an increase in the number of field goal attempts per game has been observed.

In contrast to wheelchair basketball, within the last five years, there have been attempts to identify the key components of effective field-goal shooting in able-bodied basketball to increase the effectiveness of each shot attempt. Skinner (2012), for example, developed four predictive models to examine the effects of the shooter's sequence, shot clock time remaining, shooter's sequence from a turnover and the shooting rates of optimal shooters on the quality of the shot taken in the NBA. However, each model contained only a single predictor and the parameter estimates from these singular predictive models were then collated to provide an overall expected points per possession score. Furthermore, through conducting this technique the interactive effects of the action variables within the four separate models are not known. In addition, the influence of the defence on the quality of the shot outcome was not considered, however, this effect will be explored within this chapter.

Gorman and Maloney (2016), in contrast, examined the change in a shooter's execution when a defender was added to a shot attempt. Through analysing four field-goal shot types, the study found the presence of a defender resulted in a decreased shooting accuracy of 20 per cent as well as a faster shot action, a longer period of time spent in the air and a longer flight time of the ball. Despite this, the study's findings cannot be applied to elite basketball players due to (i) the use of 12 junior national programme male basketball players, (ii) the data was collected in a training scenario, (iii) the total number of shot attempts was not defined and, (iv), during a defended shot only a one versus one situation was explored. The interactive effects of each action variable within Skinner's (2012) and Gorman and Maloney's (2016) work were not explored, therefore, the dynamic interactions which occur in basketball were not examined and the information does not explain how a player can achieve a higher probability of achieving shooting success.

More recently, Gómez, Alarcón and Ortega (2015) used binary logistic regression modelling to highlight that the execution of shooting in basketball is influenced by a number of environmentally related action variables. The authors grouped offensive and defensive action variables into six categories and recorded the sequential nature for each shot attempt, to explore the factors that contribute to shooting effectiveness. The study identified during balanced games (differences between 0 to 9 points) the shooting distance and the shooting zone were found to be significant action variables. However, in unbalanced games (differences above 10 points), the number of passes and the duration of a possession were found to be significant action variables. Despite these findings, the binary logistic regression model cannot be used in practice. The ORs for significant action variables are only presented and thus the ORs for non-significant action variables within a CPV are not presented. As a result, the odds and probability of achieving a successful shot attempt cannot be calculated since the model needs to be re-fitted with only the significant predictors included. In addition, the accuracy of the data used to develop the model is unknown and the predictability of the final model was not reported. Despite these limitations, the research suggested the effectiveness of shooting is dependent on time, space and task-related action variables, which were shown to be important components in the Skinner (2012) and Gorman and Maloney (2016) study and important aspects for coaches to consider when developing players' shooting effectiveness.

These research findings could be applicable to shooting in wheelchair basketball because the fundamental principles of basketball and wheelchair basketball are the same (Oudejans *et al*., 2012). The improvements seen in NBA players' shooting over the past seasons were identified in the works of Goldsberry (2012), Chang *et al.* (2014) and Shortridge, Goldsberry and Adams (2014), and were illustrated in the end of season statistical reports (National Basketball Association, 2017a, 2017b). These improvements could also have the same beneficial effects for wheelchair basketball players if equivalent research is conducted. Therefore, this chapter aims to (i) develop a field-goal shooting specific SPA template, (ii) identify the key action variables associated with shooting success and (iii) explore the impact of each key action variable upon the outcome of a shot by acknowledging the context through the use of binary logistic regression modelling.

5.3 Method

This section is divided into two parts, firstly, the series of steps undertaken to establish a valid and reliable SPA template for analysing field-goal shooting is outlined, and secondly, the processes undertaken for collecting and modelling reliable shooting performance data are presented.

5.3.1 Establishing a SPA template for analysing field-goal shooting

The nine-stage process used in Chapter Three to develop a valid and reliable SPA template for analysing team performance was followed to create a field-goal shooting specific SPA template. A list of 72 action variables within 22 categories (See Appendix 6), created from previous literature and personal knowledge, was provided to the same wheelchair basketball coaches who completed the identification work in Chapter Three. The list was scrutinised and debated during a single focus group. The Number of Passes category was subsequently removed due to the coaches being interested in the actions during the shot and in agreement with the binary logistic model developed by Gómez, Alarcón and Ortega (2015) regarding shooting effectiveness in able-bodied basketball, reducing the number of categories to 21. The coaches were also sceptical of the action variables within the Defensive Pressure category considered in Gómez, Alarcón and Ortega's (2015) study, due to the subjective nature of the variables. However, this CPV was maintained but the number of action variables within the CPV was objectified. In addition, the Defensive System variable was replaced by the action variables in the Number of Defenders category, because during an act of shooting, defensive players are typically out of position as they are scrambling to defend the shot (Csataljay *et al.*, 2013). Operational definitions for the 69 remaining action variables in the 21 categories were developed and presented to the coaches and member of support staff during a second focus group. The BWB staff enhanced the operational definitions of the action variables in the Shot Positioning, Shot Movement and Defensive Pressure categories. Following the agreement of the action variables and operational definitions, video clips of each action variable were created to establish content validity. The three coaches and the member of the support staff agreed with the final list of 69 action variables and operational definitions in the 21 categories (See Appendix 7).

Following the confirmation of the 21 categories and the 69 action variables and operational definitions, a shooting-specific SPA template was developed in SportsCode Version 10 (See Figure 5-1). The lessons learnt when developing the team SPA template in Chapter Three were considered, therefore the spacing between action variable buttons within the same CPV was increased. The developed shooting-specific SPA template was then subjected to an intra-observer reliability test. A total of 53 field-goal shots from one team's performance at the 2015 European Wheelchair Basketball Championships were observed on two separate occasions, four weeks apart. The 21 categories reported percentage error values of below five per cent error and were either in perfect ($k = 1.000$) or almost perfect agreement ($k = 0.907$-0.967) between the first (Ob1) and second observation (Ob2) (see Appendix 8).

The categories that reported a low level of error or almost perfect agreement were explored to identify the source of the discrepancy. Where a discrepancy was identified, the specific video clip was re-observed to create a final agreed observation (Ob3). The same wheelchair basketball coach (Ob4) and the same performance analyst intern (Ob5) that completed the inter-observer reliability test in Chapter Three, were used to conduct an inter-observer reliability test. The Ob3 was then used to compare against Ob4 and Ob5. Prior to completing the inter-observer tests, the coach and performance analyst intern were allowed to familiarise themselves with the SPA template. The individuals used a trial shooting sample from a men's warm-up game that consisted of 100 field-goal attempts. The inter-observer reliability tests were not completed until both observers felt they were able to accurately record the shot attempts. Comparing Ob3 against Ob4 and Ob3 against Ob5 reported acceptable percentage error values (less than five per cent) and perfect or almost perfect Weighted Kappa agreement coefficients ($k < 0.800$) for the 21 categories. The same agreement levels (less than five per cent error and perfect or almost perfect agreement coefficients) were also observed when three observations were triangulated (Ob3 against Ob4 against Ob5) (see Appendix 8). The intra-observer and inter-observer reliability results highlight the observers were able to accurately record the specific action variables that occurred during each shot attempt when using the shooting specific SPA template (See Figure 5-1).

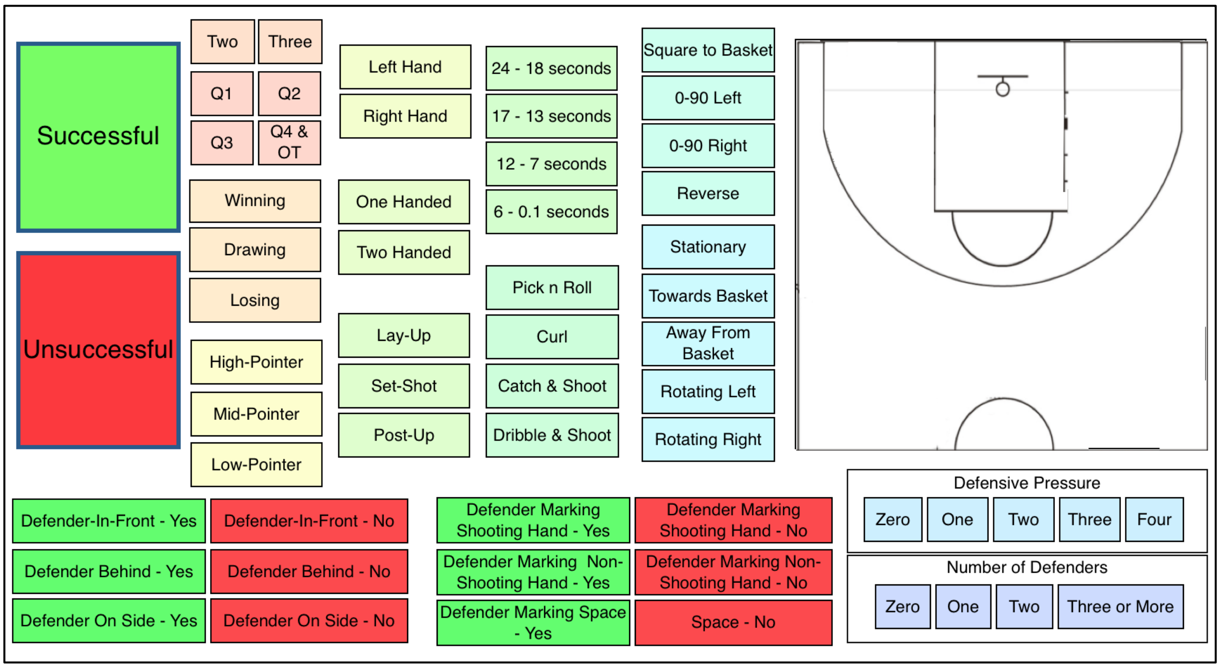


Figure 5-1: Shooting SPA template for coding wheelchair basketball performance.

5.3.2 Collecting and modelling valid and reliable shooting performance data

Following the development of the valid and reliable shooting specific SPA template (See Figure 5-1), the template was used to analyse shot attempts from the 2015 European Wheelchair Basketball Championships. A total of 1,144 shot attempts from nine games, which included when a top-five team played another top-five team, were analysed (See Table 5-1). The nine games were selected at the request of BWB coaches, with the intention of providing an objective insight into the key characteristics of future opponents. The shot attempts were analysed over a two-week period at the beginning of 2016. On any given day, a maximum of 125 shot attempts was analysed, whilst taking regular five-minute breaks, in an attempt to reduce potential errors (Liu, Jaramillo and Vincenzi, 2015). Periodic assessment checks were conducted in an attempt to limit the overall loss of accuracy (Kazdin, 1977). Following the analysis of every 100 shots, 10 randomly selected shots were re-observed to identify any discrepancies. No adjustments to the analysed data were completed

Table 5-1: Number of field-goal attempts taken in each of the games subjected to SPA procedures.

Stage	Team 1	Team 1 Shot Attempts	Team 2	Team 2 Shot Attempts
Pool Stage	Germany	60	Great Britain	71
Pool Stage	Great Britain	68	Spain	65
Pool Stage	Germany	66	Spain	70
Pool Stage	Netherlands	64	Turkey	60
Quarter-Final	Turkey	62	Spain	60
Semi-Final	Turkey	53	Netherlands	63
Semi-Final	Germany	66	Great Britain	66
Medal Game	Germany	69	Netherlands	51
Medal Game	Great Britain	68	Turkey	62

Upon completion of the data collection in SportsCode, the shot attempt data were exported into Microsoft Excel using the ‘Sorter’ function in SportsCode. The 1,144 rows of data, with each row equating to a single shot attempt, consisted of 22 columns (see Appendix 10), which included the 21 categories and a column entitled Shot Number. The dataset was subjected to data checking procedures to identify any discrepancies within the data. If any missing or duplicated data were identified, the specific shot attempt was identified, through the Shot Number, and either re-analysed or removed. During the checking procedures, no data were removed and only one shot attempt was re-analysed because there were no action variables recorded in the Shot Movement category.

Following checking and sorting of the data set, the Shot Number column was removed, leaving a data set comprising of 21 categories. The Shot Outcome column became the dependent variable with each of the remaining 20 columns now being referred to as a CPV. Note that the action variables within each CPV continued to be referred to as action variables. The dataset was subjected to the same five stage data modelling process (The University of Sydney, 2010) using R (R Core Team 2015) that was undertaken in Chapter Four. The five-stage modelling approach was used with a training sample of 70 per cent of the data to i) explore potential associations of the CPVs with the shot outcome (successful or unsuccessful), ii) identify the statistical significance association of each CPV and the shot outcome, iii) determine the correlation between each pair of CPVs, iv) build predictive models through a manual forward selection approach then automated forward selection, backwards elimination and stepwise approaches, and v) explore the fit of the final model and test its ability to predict out of sample shooting performance using the remaining 30% testing sample.

5.3.3 Exploratory data analysis

The frequency counts of each CPV were explored as an initial stage (See Appendix 9), to ensure all action variables within a CPV had a minimum frequency count of 10 (Crawley, 2007; Field, Miles and Field, 2012). The CPV with the lowest frequency count being observed was in the Pre-Shot CPV. The Curl action was recorded 16 times during the nine games and as the result is above 10. This should not adversely affect the potential estimation error in the results. No CPVs were removed at this stage of the model building process.

5.3.4 Univariable analyses

The entire dataset (1,144 shots) that included 20 CPVs were subjected to chi-squared tests, to assess their association with Shot Outcome (which will be the dependent variable in the resulting model). The chi-squared tests identified a statistically significant association ($p < 0.05$) for 11 of the 20 CPVs (See Table 5-2). Shot Positioning demonstrated the greatest degree of association with the lowest p-value ($p < 0.001$) and the largest chi-squared value (χ^2=157.62). The CPVs which were statistically significant ($p < 0.05$) were shortlisted for assessments of multicollinearity with each other.

Table 5-2: Chi-square tests for each individual CPV.

CVP	χ^2	df	p-value
Classification	2.43	2	0.296*
Defender Behind	3.09	1	0.079*[a]
Defender In Front	52.40	1	< 0.001
Defender Marking Non-Shooting Hand	3.50	1	0.061*
Defender Marking Shooting Hand	71.73	1	< 0.001
Defender Marking Space	35.64	1	< 0.001
Defender On Side	3.36	1	0.067*[a]
Defensive Pressure	35.33	4	< 0.001
Game Status	4.48	2	0.107*
Number of Defenders	30.87	3	< 0.001
Number of Hands on the Ball	9.49	1	0.002
Pre-Shot	4.07	3	0.254*
Quarter	2.72	3	0.436*
Shot Clock Remaining	5.27	3	0.153*
Shot Hand	0.35	1	0.552*
Shot Location	41.184	9	< 0.001
Shot Movement	38.27	4	< 0.001
Shot Point	15.52	1	< 0.001
Shot Positioning	157.62	3	< 0.001
Shot Type	9.52	2	0.009

*: Denotes a CPV that was non-significant ($p < 0.05$); [a]Borderline statistical significant CPV.

5.3.5 Assessments of multicollinearity

The Number of Defenders CPV demonstrated perfect collinearity, equal to 1.0, against the Defensive Pressure CPV. The Number of Defenders CPV was removed in favour of maintaining the Defensive Pressure CPV due to the larger chi-squared value associated with this later CPV. However, the final model was refitted, swapping the two CPVs, to identify if this made any difference to the final fit of the model. No differences were identified and thus the Defensive Pressure CPV remained in the final model. The remaining 10 CPVs were measured for potential multicollinearity before being considered for use in model building. Using, the *vif* function in the 'car' package revealed that the 10 CPVs were below the VIF value threshold of 10 (Myers, 1990) and therefore the 10 CPVs were included for multivariable analyses (See Table 5-3).

Table 5-3: VIF for the 10 CPV that remained for consideration in the model.

CPV	VIF	df
Defender In Front	1.42	1
Defender Marking Shooting Hand	1.67	1
Defender Marking Space	1.36	1
Defensive Pressure	1.17	4
Number of Hands on the Ball	1.09	1
Shot Location	1.14	9
Shot Movement	1.14	4
Shot Point	2.33	1
Shot Positioning	1.08	3
Shot Type	1.40	2

5.3.6 Model development

The entire dataset was randomly split using the ‘createDataPartition’ function in the ‘caret’ package in R into a 70 per cent data training sample (801 shots) and a 30 per cent data testing sample (343 shots). The split was calculated utilising the percentage of observation equation (Deppa, 2015) as used in section 4.4.5 with $\sqrt{\max k} = 3.1623$ and $p\% = 31.623\%$.. The ten CPVs for the training dataset were then subjected to a manual forward selection process, making use of the residual deviances to build the model (See Table 5-4). The CPV with the lowest residual deviance as a single predictor in the model was Shot Positioning, which therefore entered the model first and was retained. With the Shot Positioning CPV being retained, the CPV which then reduced the residual deviance the most, Defender Marking Shooting Hand, was retained as the second CPV in the model. The process of adding and retaining additional CPVs that reduced the residual deviance the most continued in this way. If through adding a CPV to the model, the residual deviance decreased by less than one then the CPV was not added to the model and the process of manual forward selection ceased. In addition, the change in the deviance from one model to the next was compared with the value from a chi-squared distribution. Shot Point was not added to the model because the residual deviance only decreased by 0.41 when that CPV was included in the model at Stage Ten. During the other stages, the reduction in residual deviance was either greater than the chi-squared value or borderline. Therefore, the model building process stopped at Stage Nine and incorporated nine CPVs in the model. The AIC value for the manual forward selection model was calculated to explore the quality of the model relative to those developed later using the automated selection procedures. The AIC value for this manually developed model had a residual deviance of 855.83 and included 27 parameters. Therefore, the AIC value for the manual forward selection model was 855.83 + 2 x 27 = 909.83, and will be used for later comparisions during the model building processes.

Table 5-4: Residual deviance values for the manual forward selection process.

Number of CPVs in Model	Shot Positioning	Defender Marking Shooting Hand	Shot Location	Shot Movement	Defensive Pressure	Defender Marking Space	Defender In Front	Shot Type	Number of Hands on the ball	Shot Point
One	978.35*	1044.8	1066.8	1076.9	1069	1067.1	1054.7	1089.6	1086	1083.8
Two (including Shot Positioning)		942.83**	954.19	958.74	961.41	956.84	951.48	975.89	968.86	967.87
Three (including Shot Positioning + Defender Marking Shooting Hand)			910.63	923.82	941.7	934.82	934.89	932.05	934.34	928.26
Four (including Shot Positioning + Shooting Hand + Shot Location)				897.92	906.85	903.16	907.26	905.94	907.6	910.43
Five (including Shot Positioning + Defender Marking Shooting Hand + Shot Location + Shot Movement)					892.04	892.24	892.39	895.78	894.02	897.66
Six (including Shot Positioning + Defender Marking Shooting Hand + Shot Location + Shot Movement + Defensive Pressure)						879.17	886.37	888.79	887.56	891.88
Seven (including Shot Positioning + Defender Marking Shooting Hand + Shot Location + Shot Movement + Defensive Pressure + Defender Marking Space)							868.91	874.53	872.69	877.82
Eight (including Shot Positioning + Defender Marking Shooting Hand + Shot Location + Shot Movement + Defensive Pressure + Defender Marking Space + Defender In Front)								862.51	863.83	868.62
Nine (including Shot Positioning + Defender Marking Shooting Hand + Shot Location + Shot Movement + Defensive Pressure + Defender Marking Space + Defender In Front + Shot Type)									855.83	862.13
Ten (including Shot Positioning + Defender Marking Shooting Hand + Shot Location + Shot Movement + Defensive Pressure + Defender Marking Space + Defender In Front + Shot Type + Number of Hands on the Ball)										855.42***

* Shot Positioning enters the model first with the lowest residual deviance
** Defender Marking Shooting Hand enters next as the CPV that with Shot Positioning produces the lowest residual deviance
*** Including Shot Point at Step Ten would reduce the residual deviance by 0.41 from 855.83 to 855.42 and so was not added to the model and the process ends.

The manually developed model was then compared to models developed through an automated approach (See Table 5-5). The automated forward selection approach gave exactly the same model as above. The automated backwards elimination model and the automated stepwise model both eliminated the Defender Marking Shooting Hand CPV (as well as Shot Point) and resulted in a lower (better) AIC estimate of 907.85. The final binary logistic regression shooting model was chosen using the model with the eight CPVs obtained using the backwards approach and also the stepwise approach, as this produced the lowest AIC estimate.

During the model building process, a similar model building process was also conducted utilising the 10 candidate CPVs above, as well as the three CPVs which were reported as being borderline statistically significant in Table 5-2 (Defender Behind, Defender Marking Non-Shooting Hand and Defender On Side). The final model, which was developed was slightly different but showed the same goodness of fit. However, the action variables within the Shot Location CPV produced higher standard error values. The model, which included the three borderline CPVs, was therefore not used as the final binary logistic regression model, in favour of the one reported above.

Table 5-5: Summary of the AIC values using the four modelling approaches.

	Manual Forward Selection	Automated Forward Selection	Automated Backwards Elimination	Automated Stepwise
CPV within the model	Defender In Front Defender Marking Shooting Hand Defender Marking Space Defensive Pressure Number of Hands on the Ball Shot Location Shot Movement Shot Positioning Shot Type	Defender In Front Defender Marking Shooting Hand Defender Marking Space Defensive Pressure Number of Hands on the Ball Shot Location Shot Movement Shot Positioning Shot Type	Defender In Front Defender Marking Space Defensive Pressure Number of Hands on the Ball Shot Location Shot Movement Shot Positioning Shot Type	Defender In Front Defender Marking Space Defensive Pressure Number of Hands on the Ball Shot Location Shot Movement Shot Positioning Shot Type
AIC	909.83	909.83	907.85	907.85

To explore each action variable's individual contribution to the final shooting model, Equation 2 (reproduced from Chapter Four) was used to replicate the same approach as described previously in Chapter Four.

$$Loge\left[\frac{P(y_i = 1)}{P(y_i = 0)}\right] = \alpha + X_i\beta.$$

Equation 2: Logarithm of the odds of winning (reproduced from Chapter Four).

The estimated intercept regression coefficient of 0.725, presented in Table 5-6, reflects the log-odds of achieving a successful shot where the attempt includes the "reference" action variables:

- Shot Positioning – Square to Basket
- Shot Location – 2 Point – Centre – Long
- Defender Marking Space – No
- Defender In Front – No
- Shot Movement – Stationary
- Defensive Pressure – Zero
- Number of Hands on the Ball – One
- Shot Type – Set-Shot.

The estimated intercept regression coefficient was used to calculate the OR value, which is 2.064 {=exp(0.725)}, and the value can help predict the probability of a shot attempt being successful = odds/(1+odds) = 2.064/3.064 = 0.6736 or a 67.36 per cent chance of success for the reference action variables listed above.

The ORs for the remaining CPVs are also presented in Table 5-6. This enabled the effect of a change from the "reference" action variables on the odds of a successful shot attempt to be calculated. For example, should the player's movement in the process of taking the shot have been Rotating Left instead of Stationary, then the odds of achieving a successful shot would be multiplied by 2.013, and therefore the likelihood of success would have increased. In contrast, should the shot attempt have been taken when the player was "Moving

Away From Basket” instead of “Stationary”, then the odds of achieving success would be multiplied by 0.516 and the likelihood of success would be reduced. However, it is important to note that the p-value of 0.078 associated with “Rotating Left” suggested that this is not statistically significant and so the difference between this action and being “Stationary” could simply be due to chance (although this is a borderline case since p is close to 0.05). In contrast, “Moving Away From Basket” has a p-value of 0.036 and is statistically significant, suggesting that “Moving Away From Basket” would reduce the likelihood of achieving shooting success.

Table 5-6: Final model illustrating the estimated regression coefficients, standard errors, P-Values and ORs for the intercept variable and for each action variable within the CPVs.

		Estimate	Std. Error	p-value	OR
(Intercept)		0.725	0.600	0.227	2.064
Shot Positioning	Square to Basket	Included in intercept			
	10-90 Left	-1.893	0.224	< 0.001	0.151
	10-90 Right	-1.785	0.350	< 0.001	0.168
	Reverse	-1.840	0.683	0.007	0.159
Shot Location	2 Point - Centre - Long	Included in intercept			
	2 Point - Centre - Mid	1.147	0.515	0.026	3.149
	2 Point - Centre - Near	1.640	0.506	0.001	5.154
	2 Point - Left - 45	1.355	0.553	0.014	3.878
	2 Point - Left - Base	0.961	0.718	0.181	2.614
	2 Point - Left - Elbow	0.898	0.644	0.163	2.454
	2 Point - Right - 45	1.151	0.536	0.032	3.162
	2 Point - Right - Base	1.070	0.708	0.131	2.917
	2 Point - Right - Elbow	1.656	0.613	0.007	5.239
	3 Point	0.550	0.525	0.295	1.733
Defender Marking Space	No	Included in intercept			
	Yes	1.251	0.216	< 0.001	3.495
Defender In Front	No	Included in intercept			
	Yes	-0.846	0.238	< 0.001	0.429
Shot Movement	Stationary	Included in intercept			
	Towards Basket	-0.264	0.250	0.291	0.768
	Away From Basket	-0.661	0.316	0.036	0.516
	Rotating Left	0.699	0.396	0.078	2.013
	Rotating Right	-0.096	0.594	0.872	0.909
Defensive Pressure	Zero	Included in intercept			
	One	-0.403	0.284	0.156	0.668
	Two	-1.052	0.352	0.003	0.349
	Three	-1.202	0.402	0.003	0.301
	Four	-1.969	0.770	0.011	0.140
Number of Hands on the Ball	One Hand	Included in intercept			
	Two Hands	-0.763	0.295	0.010	0.466
Shot Type	Set-shot	Included in intercept			
	Lay-Up	-0.637	0.312	0.041	0.529
	Post-Up	0.265	0.259	0.305	1.304

5.3.7 Model diagnostics

The same diagnostic tools were used to evaluate the model's ability to predict shooting performance that was used previously in Chapter Four. The pseudo r-squared values presented in Table 5-7 showed that the model explained a good amount of the variation in shooting outcome. This assertion can be made because the McFadden r-squared value fell within the 0.2-0.4 threshold, which suggested the logistic regression model represented an excellent fit (McFadden, 1974).

Table 5-7: Pseudo r-squared values comparing the final model to the null model.

Pseudo r-squared for logistic regression	
McFadden r-squared	0.217
Cox and Snell r-squared	0.257
Nagelkerke r-squared	0.345

When each of the ten groups' predicted probability versus observed proportions were calculated and plotted in a calibration curve (Hosmer and Lemeshow, 2000; Field, Miles and Field, 2012), the curve confirmed excellent overall calibration due to the close proximity of the ten points to the bisector line (See Figure 5-2). Therefore, due to the calibration curve and the pseudo r-squared values confirming good or excellent fit for the model, the model's ability to accurately predict could be explored using the testing data sample.

A ROC curve in Figure 5-3 illustrated how well the shooting model developed, using the 70 per cent training data sample (801 shot attempts), separated the successful and unsuccessful shot attempts in the 30 per cent testing data sample (343 shot attempts). The curve demonstrates a good ability to accurately predict the outcome of the shot attempt due to the curve being above the 45-degree straight line. To quantify the model's ability to accurately predict, the area under the ROC curve was calculated and a value of 0.798 achieved. The value, according to Hosmer and Lemeshow (2000), indicates the shooting model is considered acceptable (0.7-0.8) at accurately predicting shot probabilities in elite men's wheelchair basketball.

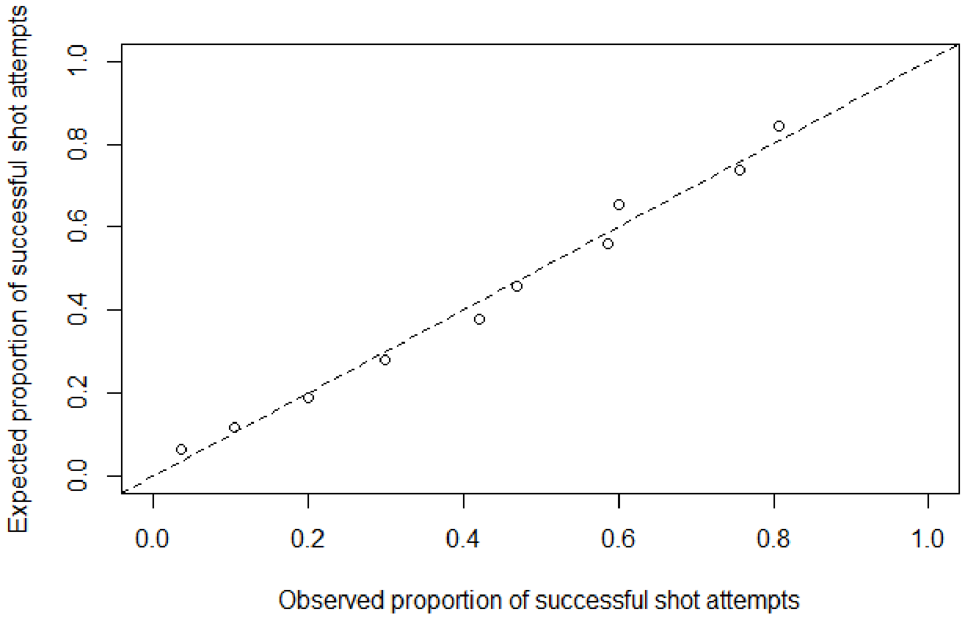


Figure 5-2: Calibration curve representing the observed proportion versus expected proportion from the model developed using the 70 per cent data sample (bisector, dashed line).

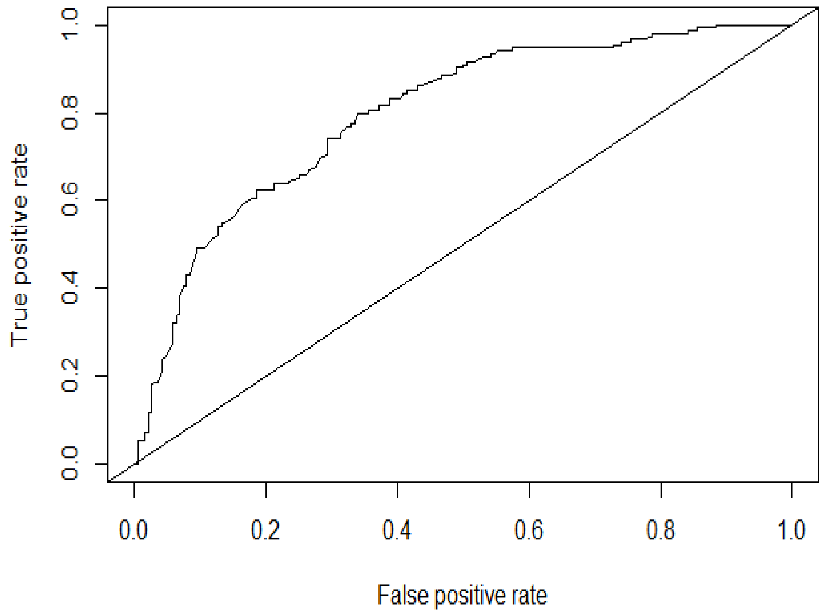


Figure 5-3: ROC curve illustrating the shooting model's performance against the 30 per cent testing data sample.

5.4 Application of model

The estimated regression coefficients, which were given as log-odds in Table 5-6, can be converted into probabilities to assist with the interpretation and application of the model utilising Equation 3. The equation can be used to calculate the change in probability from the intercept probability when an action variable within a CPV changes. This change in probability, due to a change of an action variable within a CPV, can be used to explore the impact of an action variable on the probability of achieving shooting success.

$$\text{probability} = \exp(log - odds) /(1 + exp(log - odds))$$

Equation 3: Equation used to calculate the probability of an event occurring through converting logits (reproduced from Chapter Four).

5.4.1 Changes in Shot Positioning and Shot Movement

The ORs presented in Table 5-6 demonstrated the odds of a successful basket significantly decreased when a player's Shot Positioning was different from the intercept of "Square to Basket". The odds of achieving a successful basket approximately doubled when the player's Shot Movement was "Rotating Left" in comparison to "Stationary". The remaining action variables within the Shot Movement CPV decreased the odds of shooting success. However, the action variables within the Shot Movement CPV, with the exception of "Away From Basket", are non-significant in relation to Shot Outcome.

Table 5-8 showed how the OR translate to the probability of shot success being affected by changes to both Shot Positioning and Shot Movement and how these interact with changes in the remaining six CPVs. The results demonstrated the probability of success decreased if the shooter's positioning was different from the intercept action variable of "Square to Basket". Not adopting a "Square to Basket" Shot Position seemed to be associated with some of the lowest efficiency rates for shots.

In relation to a player's Shot Movement, "Rotating Left" was associated with the highest shooting efficiency. However, recall that this was actually borderline non-significant when compared to the baseline action variable of "Stationary" for this CPV. Furthermore, the number of left-handed and right-handed players was not recorded. Moving "Away from Basket" was shown earlier to significantly reduce the chances of shooting success and Table 5-8 illustrated the potential reduction in the probability of scoring in this case.

Table 5-8: Change in the chance of a successful basket due to an action variable changing in the Shot Positioning and Shot Movement CPVs (percentages in bold indicates the inclusion of the action variable improves the chance of shooting success from the intercept).

		Shot Positioning (Assuming Shot Movement is "Stationary")				Shot Movement (Assuming Shot Positioning is "Square to Basket")				
		Square to Basket	10-90 Left	10-90 Right	Reverse	Stationary	Towards Basket	Away From Basket	Rotating Left	Rotating Right
Shot Location	2 Point - Centre - Long	67.37%	23.72%	25.73%	24.69%	67.37%	61.33%	51.60%	**80.60%**	65.23%
	2 Point - Centre - Mid	**86.67%**	49.48%	52.17%	50.80%	**86.67%**	**83.31%**	**77.05%**	**92.90%**	**85.52%**
	2 Point - Centre - Near	**75.90%**	61.59%	64.11%	62.83%	**75.90%**	**89.10%**	**84.61%**	**95.54%**	**90.63%**
	2 Point - Left - 45	**88.89%**	54.66%	57.32%	55.97%	**88.89%**	**86.01%**	**80.52%**	**94.15%**	**87.91%**
	2 Point - Left - Base	**79.49%**	44.84%	47.53%	46.16%	**79.49%**	**80.57%**	**73.59%**	**91.57%**	**83.06%**
	2 Point - Left - Elbow	**83.52%**	43.29%	45.96%	44.60%	**83.52%**	**79.56%**	**72.35%**	**91.07%**	**82.16%**
	2 Point - Right - 45	**71.05%**	49.58%	52.27%	50.90%	**71.05%**	**83.37%**	**77.12%**	**92.92%**	**85.57%**
	2 Point - Right - Base	**85.75%**	47.55%	50.25%	48.88%	**85.75%**	**82.22%**	**75.66%**	**92.37%**	**84.54%**
	2 Point - Right - Elbow	**74.46%**	61.96%	64.47%	63.20%	**74.46%**	**89.25%**	**84.81%**	**95.61%**	**90.76%**
	3 Point	**78.16%**	35.02%	37.52%	36.24%	**78.16%**	**73.32%**	64.89%	**87.80%**	**76.48%**
Defender Marking Space	No	67.37%	23.72%	25.73%	24.69%	67.37%	61.33%	51.60%	**80.60%**	65.23%
	Yes	**87.83%**	52.07%	54.76%	53.39%	**87.83%**	**84.71%**	**78.83%**	**93.55%**	**86.76%**
Defender In Front	No	67.37%	23.72%	25.73%	24.69%	67.37%	61.33%	51.60%	**80.60%**	65.23%
	Yes	46.98%	11.77%	12.94%	12.34%	46.98%	40.49%	31.39%	64.06%	44.60%
Defensive Pressure	Zero	67.37%	23.72%	25.73%	24.69%	67.37%	61.33%	51.60%	**80.60%**	65.23%
	One	57.98%	17.21%	18.80%	17.98%	57.98%	51.45%	41.61%	**73.52%**	55.63%
	Two	41.90%	9.80%	10.79%	10.28%	41.90%	35.64%	27.13%	59.19%	39.58%
	Three	38.30%	8.55%	9.43%	8.97%	38.30%	32.28%	24.27%	55.53%	36.05%
	Four	22.37%	4.16%	4.61%	4.38%	22.37%	18.12%	12.95%	36.70%	20.75%
Number of Hands on the Ball	One Hand	67.37%	23.72%	25.73%	24.69%	67.37%	61.33%	51.60%	**80.60%**	65.23%
	Two Hands	49.05%	12.66%	13.91%	13.26%	49.05%	42.51%	33.20%	65.95%	46.66%
Shot Type	Set-shot	67.37%	23.72%	25.73%	24.69%	67.37%	61.33%	51.60%	**80.60%**	65.23%
	Lay-Up	52.20%	14.12%	15.49%	14.78%	52.20%	45.61%	36.05%	68.72%	49.80%
	Post-Up	**72.91%**	28.84%	31.11%	29.94%	72.91%	67.39%	58.15%	**84.41%**	**70.97%**

The impact when the Shot Positioning and Shot Movement CPVs were combined on shot success is presented in Figure 5-4, illustrating achievement of the highest shooting efficiency when in a “Square to Basket” Shot Positioning and “Rotating Left” (80.60%). The data also demonstrated the shooting player should attempt to remain in a “Square to Basket” and is likely to have a greater than 50% chance of success. The data demonstrated that if the player ends up in either a “10-90 Left”, “10-90 Right” or a “Reverse” position, they should attempt to move in a “Rotating Left” manner at the point of release. This movement, although reducing their shooting efficiency to 38.49%, 41.07% and 39.75% respectively, was still larger than other movements. Figure 5-4 highlighted the magnitude of shooting success if a player is unable to establish a “Square to Basket” Shot Position or a “Rotating Left” Shot Movement. For example, advancing “Towards Basket” or “Away From Basket” resulted in the lowest chance of shooting successes regardless of the Shot Positioning (13.84% to 21.02%) whilst shooting from a “Stationary” position resulted in a success rate between 23.72% and 25.73%.

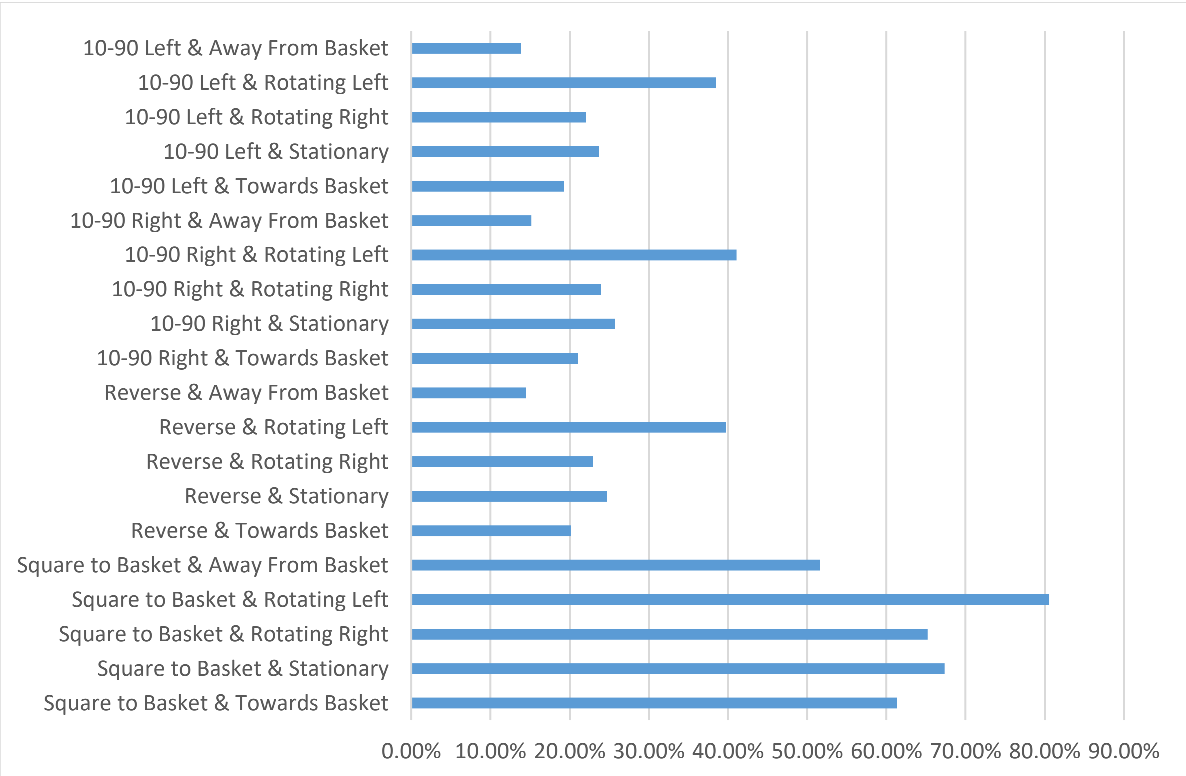


Figure 5-4: Changes in probability due to an action variable change in the Shot Movement and Shot Positioning CPVs. Changes in Shot Location

5.4.2 Changes in Shot Location

Figure 5.5 showed how the chance of shot success was affected by changes in Shot Location and how these interacted with changes in the remaining seven CPVs. The ORs indicated if a player attempts a shot from the “2 Point – Right – Elbow” or “2 Point – Centre – Near” they are five times more likely to achieve success in comparison to a shot from the “2 Point – Centre – Long” location. Furthermore, the odds of success from the 45-degree locations or the “2 Point – Centre – Mid” locations are tripled in comparison to the intercept Shot Location. Whilst the “3 Point” Shot Location has an OR greater than one, indicating the odds of success will increase and thus the odds of success are greater than a shot attempt from the “2 Point – Centre – Long” location. However, the odds of achieving success from the “2 Point – Centre – Near”, “2 Point – Left – 45”, “2 Point – Right – 45” and “2 Point – Right – Elbow” were the only Shot Locations to be significantly related to Shot Outcome ($p < 0.05$).

Shot attempts taken from the “2 Point – Centre – Long” Shot Location attribute to the lowest chance of shooting success (See Figure 5-5). The figure also highlighted the chance of achieving shot success decreased, below the intercept, regardless of the Shot Location if the player’s Shot Positioning was not “Square to Basket”. Furthermore, shot success was found to increase from the intercept Shot Location regardless of the Shot Movement, Number of Hands on the Ball or the Shot Type with the exception of the “3 Point” Shot Location. This finding is intuitive because a player taking a “3 Point” shot is further away from the basket and subsequently has the lowest odds (OR = 1.733) and the highest probability that the result is a chance result for the Shot Location CPV ($p = 0.295$). Figure 5-5 also indicated that the chance of shooting success was likely to increase when a player was attempting a shot and had a Defender Marking Space regardless of the specific Shot Location (chance < 88.38%). However, when there was a Defender In Front the chance of shooting success decreased regardless of the Shot Location. In addition, as the Defensive Pressure increased the chance of shooting success was found to decrease in the region of 31.64% to 45.00%, regardless of the Shot Location.

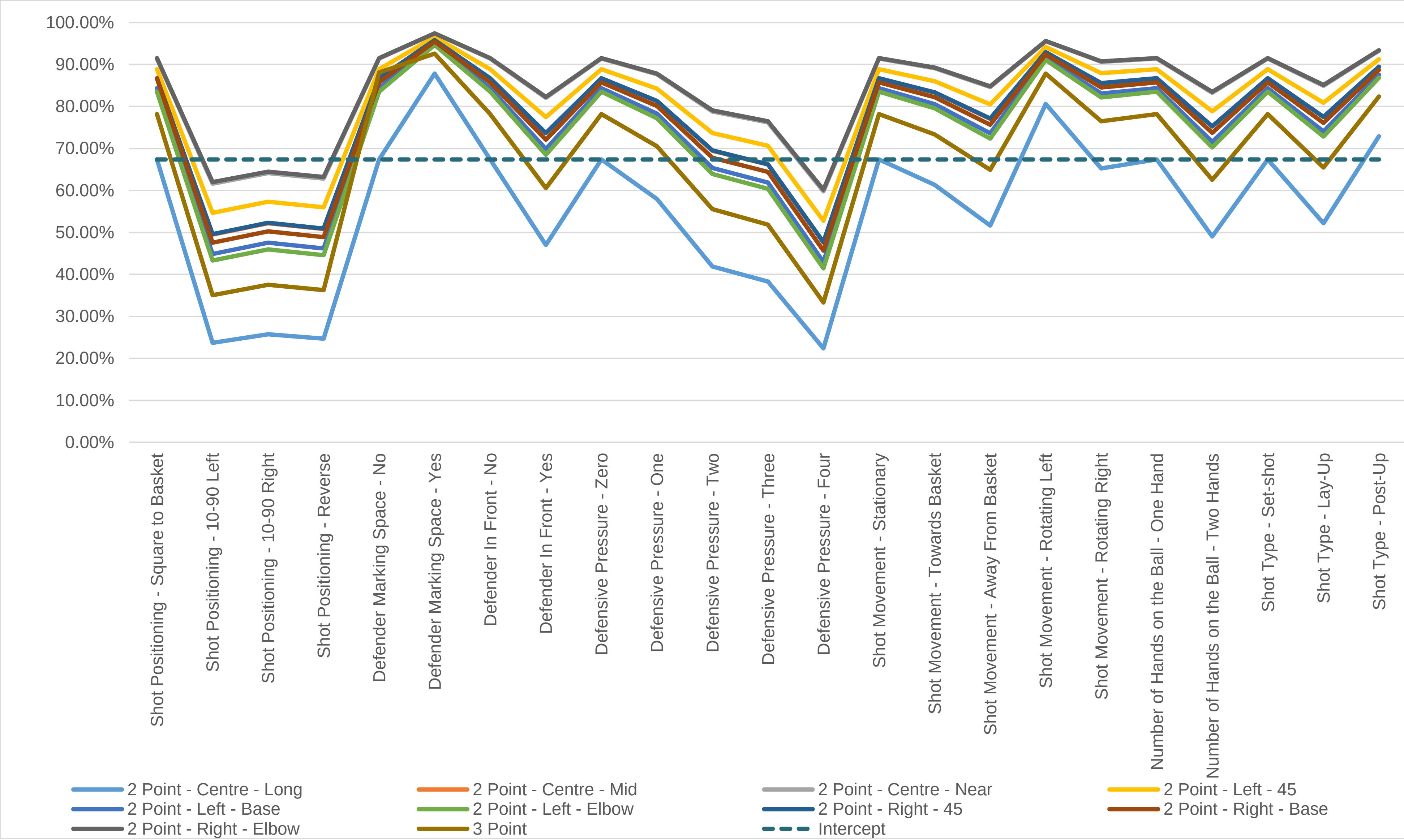


Figure 5-5: Changes in the chance of shooting success due to an action variable changing in the Shot Location CPV.

5.4.3 Changes in Shot Type

The odds of shooting success were shown to increase when a player attempted a shot adopting a “Post-Up” Shot Type in comparison to a “Set-Shot”. However, when the player attempted a “Lay-Up” their odds of success halved compared to a shot attempt using a “Set-shot” (See Table 5-6). Although, the ORs presented were only found to be significant for the “Lay-Up” Shot Type ($p < 0.05$). The effect to which the chance of shooting success fluctuates, due to a change of an action variable Shot Type, and how this interacts with the remaining CPV’s, is illustrated in Table 5-9. This identified the highest chance of success was found to be a “Post-Up” shot from either the “2 Point - Centre – Near” (93.28%) or the “2 Point – Right – Elbow” (93.38%). Although, as stated earlier the “Post-Up” Shot Type was found to be non-significant ($p=0.305$). In contrast to the “Post-Up” Shot Type, a “Lay-Up” shot ($p < 0.05$) taken from the “2 Point – Centre – Near” location was found to attribute an 84.92% chance of success. A “Lay-Up” shot taken from the “2 Point – Right – Elbow” location generated a higher chance of success (85.12%).

Table 5-9: Change in the chance of a successful basket due to an action variable changing in the Shot Type CPV.

		Shot Type		
		Set-Shot	Lay-Up	Post-Up
Shot Positioning	Square to Basket	67.37%	52.20%	**72.91%**
	0-90 Left	23.72%	14.12%	28.84%
	0-90 Right	25.73%	15.49%	31.11%
	Reverse	24.69%	14.78%	29.94%
Shot Location	2 Point - Centre - Long	67.37%	52.20%	**72.91%**
	2 Point - Centre - Mid	**86.67%**	**77.47%**	**89.44%**
	2 Point - Centre - Near	**91.41%**	**84.92%**	**93.28%**
	2 Point - Left - 45	**88.89%**	**80.89%**	**91.25%**
	2 Point - Left - Base	**84.37%**	**74.06%**	**87.56%**
	2 Point - Left - Elbow	**83.52%**	**72.83%**	**86.85%**
	2 Point - Right - 45	**86.72%**	**77.54%**	**89.48%**
	2 Point - Right - Base	**85.75%**	**76.10%**	**88.70%**
	2 Point - Right - Elbow	**91.54%**	**85.12%**	**93.38%**
	3 Point	**78.16%**	65.43%	**82.35%**
Defender Marking Space	No	67.37%	52.20%	**72.91%**
	Yes	**87.83%**	**79.23%**	**90.39%**
Defender In Front	No	67.37%	52.20%	**72.91%**
	Yes	46.98%	31.91%	53.59%
Defensive Pressure	Zero	67.37%	52.20%	**72.91%**
	One	57.98%	42.19%	64.27%
	Two	41.90%	27.61%	48.45%
	Three	38.30%	24.71%	44.72%
	Four	22.37%	13.23%	27.31%
Shot Movement	Stationary	67.37%	52.20%	72.91%
	Towards Basket	61.33%	45.61%	67.39%
	Away From Basket	51.60%	36.05%	58.15%
	Rotating Left	**80.60%**	**68.72%**	**84.41%**
	Rotating Right	65.23%	49.80%	**70.97%**
Number of Hands on the Ball	One Hand	67.37%	52.20%	**72.91%**
	Two Hands	49.05%	33.74%	55.65%

5.4.4 Changes in the defenders' marking, positioning and pressure

The odds of shooting success significantly increased when there was a Defender Marking Space ($p < 0.001$) (See Table 5-6). The extent to which the probability of shooting success fluctuates, due to a change of an action variable in Defender Marking Space and Defender In Front, and how this interacts with the remaining CPV's, was illustrated in Table 5-10. Here the data demonstrated that when the space around the shooting player is marked by a defender, the shooting player's odds of success significantly increased by 3.5% ($p < 0.001$). As a result, the player's chance of a successful shot when there is a Defender Marking Space, dependent upon changes in other action variables, fluctuated between 52.07% and 97.42% (Table 5-10). Whereas when there was no Defender Marking Space, the player's chances of success were lower but experienced greater fluctuation (23.72% to 91.54%) (Table 5-10).

Table 5-6 highlighted that when there is a defender in front of the shooting player, the shooting player's odds of success significantly decreased by greater than half (OR = 0.429) ($p < 0.001$). Thus, the effect of having a Defender In Front reduces the success rate by 16.40%±3.97% in comparison to when there is no Defender In Front (Table 5-10). The shooting player, whilst being defended in front, had a success rate of 82.27% (mean: 51.14%±21.39%) whereas when they were not being defended in front this increases to 91.54% (mean: 67.54%±20.31%) (Table 5-10). As a result, no matter what the states are for the other action variables, not having a Defender Marking Space increased the chance of shooting success by approximately 10-25% whereas having a Defender in Front decreased the probability of shooting success by approximately 10-20%.

It was also found that as the Defensive Pressure increased the odds of achieving success decreased, however, this was only found to be significant for four of the five action variables in the Defensive Pressure CPV (See Table 5-6). This finding highlighted that as the Defensive Pressure increases the chances of shooting success progressively decrease. It is important to note that the difference between a Defensive Pressure of "Two" and "Three" (Two: OR = 0.349; Three: OR = 0.301) does not have as large an effect on the shooting player's ability as the difference between "One" and "Two" (One: OR = 0.668; Two: OR = 0.349) (See Figure 5-6). Thus, the data highlighted that the optimal amount of Defensive Pressure to use is "Two" and not "Three", whilst not unsurprisingly, increasing the Defensive Pressure from "Three" to "Four" decreases the odds of shooting success further to 0.140.

Table 5-10: Change in the chance of a successful basket due to an action variable changing in the Defender In Front and Defender Marking Space CPV.

		Defender In Front		Defender Marking Space	
		Yes	No	Yes	No
Shot Positioning	Square to Basket	46.98%	67.37%	**87.83%**	67.37%
	0-90 Left	11.77%	23.72%	52.07%	23.72%
	0-90 Right	12.94%	25.73%	54.76%	25.73%
	Reverse	12.34%	24.69%	53.39%	24.69%
Shot Location	2 Point - Centre - Long	46.98%	67.37%	**87.83%**	67.37%
	2 Point - Centre - Mid	**73.61%**	**86.67%**	**95.78%**	**86.67%**
	2 Point - Centre - Near	**82.04%**	**91.41%**	**97.38%**	**91.41%**
	2 Point - Left - 45	**77.45%**	**88.89%**	**96.55%**	**88.89%**
	2 Point - Left - Base	**69.85%**	**84.37%**	**94.96%**	**84.37%**
	2 Point - Left - Elbow	**68.50%**	**83.52%**	**94.65%**	**83.52%**
	2 Point - Right - 45	**73.69%**	**86.72%**	**95.80%**	**86.72%**
	2 Point - Right - Base	**72.09%**	**85.75%**	**95.46%**	**85.75%**
	2 Point - Right - Elbow	**82.27%**	**91.54%**	**97.42%**	**91.54%**
	3 Point	60.56%	**78.16%**	**92.59%**	**78.16%**
Shot Movement	Stationary	46.98%	67.37%	**87.83%**	67.37%
	Towards Basket	40.49%	61.33%	**84.71%**	61.33%
	Away From Basket	31.39%	51.60%	**78.83%**	51.60%
	Rotating Left	64.06%	**80.60%**	**93.55%**	**80.60%**
	Rotating Right	44.60%	65.23%	**86.76%**	65.23%
Number of Hands on the Ball	One Hand	46.98%	67.37%	**87.83%**	67.37%
	Two Hands	29.23%	49.05%	**77.08%**	49.05%
Shot Type	Set-shot	46.98%	67.37%	**87.83%**	67.37%
	Lay-Up	31.91%	52.20%	**79.23%**	52.20%
	Post-Up	53.59%	**72.91%**	**90.39%**	**72.91%**

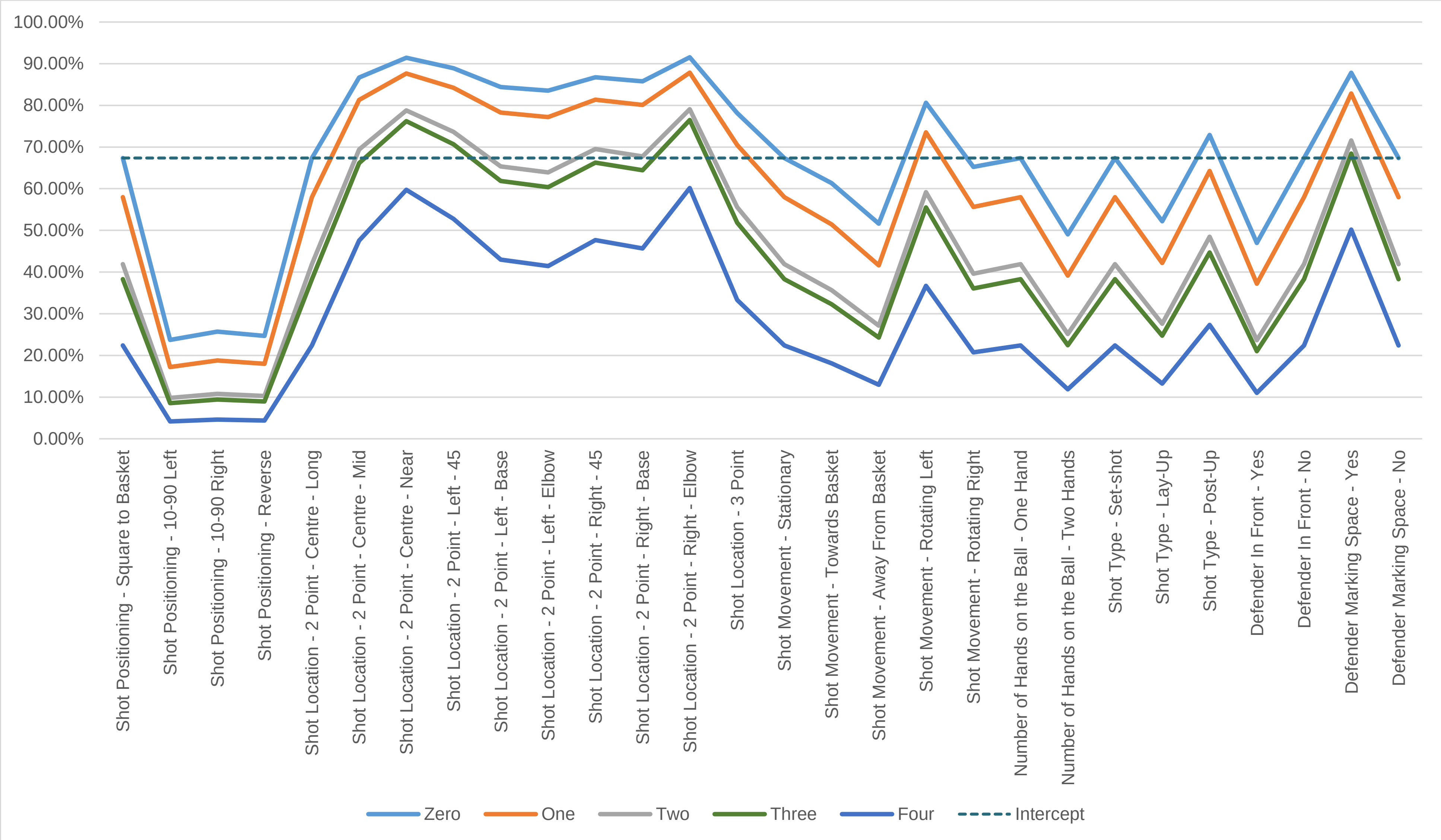


Figure 5-6: Changes in probability due to an increase in Defensive Pressure.

5.5 Discussion

This chapter aimed to develop a field-goal shooting specific SPA template, to identify the key action variables associated with shooting success and explore the impact of each key action variable upon the outcome of a shot through the use of binary logistic regression modelling. Due to the limited field-goal shooting research in wheelchair basketball, use was made of recently published field-goal shooting literature in able-bodied basketball, predominately from the NBA (e.g. Gómez, Alarcón and Ortega, 2015), along with personal knowledge and the knowledge of wheelchair basketball coaches and support staff, to develop a valid list of action variables and operational definitions. These variables were used to develop a shooting specific SPA template and deployed to the analysis of 1,144 field-goal shot attempts from the top five European wheelchair basketball teams when they played against another top-five team. The findings demonstrated a number of similarities, but also differences to able-bodied basketball, thus offering meaningful information and insight for wheelchair basketball coaches, players and support staff.

A binary logistic regression model showed that the probability of achieving a successful shot attempt improved when the player was taking a "Post-Up" shot attempt in comparison to a "Set-Shot" or a "Lay-Up" shot attempt. The "Lay-Up" shot was shown to produce the lowest probability of success of the three shot types being explored in this chapter. However, within able-bodied basketball, the "Lay-Up" is typically associated with one of the highest likelihoods of success (56.12 per cent) (Csapo *et al.*, 2015). One of the possible reasons for the "Lay-Up" in wheelchair basketball resulting in the lowest probability of field-goal shooting success could be due to the release height of the ball and seating height of the player. The seating height in this instance referred to the distance from the floor to the top of the player's head. Cavedon, Zancanaro and Milanese (2015) discovered junior wheelchair basketball players have a seating height of between 124.2cm and 134.1cm for low-point and high-point players with a maximum seated reach height of 162.8cm and 175.4cm, respectively. With the maximum seated reach heights in mind, the shooting player is still between 148.8cm to 135.4cm away from the basket in addition to travelling at speed towards the basket. Furthermore, if low-point and mid-point classified players are attempting to raise the ball to reduce the height to the basket, their weaknesses in core-function could be a contributing factor to reducing the likelihood of shooting success (Gil *et al.*, 2015). However, a statistically significant relationship between the player's Classification CPV and Shot Outcome CPV was not identified, and thus further exploration to consider this potential relationship is required and the general issues of evasion techniques of wheelchair basketball players whilst shooting, the role of the trunk in shooting and ball release distance data.

Previous research regarding the relationship between player classification and core function (Gil *et al.*, 2015) could also explain why this chapter discovered a relationship between field-goal shooting success and Shot Positioning. The model demonstrates if a player is "Square to Basket" there is a 67.37% chance of success, whereas his chances of success reduced significantly if his position changed to "10-90 Left", "10-90 Right" or "Reverse". The findings from this chapter contradict the coaching points delivered to players in wheelchair basketball. In the BWB grade one coaching manual, Gordon (2013, p.42) recommends assistance coaches should instruct their players to have their chair set up "at a slight angle with the driving wheel on the side of the player's shooting hand slightly forward". Previous kinematic research identified that the propulsion for shooting is generated largely from the trunk, arms and upper body (Malone, Gervais and Steadward, 2002). Thus, researchers believed angling the chair between 30-45º allows for greater trunk stability (Owen, 1982) and elbow extension (Thiboutot, 1999), subsequently the required force to propel the ball towards the basket. However, both of these studies are non-peer reviewed sources and thus the generated conclusions cannot be generalised.

The findings from this chapter contradicted the shooting recommendations made by Gordon (2013) and the data in the work of Owen (1982) and Thiboutot (1999). In this chapter, the data demonstrated the probability of shooting success increased if the shooting player remained "Square to Basket". Williams *et al.* (2016) also reiterated the importance of a "Square to Basket" position in able-bodied basketball to increase the likelihood of achieving shooting success due to the ability to generate appropriate force. However, wheelchair basketball coaches could be making this recommendation in an attempt to compensate for the potential core weakness in wheelchair basketball players. Thus, by angling the body slightly, players are able to rely on the upper extremities to provide stability instead of the core in an attempt to improve shooting accuracy (Limroongreungrat, Jamkrajang and Tongaim, 2010). Further to this, by angling the body slightly the wheelchair basketball player is able to engage the shoulder joints which contribute to the vertical components of release velocity and backspin (Nunome *et al.*, 2002; Okubo and Hubbard, 2015).

In addition, the use of the upper extremities and the reduction in core function could assist in helping to understand why “Rotating Left” doubled the odds of success. The chair rotating towards the left could suggest that a player utilising their right-hand to propel the ball, results in the player transferring body weight to the right side, and thus causing the chair to rotate to the left as they propel the ball towards the basket. Thus, this direction of rotation due to the opposing force follows Newton's (1687) Third Law, whereby all forces occur in equal but oppositely directed pairs. The reverse could be observed for left-handed players. The odds ratio is also likely to illustrate that a greater number of right-handed shot attempts were taken than left-handed attempts. Oudejans, Van De Langenberg and Hutter (2002) inferred that this is the case with able-bodied basketball players. They suggested that there is a tendency to attempt to retain the centre of mass despite shifting the ball from a central position to the right-hand side at the point of release (right-handed shooters). This shift in the ball to the right-hand side and the attempt to maintain a stable base could result in the player slightly rotating to the left at the point of release. However, this study focused on visual control with able-bodied players over a decade ago and thus could not transfer to wheelchair basketball players. It is also unknown whether the rotation of the players in this chapter was due to a strategic decision or due to the player taking a shot from a less stable base because of minor movements in the wheels and chair set-up due to changes in the centre of mass (Caspall *et al.*, 2013; van der Slikke *et al.*, 2016). Subsequently, the increase in odds for “Rotating Left” could, therefore, be attributed to a greater number of right-handed (1,068) to left-handed (76) shot attempts. However, only 64 shot attempts were observed whereby the player was “Rotating Left” and therefore further exploration is required regarding whether the shot movement patterns for left-handed and right-handed players are attributed to “Rotating Right” and “Rotating Left” as well as skill acquisition research regarding the learning of shooting technique in wheelchair basketball.

The model also highlighted that as Defensive Pressure increased the probability of shooting successes decreased. This finding supports research within wheelchair basketball (Hindawi *et al.*, 2013), basketball (Mexas *et al.*, 2005; Gómez, Tsamourtzis and Lorenzo, 2006) and invasion games (Lorains, Ball and MacMahon, 2013; Sullivan *et al.*, 2014) regarding the reduction in skill execution as a result of increased defensive pressure. According to Gomez *et al.* (2015), this reduction in skill execution, as a result of a stressful situation being created by an increase in defensive pressure, can be attributed to choking episodes. This creation of a stressful situation was observed within the Defender In Front CPV, whereby the probability of shot success decreased by approximately 10-20% if the defender was positioned in front of the shooting player.

Elderton (2008) and Humberto Almeida *et al.* (2012) highlighted it is the role of the coach and support staff to recreate these pressurised situations in a training environment. This recreation could enable the player to become accustomed to any potentially stressful situations that might arise in a future game. Therefore, when the player is exposed to a similar stressful situation in the game, which they have previously experienced, they would be able to execute an effective performance (Driskell, Sclafani and Driskell, 2014). However, caution must also be taken when attempting to exert Defensive Pressure to disrupt a shooting player’s success. The data identified that achieving a Defensive Pressure of “Two” when a player was shooting resulted in the optimum defensive strategy. Whereas making a player shoot with a Defensive Pressure of “Three” did not result in a large reduction in shooting efficiency, but would potentially make the defensive team vulnerable elsewhere on the court. Researchers have also found there to be a balance in optimum defensive strategies, ensuring that overloading Defensive Pressure does not leave other areas of a pitch or court vulnerable to being exploited by the team in possession of the ball (Gretz, 1994; Tenney and Schmid, 2016). Thus, coaches and players need to consider the optimum Defensive Pressure strategies to use at the point when an opponent is taking a shot, but also offensively regarding when to shoot or distribute the ball to another team member to shoot.

The developed model has identified offensive and defensive characteristics that can affect an individual's probability of success. Therefore, the model can be used to make adjustments, in a training environment, to a player's initial shooting set-up as well as recreating similar levels of Defensive Pressure that would be faced during a game. In addition, the model can be used to inform offensive and defensive strategies either prior to or during a game. The defensive information within the model can be used to amend the defensive strategies adopted by a team, adjusting their positioning to be either in front of the shooting player or allowing them to shoot with the Defender Marking Space. The information can also be used to make adjustments to the offensive strategy adopted, creating shooting opportunities with lower levels of Defensive Pressure which have been shown to produce a higher probability of success. Overall, if aspects of the model were to be considered within a team's preparations by the coaches, players and/or support staff, it is assumed that an improvement in shooting performance would be observed due to the predictive strength of the model developed.

5.6 Key applied messages

As a result of the findings, four key applied messages should be considered by wheelchair basketball coaches, players and support staff during training and game preparation:

1. When making a shot attempt, if the shooting player is positioned with their shoulders directly facing the basket instead of at a slight angle the model identified that a higher rate of success could be achieved. However, despite a player's best intentions, due to the effects of

defenders, their classification and other situational variables, they may not be able to control their Shot Positioning and remain in a “Square to Basket” position. Hence making sure a player is attempting to take a shot whilst in a “Square to Basket” position with a stable base appeared to be the most important issue to achieve during play. If the play is unable to do so, attempts should be made to begin “Rotating Left”. From a defensive viewpoint, attempting to make the shooter move away from the basket or at least ensuring they are not stationary or rotating left appeared to be a logical strategy to adopt based on these results.

2. The likelihood of achieving a successful shot outcome increased when the player released the ball from a higher release point. Elevating the ball above the shooting player’s head would firstly reduce the distance towards the basket and secondly reduce the likelihood of a defending player blocking the ball or disrupting the player’s shot. The chances of success were also found to be higher when this shot type was attempted from greater distances and thus coaches and players may wish to explore the option of attempting Post-Up shots from further away from the basket. Therefore, players should be encouraged to attempt Post-Up shots, dependent on their ability to maintain a stable base of support, reducing the distance between themselves and the basket but also reducing the chance of a defending player blocking the attempt.

3. If the space around a shooting player’s cylinder was interfered with by a defender, the likelihood of achieving shot success decreased. Therefore, from a defensive perspective, a maximum of two players should attempt to block between 90 to 180 degrees of the shooting player’s cylinder. This may result in the player’s visibility of the target becoming inhibited and as a result, the player may attempt to move the ball across his body. This ball movement, due to the player’s classification, could affect their core stability and ability to effectively shoot the ball. However, from an offensive perspective, team members should use their chairs to screen or block the progress of a defensive player and thus reduce the defensive pressure and the defensive player’s ability to position

themselves in front of the shooting player. In addition, to increase the chance of shooting success players should attempt to find a mismatch in height. If the shooting player has a superior height advantage, the defender is only able to mark the space around the chair and cause minimal Defensive Pressure. In this scenario, the defender is only preventing the player with the ball from progressing further towards the basket. Coaches, players and support staff should work on creating opportunities that result in causing the defender to mark the space whilst restricting the defender to position themselves in front of the chair. Coaches and players will already have this subjective view and be aware that by defending in front of the shooting player their shooting efficiency will be affected.

4. Shooting from the right elbow, 'near' the basket or from the '45' locations was found to have the highest odds of achieving a successful shot. Coaches, players and support staff should devise strategies if they are unable to achieve a mismatch in a possession. The players should attempt to move the ball and rotate from their current on-court position to achieve a shot attempt from a location that has been shown to increase the odds of success. Alternatively, during training sessions, players should practice a variety of locations but position themselves "Square to Basket" to ensure that the correct movement patterns become engrained to allow the player to achieve the highest chance of success during a game.

5.7 Conclusion

In this chapter, a valid and reliable SPA template has been developed and the key determinants of field-goal shooting success in elite men's wheelchair basketball were identified through chi-squared tests then binary logistic regression modelling. The final binary logistic regression field-goal shooting model incorporated eight CPVs and identified the effect of each action variable on the probability of a successful shot attempt (See Table 5-6). The model highlighted the ability to achieve the highest probability of a successful shot attempt was affected by the shooter deviating from a “Square To Basket” position irrespective of their Shot Location, and if the Defensive Pressure increased the probability of success decreased.

Despite the findings presented above, the limitations of this work require addressing. Firstly, only nine games from an elite wheelchair basketball tournament were used to develop the model and thus these findings cannot be generalised. Secondly, as highlighted within Chapter Four the defensive distances and pressure placed on shooters have been subjectively calculated and thus objective measurement tools would aid the accuracy of the model. However, what this chapter has achieved is to provide the first in-depth exploration of the key determinants of field-goal shooting in wheelchair basketball. Similarly to the processes and findings in Chapter Four, the use of real-life testing, rather than in a laboratory setting, allowed for rich empirical evidence to be collected that can inform practice. Referring to the coaching process models presented in Chapter One (See Figure 1-1) and Chapter Two (See Figure 2-1), the processes undertaken so far within this thesis have involved analysing performances (“Performance analysed” and “Related to past performances” (Franks, Goodman and Miller, 1983)) and profiling performance (“Modelling performance” and “Prediction” (Hughes, 2004a, p.99)). Once these stages have been completed, the key messages extracted from the data and information can be used to inform future practice (Cushion, 2007b; Wright, Carling and Collins, 2014; Passos, 2017). Subsequently, wheelchair basketball coaches, players and support staff could use the findings from Chapter Four and Chapter Five to assist player development in training and establish offensive and defensive strategies that would result in achieving the highest odds of game and shooting success in the build-up and during the 2016 Rio de Janeiro Paralympic Games.

Chapter 6 Comparing team and shooting strategies across tournaments

6.1 Overview

This chapter presents the steps undertaken to investigate whether Great Britain adjusted their team and shooting strategies at the 2016 Rio de Janeiro Paralympic Games based upon the objective evidence provided in Chapter Four and Chapter Five. The probabilities discovered in Chapter Four and Chapter Five were shared with the coaching staff, players and support staff as they emerged, in an attempt to support the team's preparations for the 2016 Paralympic Games. Using the SPA templates developed in Chapter Three and Chapter Five, Great Britain's team and shooting performances during the 2016 Paralympic Games were analysed. The team and shooting data from Great Britain's performances at the 2015 European Championships and the 2016 Paralympic Games were then compared using the frequency counts and percentage distributions of action variables within each CPV for the seven-team CPVs and eight shooting CPVs. Drawing on previous research and theoretical concepts, the chapter concludes by critically exploring reasons why differences in performance were observed between the two competitions.

6.2 Introduction

The data and information collected via SPA have been used by coaches, players and support staff to provide objective evidence to inform the decision-making processes in an attempt to enhance performance (Ibañez, Perez and Macias, 2003; Causer and Hodges, 2013; Davenport, 2014). The evidence provided coaches with an objective indication of a team and individual's areas of strength and weakness because their subjective opinions regarding performance are reduced. The data allowed coaches and support staff to create data-driven training programmes in an attempt to improve the performances of the team and the individual (Nibali, 2017). Research has shown that some coaches from team invasion sports have begun to adopt a data-driven approach to aid in the development of specific game strategies (Bhandari *et al.*, 1997; Brugha, Freeman and Treanor, 2013; Franks and Hughes, 2016; Demenius and Kreivytė, 2017). The coaches that adopt this data-driven approach, use the data to develop a strategy that exploits an opponent's weakness in an attempt to increase the likelihood of achieving success (Garganta, 2009; Miller, 2016).

Baker and Kwartler (2015) reported that adopting a data-driven approach within American Football enabled coaches to gain objective insight into potential play patterns of opponents and where the team are most likely to attack. Using the data, coaches can develop opponent-specific game plans and prepare players for what they could experience during the game. Gerrard (2017), who has experience of SPA in association football and rugby, believed the data allow coaches to understand the deeper entities of a performance, unlocking the aspects that can be controlled by athletes and tailoring a game plan around the controllable aspect in an attempt to achieve success. Further to these suggestions, Demenius and Kreivytė (2017) found basketball coaches believed that adopting a data-driven approach gave them an objective insight into the opponent's offensive and defensive tactics. Coaches are subsequently able to adjust training sessions in the week prior to the games and implement bespoke game plans that would exploit the opponent's weaknesses with the aim of increasing the likelihood of winning the game.

Despite research highlighting the benefits of adopting a data-driven approach, Wright, Atkins and Jones (2012) found a small number of experienced coaches were reluctant to use the objective evidence to inform their decisions due to the usability and reliability of the data. In addition, the complex and constantly changing nature of team sport could also be a reason why coaches are sceptical of adopting a data-driven approach. This unstable nature of team sport could cause difficulties in establishing patterns of play and answering the important questions of how and why an action occurred (Gerrard, 2007). These issues potentially raise uncertainties within coaches' and players' minds regarding the accuracy of the data and whether they should trust the information that is being collected to inform their decision making processes. However, with the technological advancements within the field and the collection of sequential action variables, the data have begun to provide a holistic insight into performance (Wright, Carling and Collins, 2014). Coaches and support staff are now being presented with data regarding a player's and/or team's abilities, athleticism, attitude and awareness instead of only being shown the frequency counts of observed actions (Gerrard, 2017). This could be why Wright, Atkins and Jones (2012) discovered 80 per cent of the experienced coaches used a data-driven approach to inform their game planning with other coaches following this trend (Dellaserra, Gao and Ransdell, 2014; Otte and Bangerter, 2014; Pascal, Sass and Gregory, 2015; Gerrard, 2017).

A shift in players' mindset has also been observed regarding the use of SPA, moving away from a state of feeling constantly monitored (Carling, Williams and Reilly, 2005) to embracing the discipline as a valuable resource to enhance performance (Francis and Jones, 2014). As well as being used as a tool to help develop their own as well as the team's performance, Francis and Jones (2014) found SPA provisions and data allowed the rugby union players to gain an insight into their opponents' strengths and weaknesses. The players were able to go into games with knowledge regarding how their opponents were likely to attack. This enabled the players, in collaboration with the coaches, to alter their defensive systems in an attempt to counter the opponent's style of play. In addition, Mackenzie and Cushion (2014, p.26) discovered association football players believed SPA gave them "a heads up to what's gonna happen", allowing an individual to "go into a game knowing who is their main header of the ball, who I'm marking is gonna spin round the back in a set piece and I know it's gonna happen, and I can combat that to sort of prevent more chances and goal scoring opportunities".

Although these changes and reliance on data have been observed within able-bodied team sports by coaches and players, the use of SPA information to inform a data-driven approach has not been explored in disability sports and in particular wheelchair basketball. The findings from Chapter Four and Chapter Five, which used data from the 2015 European Championships to identify the key determinants of team and shooting success, were shared with the BWB coaches, players and support staff in an attempt to inform their decision-making process during the Rio de Janeiro Paralympic Games. Therefore, whether the men's Great Britain wheelchair basketball team adjusted their team and shooting strategies at the 2016 Paralympic Games in comparison to the 2015 European Championships based on the utilisation of a data-driven approach is explored in this chapter.

6.3 Method

6.3.1 Team strategy comparison

First, Great Britain's performances (eight games) at the 2015 European Wheelchair Basketball Championships (See Figure 6-1) were exported from the data set used in Chapter Four into a new Microsoft Excel spreadsheet. In addition, a new category "Tournament" was created to distinguish between data from the European Wheelchair Basketball Championships and the Paralympic Games. The new spreadsheet included 784 rows of data with 23 columns, each row representing a single ball possession (see Appendix 15). Second, Great Britain's video recordings (eight games) from the 2016 Rio de Janeiro Paralympic Games (See Figure 6-2) were analysed using the SPA template developed in Chapter Three. During the SPA process, the shooting action was not observed in one possession due to an action replay, however, the start and end actions along with the defensive system used were observed and therefore the possession was retained. The categorical data were exported into Microsoft Excel using the 'Sorter' function in SportsCode and information regarding the Offensive Team, Defensive Team, Game Outcome, Stage of Competition and Possession Number was added. The eight games resulted in 802 rows of data, each of which relates to a single ball possession consisting of 23 columns (see Appendix 15). Each possession was subjected to a data cleaning process by examining the data to identify any missing or duplicated action variables. If any discrepancies were identified, the specific game and possession were identified and re-analysed, however, no errors were identified in the 802 possessions.

On completion of the analysis, percentage distributions and frequency counts for the action variables within the seven CPVs, which were included in the team model (see Chapter Four), along with chi-squared tests were calculated for the two sets of performance data. Comparisons were then made between Great Britain's performance data at the 2015 (784 rows) and the 2016 (802 rows) tournament. In addition, data were extracted from opponents during the two tournaments to explore how Great Britain's defensive systems had operated. The purpose of this analysis was to explore whether the key advice offered to the coaches, players and support staff from Chapter Four, regarding line-up configurations, game status and defensive systems, was adopted during games at the Paralympic Games.

Pool Games				
Day 1	Day 2	Day 3	Day 4	Day 5
Great Britain (92)	**Poland (85)**	**Great Britain (80)**	**Germany (89)**	**Great Britain (70)**
v	v	v	v	v
Czech Republic (42)	Great Britain (73)	France (46)	Great Britain (55)	Spain (58)

Quarter-Final	Semi-Final	Gold Medal Game
Day 7	Day 8	Day 10
Great Britain (77)	Germany (68)	**Great Britain (87)**
v	v	v
Italy (48)	**Great Britain (77)**	Turkey (66)

Figure 6-1: Outline of the eight games that were analysed for the Great Britain team during the men's wheelchair basketball competition at the 2015 European Championships (the winner of the game is shown in BOLD and the number of points scored being placed within the brackets).

Pool Games				
Day 1	Day 2	Day 3	Day 4	Day 5
Great Britain (93)	Iran (60)	**Great Britain (73)**	**Great Britain (66)**	**USA (65)**
v	v	v	v	v
Algeria (31)	**Great Britain (84)**	Brazil (55)	Germany (52)	Great Britain (48)

Quarter-Final	Semi-Final	Bronze Medal Match
Day 7	Day 8	Day 10
Great Britain (74)	**Spain (69)**	**Great Britain (82)**
v	v	v
Australia (51)	Great Britain (63)	Turkey (76)

Figure 6-2: Outline of the eight games that were analysed for the Great Britain team during the men's wheelchair basketball competition at the 2016 Rio de Janeiro Paralympic Games (the winner of the game is shown in BOLD and the number of points scored being placed within the brackets).

6.3.2 Shooting strategy comparison

The same methodological approach, as outlined in above 6.3.1, was completed to explore whether the men's Great Britain wheelchair basketball team adjusted their shooting strategies at 2016 Paralympic Games in comparison to the 2015 European Championships. First, Great Britain's performances against the other top five teams at the 2015 European Wheelchair Basketball Championships, which consisted of four games (See Figure 6-3), were exported from the data set used in Chapter Five into a new Microsoft Excel spreadsheet. In addition, a new category “Tournament” was created to distinguish between data from the European Wheelchair Basketball Championships and the Paralympic Games. The new spreadsheet included 273 rows of data with 23 columns, with each row representing a shot attempt (see Appendix 16).

Pool Games					
Day 4			Day 5		
Germany v Great Britain			**Great Britain** v Spain		
2 Point Shot Attempts			2 Point Shot Attempts		
Suc	Unsuc	Total	Suc	Unsuc	Total
22	36	58	27	34	61
3 Point Shot Attempts			3 Point Shot Attempts		
Suc	Unsuc	Total	Suc	Unsuc	Total
3	10	13	0	7	7

Semi-Final		
Day 8		
Germany v **Great Britain**		
2 Point Shot Attempts		
Suc	Unsuc	Total
32	28	60
3 Point Shot Attempts		
Suc	Unsuc	Total
3	3	6

Gold Medal Game		
Day 10		
Great Britain v Turkey		
2 Point Shot Attempts		
Suc	Unsuc	Total
34	25	59
3 Point Shot Attempts		
Suc	Unsuc	Total
5	4	9

Figure 6-3: Outline of the number of successful and unsuccessful field-goal attempts being taken during the four games that were analysed for the Great Britain team during the men’s wheelchair basketball competition at the 2015 European Championships (the winner of the game being shown in BOLD).

Second, field-goal shot attempts were extracted from Great Britain’s games during the 2016 Rio de Janeiro Paralympic Games (eight games) (See Figure 6-4) and analysed using the shooting-specific SPA template developed in Chapter Five. One shot attempt was not analysed due to the shot attempt not being shown on the video recordings due to an action replay of a previous shot attempt. On completion of the shot attempt analysis, the categorical data for each shot attempt was exported into Microsoft Excel using the ‘Sorter’ function in SportsCode. The new spreadsheet consisted of 525 rows of data and 23 columns, with each row representing a shot attempt during the eight games (see Appendix 16). Each shot attempt was subjected to a data cleaning process which involved examining that data to identify any missing or duplicated data. If any discrepancies were identified, the specific Shot Number was identified and re-analysed, however, no errors were identified.

Pool Games

Day 1

Great Britain v Algeria

2 Point Shot Attempts

Suc	Unsuc	Total
39	27	66

3 Point Shot Attempts

Suc	Unsuc	Total
2	4	6

Day 2

Iran v **Great Britain**

2 Point Shot Attempts

Suc	Unsuc	Total
36	27	63

3 Point Shot Attempts

Suc	Unsuc	Total
2	3	5

Day 3

Great Britain v Brazil

2 Point Shot Attempts

Suc	Unsuc	Total
31	35	66

3 Point Shot Attempts

Suc	Unsuc	Total
1	2	3

Day 4

Great Britain v Germany

2 Point Shot Attempts

Suc	Unsuc	Total
30	27	57

3 Point Shot Attempts

Suc	Unsuc	Total
1	4	5

Day 5

USA v Great Britain

2 Point Shot Attempts

Suc	Unsuc	Total
20	21	41

3 Point Shot Attempts

Suc	Unsuc	Total
1	6	7

Quarter-Final

Day 7

Great Britain v Australia

2 Point Shot Attempts

Suc	Unsuc	Total
30	29	59

3 Point Shot Attempts

Suc	Unsuc	Total
1	3	4

Semi-Final

Day 8

Spain v Great Britain

2 Point Shot Attempts

Suc	Unsuc	Total
24	29	53

3 Point Shot Attempts

Suc	Unsuc	Total
4	9	13

Bronze Medal Game

Day 10

Great Britain v Turkey

2 Point Shot Attempts

Suc	Unsuc	Total
30	37	67

3 Point Shot Attempts

Suc	Unsuc	Total
4	6	10

Figure 6-4: Outline of the number of successful and unsuccessful field-goal attempts being taken during the four games that were analysed for the Great Britain team during the men's wheelchair basketball competition at the 2016 Paralympic Games (the winner of the game being shown in BOLD).

On completion of the analysis, Percentage Distributions (%D) and frequency counts for the action variables within the eight CPVs, which were included in the shooting model (see Chapter Five), were calculated for the two sets of shooting performance data. Comparisons were then made between Great Britain's shooting performance data at the 2015 European Championships (273 rows) and the 2016 Paralympic Games (523 rows) to examine the changes in performances during the two competitions. The purpose of this analysis was to explore whether the key advice offered to the coaches, players and support staff from Chapter Four, regarding shooting positioning, shot type, shot location and defending shoots, was adopted during games at the Paralympic Games.

6.4 Results

6.4.1 Team strategy comparison

Great Britain's win to loss ratios across the two competitions were identical (six winning performances and two losing performances, with one winning performance in both competitions going to extra-time). However, during 2015 Great Britain scored on average two more points per game than in 2016 (76±11 points to 74±15 points). Despite this information, Great Britain, in 2016, had a lower proportion of possessions starting in a state of "Winning" (56.61%) in comparison to in 2015 (67.48%) (See Table 6-1). A Chi-square test indicated that these differences were statistically significant ($p < 0.01$). "Drawing", in both competitions, had the lowest frequency in comparison to "Winning" or "Losing". "Winning" still remained the state with the highest frequency count and percentage distribution in comparison to the other states in both tournaments.

Table 6-1: Great Britain's Game Status at the start of a possession (%D referred to the percentage distribution of the action variables within one tournament)

Game Status	2015 European Championships		2016 Paralympic Games	
	Frequency	%D	Frequency	%D
Winning*	529	67.48%	454	56.61%
Drawing*	31	3.95%	65	8.10%
Losing*	224	28.57%	283	35.29%
Overall	784	100%	802	100%

*: Denotes a significant (p<0.05) relationship between the tournaments.

Great Britain used "Zero" Defensive Unit - 3.0-3.5 players during fewer possessions in 2016 (11.71%) in comparison to 2015 (32.61%) (See Table 6-2). Conversely, the frequency counts where "One" Defensive Unit - 3.0-3.5 players were on-court during 2016 were almost double the 2015 counts (30.71% v 56.57%). The Chi-square test indicated statistically significant differences ($p < 0.05$) between 2015 and2016 for "Zero" and "One" Defensive Unit – 3.0-3.5 players. These findings largely conflict with the advice given to the coaches and athletes regarding the optimum number of Defensive Unit – 3.0 or 3.5 players, with an increase in "One" player being observed.

Table 6-2: The number of Defensive Unit – 3.0-3.5 player's used per possession by Great Britain

Defensive Unit – 3.0-3.5	2015 European Championships		2016 Paralympic Games	
	Frequency	%D	Frequency	%D
Zero*	257	32.61%	82	11.71%
One*	242	30.71%	396	56.57%
Two	271	34.39%	268	38.29%
Three or More	41	5.20%	56	8.00%
Overall	788	100%	700	100%

*: Denotes a significant (p<0.05) relationship between the tournaments.

Intuitively, Table 6-3 showed the same pattern that was discovered in Table 6-2. It was identified that during 2016, Great Britain played almost double the number of possession with "Two" Offensive Unit - 3.0-3.5 players (72.19%) in comparison to 2015 (36.73%). Furthermore, Table 6-3 showed the number of "Zero" or "One" Offensive Unit - 3.0-3.5 players involved in line-ups almost halved between the two competitions. A chi-square test identified that these differences were statistically significant ($p < 0.05$).

Table 6-3: The number of Offensive Unit – 3.0-3.5 player's used per possession by Great Britain.

Offensive Unit – 3.0-3.5	2015 European Championships		2016 Paralympic Games	
	Frequency	%D	Frequency	%D
Zero*	279	35.59%	130	16.21%
One*	217	27.68%	93	11.60%
Two*	288	36.73%	579	72.19%
Three or More	0	0.00%	0	0.00%
Overall	784	100%	802	100%

*: Denotes a significant (p<0.05) relationship between the tournaments.

Great Britain also used "Two" Offensive Unit 4.0-4.5 players much less often and "Zero or One" 4.0-4.5 players much more often in 2016 in comparison to 2015 (See Table 6-4). This visible shift in the number of Offensive Unit 4.0-4.5 players used in each possession between the two tournaments was also found to be statistically significant ($p < 0.001$).

Table 6-4: The number of Offensive Unit – 4.0-4.5 player's used per possession by Great Britain.

Offensive Unit – 4.0-4.5	2015 European Championships		2016 Paralympic Games	
	Frequency	%D	Frequency	%D
Zero or One*	355	45.28%	646	80.55%
Two*	429	54.72%	156	19.45%
Three	0	0.00%	0	0.00%
Overall	784	100%	802	100%

*: Denotes a significant (p<0.05) relationship between the tournaments.

Great Britain had a slightly higher percentage of "Free Throws", "Offensive Rebounds" and "Turnovers" during the 2016 Paralympic Games (See Table 6-5). In addition, the Great Britain team started more possessions in 2016 in comparison to 2015 from a "Turnover". The Chi-square test indicated these differences between the two tournaments were borderline ($p < 0.05$). A significant difference ($p < 0.05$) was also identified between the number of "Free Throw" between the two tournaments, with a 3% increase being identified from the

Europeans to the Paralympic Games. Note that the action variable “Other Start” produced a low-frequency count (below 10 in both tournaments) and was subsequently excluded from the Chi-square test.

Table 6-5: How possession started for Great Britain.

	2015 European Championships		2016 Paralympic Games	
Start of Possession	Frequency	%D	Frequency	%D
Defensive Rebound	186	23.72%	176	21.95%
Free Throw*	74	9.44%	103	12.84%
Inbound – Baseline	269	34.31%	261	32.54%
Inbound – Endline	29	3.70%	30	3.74%
Offensive Rebound	53	6.76%	64	7.98%
Other Start	6	0.77%	6	0.75%
Sideline – Back	44	5.61%	35	4.36%
Sideline – Front	88	11.22%	72	8.98%
Turnover*	35	4.46%	55	6.86%
Overall	784	100%	802	100%

*: Denotes a significant ($p<0.05$) relationship between the tournaments.

The comparative data presented in Table 6-6 showed Great Britain used a “Highline” defensive system more often in 2016, thus not following the advice. In contrast, Great Britain used significantly ($p < 0.05$) fewer possessions operating a 2 Man Press, 3 Man Press or 4 Man Press Defensive Systems in 2016 in comparison to 2015 and thus followed the advice. However, the team used significantly ($p < 0.05$) more possessions operating a 5 Man Press Defensive Systems in 2016 in comparison to 2015, which was found to increase the chances of an opponent scoring and winning a game from the work completed in Chapter Four. Although, the data demonstrated that Great Britain adopted a “Zone” system on fewer occasions, which conflicted with the advice provided to them from the data in Chapter Four.

Table 6-6: Defensive System operated by Great Britain against opponents.

Defensive System	2015 European Championships		2016 Paralympic Games	
	Frequency	%D	Frequency	%D
1 Man Press	32	4.06%	23	3.29%
2 Man Press*	135	17.13%	101	14.43%
3 Man Press*	50	6.35%	41	5.86%
4 Man Press*	38	4.82%	9	1.29%
5 Man Press*	11	1.40%	36	5.14%
Highline	66	8.38%	104	14.86%
Zone	344	43.66%	278	39.17%
No Defensive System	112	14.21%	108	15.43%
Overall	788	100%	700	100%

*: Denotes a significant (p<0.05) relationship between the tournaments.

6.4.2 Shooting strategy comparison

Before presenting the comparison between the two tournaments for each CPV in the final shooting model, the shooting efficiencies for the games analysed within the comparison are presented in

Table 6-7 and Table 6-8. The results illustrated Great Britain's shooting efficiency for 2 Point shot attempts improved from 48% to 51% but decreased for 3 Point shooting efficiency (31% to 30%) from 2015 to 2016. Great Britain, therefore, achieved an overall field-goal shooting efficiency of 45.99% in 2015 (Successful shots: 126; Unsuccessful Shots: 147) and 48.76% in 2016 (Successful shots: 256; Unsuccessful Shots: 269). Therefore, the team improved the shooting efficiency marginally, although, this was largely against different teams.

Table 6-7: Field-goal shooting statistics from the analysed shot attempts from Great Britain's games at the 2015 European Championships, with the game winner being shown in BOLD.

Game	Stage	2 Point			3 Point		
		Suc	Unsuc	Eff.	Suc	Unsuc	Eff.
Germany v Great Britain	Pool Game	22	36	38%	3	10	23%
Great Britain v Spain	Pool Game	27	34	44%	0	7	0%
Germany v **Great Britain**	Semi-Final	32	28	53%	3	3	50%
Great Britain v Turkey	Gold Medal Game	34	25	58%	5	4	56%

Overall		115	123	48%	11	24	31%

N.B: Suc: Number of successful shot attempts; Unsuc: Number of unsuccessful shot attempts; Eff.: Shooting efficiency (Number of successful shot attempts/ Number of unsuccessful shot attempts).

Table 6-8: Field-goal shooting statistics from the analysed shot attempts from Great Britain's games at the 2016 Paralympic Games, with the game winner being shown in BOLD.

Game	Stage	2 Point			3 Point		
		Suc	Unsuc	Eff.	Suc	Unsuc	Eff.
Great Britain v Algeria	Pool Stage	39	27	59%	2	4	33%
Iran v **Great Britain**	Pool Stage	36	27	57%	2	3	40%
Great Britain v Brazil	Pool Stage	31	35	47%	1	2	33%
Great Britain v Germany	Pool Stage	30	27	53%	1	4	20%
USA v Great Britain	Pool Stage	20	21	49%	1	6	14%
Great Britain v Australia	Quarter-Final	30	29	51%	1	3	25%
Spain v Great Britain	Semi-Final	24	29	45%	4	9	31%
Great Britain v Turkey	Bronze Medal Game	30	37	45%	4	6	40%
Overall		240	232	51%	16	37	30%

Table 6-9 indicated that players attempted a shot from a "Square to Basket" position on fewer occasions in 2016 than in 2015. It was expected that the shooting player's efficiency when adopting a different position would have reduced in 2016. This was not the case; a 36.02% increase in efficiency was observed for the "10-90 Left" position, whilst a 21.92% increase for "10-90 Right" and a 10.00% increase for "Reverse was also observed. In addition, the player's shooting efficiency, when being in a "Square to Basket" Shot Positioning, decreased by 10.23% from 2015 to 2016. Chi-square tests identified that these differences were statistically significant ($p < 0.05$).

Table 6-9: Great Britain's Shot Positioning when attempting shots.

Shot Positioning	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
10-90 Left*	7	60	67	10.45%	24.54%	112	129	241	46.47%	45.90%
10-90 Right	4	13	17	23.53%	6.23%	15	18	33	45.45%	6.29%
Reverse	2	2	4	50.00%	1.47%	9	6	15	60.00%	2.86%
Square to Basket*	113	72	185	61.08%	67.77%	120	116	236	50.85%	44.95%
Overall	126	147	273	50.41%	100%	256	269	525	48.38%	100%

*: Denotes a significant ($p<0.05$) relationship between the total number of shots taken between the two tournaments.

Great Britain demonstrated a statistically significant ($p < 0.05$) percentage distribution for the "Rotating Left" Shot Movement in 2016 in comparison to in 2015 (See Table 6-10). It was also noted that Great Britain players' shooting efficiency whilst "Rotating Left" marginally decreased from 2015 to 2016. Table 6-10 also showed that the players attempted to reduce the frequency of utilising the "Towards Basket" shot movement. It was highlighted by the model in Chapter Five that if a player's shot movement was "Towards Basket" his shooting odds would decrease by 0.768. Subsequently, the percentage distribution of shots taken whilst moving "Towards Basket" reduced by 31.81% from 57.14% in 2015 to 25.33% in 2016. It is also interesting to note in Table 6-10 that Great Britain's shooting efficiency was higher when "Stationary" in 2015 compared to 2016 despite the odds of success being lower.

Table 6-10: Great Britain's Shot Movement when attempting shots.

Shot Movement	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
Stationary	37	26	63	58.73%	23.08%	66	64	130	50.77%	24.76%
Towards Basket*	73	83	156	46.79%	57.14%	74	59	133	55.64%	25.33%
Away From Basket	10	27	37	27.03%	13.55%	34	39	73	46.58%	13.90%
Rotating Left*	4	6	10	40.00%	3.66%	49	74	123	39.84%	23.43%
Rotating Right*	2	5	7	28.57%	2.56%	33	33	66	50.00%	12.57%
Overview	126	147	273	45.79%	100%	256	269	525	48.76%	100%

*: Denotes a significant ($p<0.05$) relationship between the total number of shots taken between the two tournaments.

Table 6-11 highlighted that the frequency of a "Set-Shot" decreased from 49.08% to 40.57%, along with the shooting efficiency (49.35% versus 40.85%), from 2015 to 2016. In comparison, "Post-Up" shot type frequency (32.23% versus 44.38%) and shooting efficiency increased (38.64% versus 51.93%) from 2015 to 2016, whilst "Lay-Up" frequency decreased (18.68% versus 15.05%) and the shooting efficiencies of this shot type increased (50.98% versus 60.76%). These changes across the two tournaments were found to be statistically significant ($p < 0.05$).

Table 6-11: Great Britain's Shot Type when attempting shots.

Shot Type	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
Set-shot*	66	68	134	49.25%	49.08%	87	126	213	40.85%	40.57%
Lay-Up	26	25	51	50.98%	18.68%	48	31	79	60.76%	15.05%
Post-Up*	34	54	88	38.64%	32.23%	121	112	233	51.93%	44.38%
Overview	126	147	273	45.79%	100%	256	269	525	48.76%	100%

*: Denotes a significant ($p<0.05$) relationship between the total number of shots taken between the two tournaments.

The results in Chapter Five indicated that having "Two Hands" on the ball halved the odds of shooting success. When comparing the percentage distribution of shots taken with one hand or two hands across the two tournaments no statistical differences were identified.

Table 6-12: The Number of Hands on the Ball when a Great Britain player was attempting a shot.

Number of Hands on the Ball	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
One Hand	13	7	20	65.00%	7.33%	20	16	36	55.56%	6.86%
Two Hands	113	140	253	44.66%	92.67%	236	253	489	48.26%	93.14%
Overview	126	147	273	50.41%	100%	256	269	525	48.38%	100%

Table 6-13 indicated statistically significant differences for the baseline shot locations and the right-45 location across the two tournaments ($p < 0.05$). Despite being advised to take a higher percentage distribution of shots from the '45' locations, the opposite was identified for both locations. In particular, the percentage distribution of shots taken from the "2 Point – Right – 45" halved from 2015 to 2016, whilst the "2 Point – Left – 45" reduced marginally. Table 6-13 also highlighted that in 2015, 2.56% of shots were taken from the "2 Point – Left – Base" shot location whereas 6.29% of shots were taken from the same location in 2016. In addition, the data demonstrated that players reduced the percentage distribution of shots taken from the "2 Point – Centre – Long" location. However, a higher shooting efficiency was found for shots taken from this location during 2016 in comparison to 2015. Subsequently, the results from Table 6-13 demonstrated shooting strategies were devised from five locations: "2 Point – Centre – Near", "2 Point – Centre – Mid", "2 Point – Left – Base", "2 Point – Right

– Base" and "2 Point – Right – Elbow". The shooting efficiencies from four of the five locations reduced in 2016 in comparison to 2015. Although, the shooting efficiencies from the two shooting "45" locations with odds of greater than three increased along with the "near" shot location, which had been identified in the Chapter Five model.

Table 6-13: Great Britain's Shot Locations when attempting shots.

Shot Location	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
2 Point - Centre - Long	11	21	32	34.38%	11.72%	20	32	52	38.46%	9.90%
2 Point - Centre - Mid	14	15	29	48.28%	10.62%	28	31	59	47.46%	11.24%
2 Point - Centre - Near	46	42	88	52.27%	32.23%	108	75	183	59.02%	34.86%
2 Point - Left - 45	7	16	23	30.43%	8.42%	17	25	42	40.48%	8.00%
2 Point - Left – Base*	5	2	7	71.43%	2.56%	20	13	33	60.61%	6.29%
2 Point - Left - Elbow	8	11	19	42.11%	6.96%	8	20	28	28.57%	5.33%
2 Point - Right – 45*	18	23	41	43.90%	15.02%	17	21	38	44.74%	7.24%
2 Point - Right – Base*	5	1	6	83.33%	2.20%	17	11	28	60.71%	5.33%
2 Point - Right - Elbow	4	1	5	80.00%	1.83%	8	11	19	42.11%	3.62%
3 Point	8	15	23	34.78%	8.42%	13	30	43	30.23%	8.19%
Overview	126	147	273	45.79%	100%	256	269	525	48.76%	100%

*: Denotes a significant ($p<0.05$) relationship between the total number of shots taken between the two tournaments.

By comparing Great Britain's performance in 2016 to 2015, Table 6-14 illustrated a higher percentage distribution of shots taken under "Zero" defensive pressure. This finding aligned with the advice provided to the coaching team and players. However, despite a greater percentage of shots being taken, which according to the model should have produced a 67.37% chance of success, the player's shooting efficiency reduced to 55.15%. It was also identified that Great Britain's shooting efficiency for each pressure variable was higher in 2016.

Table 6-14: Opponents attempts to create Defensive Pressure on a Great Britain player's shot attempt.

Defensive Pressure	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
Zero*	37	21	58	63.79%	21.25%	107	87	194	55.15%	36.95%
One*	67	81	148	44.59%	54.21%	88	106	194	45.36%	36.95%
Two	12	23	35	34.29%	12.82%	35	50	85	41.18%	16.19%
Three	9	19	28	32.14%	10.26%	21	22	43	48.84%	8.19%
Four	1	3	4	25.00%	1.47%	5	4	9	55.56%	1.71%
Overview	126	147	273	45.79%	100%	256	269	525	48.76%	100%

*: Denotes a significant (p<0.05) relationship between the total number of shots taken between the two tournaments.

No statistical differences were identified between the two tournaments for Defender Marking Space and Defender In Front CPV. Chapter Five identified the odds of success tripled when there was a defending player marking space. Table 6-15 illustrated the percentage distribution of shots taken whilst a defender was marking space only marginally increased. However, the player's shooting efficiency increased from 36.74% to 45.76% when the space around the shooting player was being defended (See Table 6-16). No significant differences were observed regarding the percentage distribution of shots taken between the two tournaments when there was a "Defender In Front".

Table 6-15: Opponents attempts to defend the space around a Great Britain player whilst they are attempting a shot.

Defender Marking Space	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
No	80	125	205	39.02%	75.09%	190	179	369	51.49%	70.29%
Yes	46	22	68	67.64%	24.91%	66	90	156	42.31%	29.71%
Overall	126	147	273	45.79%	100%	256	269	525	48.76%	100%

Table 6-16: Opponents attempts to defend in front of a Great Britain player whilst they are attempting a shot.

Defender In Front	2015 European Championships					2016 Paralympic Games				
	Suc	Unsuc	Total	Eff.	%D	Suc	Unsuc	Total	Eff.	%D
No	65	42	107	60.75%	39.19%	105	90	195	53.85%	37.14%
Yes	61	105	166	36.74%	60.81%	151	179	230	45.76%	62.86%
Overall	126	147	273	45.79%	100%	256	269	525	48.76%	100%

6.5 Discussion

This chapter aimed to establish if the men's Great Britain wheelchair basketball team adopted a data-driven approach by using the information and advice provided in Chapter Four and Chapter Five, to inform the team and shooting strategies adopted at the 2016 Paralympic Games. Through comparing the frequency counts and percentage distributions of Great Britain's team performances between 2015 and 2016, it was found that data aligned with the advice generated by the predictive model for the following CPVs: Offensive Unit - 4.0-4.5, Start of Possession, Shot Type and how to reduce defensive pressure whilst shooting (see Table 6-17). The data partially aligned with the advice for the Offensive Unit - 3.0-3.5, Defensive Unit - 3.0-3.5 and Shot Location CPVs. Whilst the Game Status, Defensive System and Shot Positioning differed from the advice provided to the team before the 2016 Paralympic Games.

Table 6-17: Summary of whether Great Britain wheelchair basketball coaches and players followed the advice provided to them based on the models developed from the 2015 European Wheelchair Championships.

CPV	Advice	Outcome
Game Status	Maintain a status of Winning	Differed from advice
Offensive Unit - 3.0-3.5	Refer to Defensive Unit - 3.0-3.5	Partially followed advice
Offensive Unit - 4.0-4.5	Refrain from playing with "Three" players on-court	Followed advice
Defensive Unit - 3.0-3.5	Increase the use of these players	Partially followed advice
Start of Possession	Attempt to begin possession in the opponents half.	Followed advice
Defensive System	Limit "Highline" and Pressing Systems	Differed from advice
Shot Positioning	Adopt a "Square to Basket" position	Differed from advice
Shot Location	Shoot from near or 45 degree	Partially followed advice
Shot Type	Adopt a "Post-Up" shot type	Followed advice
Changes in Defending the Shooter	Restrict interference in the shooting player's cylinder	Followed advice

Previous research has shown that the skill sets of 3.0-3.5 players and 4.0-4.5 players are almost identical (Zwakhoven *et al.*, 2003) and thus playing with a greater number of 3.0-3.5 players can allow coaches to use the 14-point team classification limit more effectively. In addition, the higher seating height typically used by 3.0 players would result in a reduction in the distance between themselves and the basket. Further to this, 3.0-3.5 players, despite having a reduced 'sideways movement' (International Wheelchair Basketball Federation, 2014a), were shown to have a superior pushing speed, both in offence and defence, in comparison to 4.0-4.5 players (Crespo-Ruiz, Del Ama-Espinosa and Gil-Agudo, 2011). Thus, the collection of anthropometric data per player would assist in contextualising the impact of each player (Anup *et al.*, 2014). However, due to the complexity of an individual's disability and game-to-game adjustments in their chair set-up, this was not possible within this thesis.

In addition, to collect valid data regarding the impact of an individual's functional ability on performance, laboratory testing or game simulation would be required, which may not provide a true representation of game performance (O'Donoghue, 2014). Despite this, the findings from this research highlight the potential benefits of operating units with a majority of 3.0 or 3.5 players due to an observed increase of these players shooting efficiency from 39% in 2015 to 53% in 2016. This chapter's findings also support the previous research presented above and demonstrated the BWB coaches attempted to use data to inform decision-making processes regarding the team's line-up selections. A reduction in the number of Offensive Unit – 4.0-4.5 players and an increase in the number of Offensive Unit – 3.0-3.5 players was observed. However, this shift was only partially observed due to BWB only having two 3.0 classified players within the squad. Subsequently, the findings from this research conflict with previous box-score data research which concluded the higher classified a player the more effective that player is at assisting a team's performance (e.g. Gómez *et al.*, 2014). Although, the researchers who used box-score data have not evaluated the effectiveness of a line-up combination, which has been achieved within the work presented in this chapter.

Furthermore, how possession started aligned with advice provided to the coaching team. Thus, increases in possessions starting from either a “Free Throw”, “Offensive Rebound” or a “Turnover” were identified. According to the model in Chapter Four, this would have significantly increased the odds of winning a game by 1.965, 1.609 and 1.398, respectively. An increase in the number of possessions starting with a “Free Throw” indicates Great Britain received a larger number of fouls during the games at the Paralympics. Sampaio and Janeira (2003) indicated teams have a larger number of free-throw attempts if opponents are less effective at exerting defensive pressure, either whilst a player is in the act of shooting or advancing down the court. Thus, confirming that Great Britain’s offensive strategy was superior to that of the opposition’s defensive strategy. As a result, opposition teams were required to foul players in an attempt to minimise the score. Kenter (2015, p.1) also stated that “a common tactic near the end of a basketball game is for the trailing team to foul to gain an advantage by forcing the opponent to shoot free throws”. Thus, further providing evidence as to why the points difference between Great Britain and their opponents was closer at the Paralympics in comparison to games at the European Championships. The closer scores in 2016 also support the notion that the quality of opposition was greater at the Paralympic Games in comparison to the European Championships. In addition, Gómez *et al.* (2008) inferred that opponents could have perceived or been instructed to foul players in an attempt to minimise the speed of an offence and limit the score. A cumulative foul count from an opponent would also lead to a greater number of possessions starting from “Free Throw”. However, the reasons for the increase in “Free Throw” attempts are currently unknown and further exploration is required to identify if any of the able-bodied patterns relate to wheelchair basketball.

The data highlighted Great Britain had superior defensive efficiencies at the 2016 tournament due to an increased number of possessions that began with a “Turnover”. Refoyo, Romarís and Sampedro (2009) found 60% of turnovers result from the opposition stealing the ball due to a superior defensive pressure.

Likewise, Fylaktakidou, Tsamourtzis and Zaggelidis (2012) found passing errors and ball handling errors contributed to an increase in turnovers in basketball due to the opponent's defensive pressure. However, Franks *et al*. (2015) argued that defensive efficiency should also include information that includes the points conceded and shot attempts against to provide an enriched measurement of defensive play. Great Britain conceded fewer points in 2016 (459 points) in comparison to 2015 (502 points), thus providing further evidence to infer that defensive efficiency had increased.

Despite a similar shooting efficiency being observed for both tournaments, an increase in possessions that started from an "Offensive Rebound" demonstrated that Great Britain was more effective at regathering possession following an unsuccessful shot. In addition, the data supported the notion that a different offensive strategy was used in 2016 compared to in 2015. To successfully achieve an offensive rebound in wheelchair basketball, players should work collectively (Walker, 2010). The shooting player should remain in the location where they finish the shooting action. One team-mate should position themselves closer to the basket in case the ball rebounds back towards the shooting player but does not carry. Whilst the other player should position themselves on the opposite side to the shooting player in case the ball rebounds away due to a longer unsuccessful shot. Gómez *et al.* (2015) found that typically higher classified players gain more offensive rebounds in a game due to a height advantage. Thus, as Great Britain achieved a greater number of offensive rebounds the data inferred taller players positioned themselves underneath the basket. However, this specific objective information was not collected during the games. Furthermore, McGee (2007) identified that having superior offensive skills in able-bodied basketball would allow offensive players to 'box-out' defensive players, thus restricting their ability to gain a defensive rebound and allowing the offensive player to gain possession instead. However, further exploration to obtain objective data is required to confirm the positioning of players when a possession begins from an "Offensive Rebound" and highlight how the player has 'boxed-out' a defensive player.

With regards to the comparisons of the other team CPVs, the data between the tournaments demonstrated Great Britain adopted a different strategy in 2016 to the strategy used in 2015. Despite the team winning and losing the same number of games at the two tournaments (See Figure 6-1 and Figure 6-2), the model developed in Chapter Four and the evidence provided, highlighted the odds of winning a game increased when a team started the possession in a state of winning. However, Great Britain produced a lower percentage distribution of being in a state of winning when starting the possession, but they were still able to win the same number of games at the Paralympic Games. Higham *et al.* (2011) found a tournament effect existed when exploring a lower level to a higher level tournament in rugby union with the higher level tournaments presenting as more intense and more competitive. Thus the findings from this study provide supporting evidence to explain why the ability to maintain a winning state at the Paralympic Games was less likely than at the European Championships. The Paralympic Games consisted of 12 teams, with each team advancing from a Zonal Qualification Tournament and the teams were seen to be the 'best' in the world. Within the sport, there is no world ranking system and the ranking of teams was determined by the teams that qualified from the zonal tournaments. The findings from the 2016 Paralympic Games also indicated the tournament was more competitive, highlighted by the increased frequency count and percentage distribution of the Drawing state being observed at the Paralympic Games.

The frequency counts and percentage distributions between the two tournaments also differed for the Defensive System CPV. The data used to develop the team logistic regression model indicated that when the offensive team faced a "Highline" Defensive System their chances of winning the game significantly increased. The objective evidence, based on the optimal Defensive System, was provided to the coaches, players and support staff to devise a defensive team strategy and reduce the occasions that a "Highline" system was operated by Great Britain. However, during 2016 the number of times the "Highline" Defensive System was adopted increased in comparison to 2015. The "Highline" system involves the five players working together in an attempt to slow the ball by starting above the three-point line. As a result, the spacing between defenders when five players are further away from the basket increases and the likelihood of scoring and thus winning for the team in possession increases (Lamas *et al.*, 2015). The same pattern was observed by Gómez, Tsamourtzis and Lorenzo (2006) in able-bodied basketball. The researchers found defending further away from the basket, by adopting a man-to-man half-court defence, significantly contributed to the opposition winning the game. Similar findings are also apparent in other invasion sports whereby as the distance between the defender and attacker increases the chance of the attacker beating the defender increases (Passos, Araújo and Davids, 2013). This decision to also adopt a "Highline", based upon interpreting the model created in Chapter Four, would have increased the chance of the opposition team winning by 8.20% and could partially explain why Great Britain did not improve on their win to loss ratio (See Table 4-6).

In a similar vein, Great Britain's utilisation of a data-driven approach to developing their shooting strategy was found to have partially followed the advice from Chapter Five. During the 2016 Paralympic Games, players took a higher percentage distribution of Shot Types utilising a "Post-Up" in comparison to a "Set-Shot" or a "Lay-Up". The shift in percentage distribution from 2015 to 2016 also observed an improvement in shooting efficiency for "Lay-Up" and "Post-Up", but a decrease in "Set-Shot" efficiency. The findings from this chapter support able-bodied research which found coaches and players should rely on "Post-Up" shots in favour of other shot types (Tsamourtzis *et al.*, 2003; Mavridis *et al.*, 2009). The "Post-Up" shot allowed players to reduce the defensive pressure as the ball was released from a higher release height and thus defenders were subsequently further away from the ball. The findings from this chapter also demonstrated that the coaches and players adjusted their offensive strategy in an attempt to create more opportunities for players to take a "Post-Up" shot attempt. However, the mechanics and movement patterns which players performed to allow the specific shot attempt to be made have not been explored and thus are unknown.

Furthermore, the evidence from the percentage distributions for the Shot Location CPV demonstrated the players took a greater percentage of the shot attempts from closer to the basket in 2016 in comparison to 2015. The players' shooting efficiency also improved from the two tournaments when a player was 'near' the basket or at the left or right '45' locations. This pattern partially follows the advice given to the coaches, players and support staff based on the model developed using the 2015 European Championship data (see Chapter Five). Despite this finding, the coaches appeared to devise systems which did not allow players to maximise the '45' degree locations as the percentage of shot attempts decreased across the two tournaments. However, the findings, within this chapter, conflict with research in able-bodied basketball, which demonstrated the percentage of shot attempts outside the key and behind the free-throw line are higher than inside the key (Reich *et al.*, 2006). The differences observed within able-bodied basketball and wheelchair basketball could be explained due to the seating position of wheelchair basketball players.

Wheelchair basketball players' ball release height is lower than that of able-bodied players and thus taking a shot attempt closer to the basket reduces the distance between the shooting player and the basket (Rojas *et al.*, 2000; Malone, Gervais and Steadward, 2002). In addition, wheelchair basketball players typically have a reduced core function and have been shown to generate less power in the act of shooting (Matthew and Gretchen, 2018). In particular, lower classified players do not have the required core stability to execute a "Post-Up" shot from distance. By reducing the distance between the shooting player and the basket, the model developed in Chapter Five demonstrated the odds of shooting success increase. Therefore, the increasing frequencies of shot attempts that are taken closer to the basket indicated the players did attempt to adopt a data-driven approach. However, the findings from the 2016 Paralympic Games suggest players elected to use four other shot locations, which had lower odds. Subsequently, these remaining locations produced a reduction in shooting efficiency. Thus, this finding demonstrated the players were unable to obtain the optimum shot location or the advice that was being provided to the coaches and players was not applicable to the 2016 environment.

The data-driven recommendations indicated a player's Shot Movement should be ideally "Rotating Left" to double the odds of a successful shot. During the 2016 Paralympic Games, the percentage distribution for shots taken whilst "Rotating Left" increased from 3.66% to 23.43% (See Table 5-8), thus demonstrating alignment with the data-driven advice. These findings are supported by Rojas *et al.* (2000) in able-bodied basketball, who found when shooting players are moving, an adjustment in horizontal movement is observed, whereas, when the player is stationary there is no horizontal movement and power reduces. Thus, a shooting player's efficiency is correlated with an increase in horizontal movement. However, despite this increase, the shooting efficiency decreased. In contrast, the wheelchair basketball players' shooting efficiencies increased for "Towards Basket" and "Away From Basket" despite the odds, suggesting that the success rate would decrease.

Wheelchair basketball players, who are classified below 3.0, have a reduced core function. This reduction in controlling horizontal movement can affect a player's shooting effectiveness because their base of support is affected when they begin to rotate (Fliess-Douer *et al.*, 2016; Tweedy, Mann and Vanlandewijck, 2016). However, higher classified players are still able to maintain control of horizontal movement whilst shooting (International Wheelchair Basketball Federation, 2014a). Therefore, a potential limitation of this study was grouping the players into three specific classification groups regarding the shooting analysis. As a result, an important aspect to consider when informing players of optimal shot movement patterns is their classification, because the increased number of shots taken when "Rotating Left" could be due to players with less core control attempting shots with an unstable base of support. Thus, it is important to tailor feedback and information based on a player's functional ability. Despite this result, the findings demonstrated the wheelchair basketball players' performances aligned with the data-driven approach to inform their Shot

Movement. However, the time between players being informed of the new approach to implementing these changes was only seven months, which coupled with the generic non-classification feedback, could explain the observed patterns with the data.

The learning period of seven months could also explain why players at the 2016 Paralympic Games did not seem to adopt a data-driven approach regarding the Shot Positioning CPV. According to Diedrichsen and Kornysheva (2015), learning is an evolving process from the effortful selection of single movement elements to the combined fast, accurate and effortless production. Thus, the learning process to make small adjustments within an individual's technique takes time due to the need to form new execution-level representation or the need to call on simpler motor primitives at the execution level (Wiestler and Diedrichsen, 2013; Diedrichsen and Kornysheva, 2015). This previous research provides supporting evidence to explain why the players did not illustrate a dominant Shot Positioning with the percentage distributions being equally distributed between "Square to Basket" and "10-90 Left". According to the model in Chapter Five, the odds of shooting success are 0.151 when a player is attempting a shot in the "10-90 Left" position in comparison to 2.064 when "Square to Basket". However, the shooting efficiencies decreased from the Europeans to the Paralympics when a player attempted a shot from a "Square to Basket" position but increased from a "10-90 Left" position. Thus, the findings dispute the data and model developed from the European Championships. In addition, the models developed included multiple teams and thus specific team tactics are not accounted nor the quality of opposition. Therefore, the accuracy of the models for use by one team to inform practice may not be accurate.

Coaches can elect to focus on enhancing the areas of weaknesses to improve the shooting odds or focus on continually improving areas of strength. The findings suggest coaches elected to focus attention on areas of weakness and as a result, the strength of having a "Square to Basket" position could have been neglected. However, the increasing percentage distribution of the "10-90 Left" could be due to the increasing percentage distribution of “Post-Up” shots and “Two Hands” being on the ball. When a player is taking a “Post-Up” shot with “Two Hands” on the ball they lose control of their chair and becomes more susceptible to being re-positioned by the defending player. Although no specific research has been conducted to support or contradict this suggestion, based on the player’s centre of mass being adjusted and wheelchair basketball players’ core control being reduced (Bascou *et al.*, 2012), this could be possible.

The Defensive Pressure exerted by opponents in 2016 upon a Great Britain player whilst shooting was found to be lower in comparison to during 2015. In addition, as defensive pressure increased from “Two” to “Four” the players’ shooting efficiency was found to increase. These findings infered the Great Britain team made attempts to use a data-driven approach to develop and implement a strategy which increased the Defensive Pressure and allowed the players through training, to become used to added pressure. Within able-bodied basketball, research has found that through increasing the distance between defenders and reducing the defensive pressure the success rate of the shooting player increased (Lucey *et al.*, 2014). The findings within this chapter support the previously published research and highlight the importance of developing less pressurised shots. However, Lucey *et al.* (2014) also reported that on-court player rotations and ball movement were found to be contributing factors to the establishment of an open shot, although these factors were not recorded within this chapter or the previous chapters. Despite the reduction of Defensive Pressure, the Great Britain team was able to achieve similar average tournament shooting percentages and thus suggested these CPVs may not affect shooting performance.

Through exploring and discussing the similarities and differences observed between the two tournaments, the findings can be interpreted two ways: they occurred due to chance or they indicate an attempt had been made to adopt a data-driven approach. Researchers’ perspectives have been divided when attempting to understand the decision-making processes of individuals. One school of thought is that team sport is too dynamic and the constant decision-making processes and interactions between opponents and team members do not follow a pattern (Lebed, 2013). As a result, any similarities between the team and shooting performances between the two competitions are due to an element of chance. For example, the models developed in Chapter Four and Chapter Five only illustrated good predictability and thus imply there is an element of chance when predicting team and shooting outcomes utilising the CPVs within the study. Therefore, the similarities and differences observed between the tournaments occurred due to chance.

Alternatively, players have a limited number of available options within any given situation, and thus their decisions can be recorded and used to predict future decisions (Glazier, 2010; McGarry, 2013). This can also be indicated by the models in Chapter Four and Chapter Five which demonstrated 74.9 and 79.8 per cent predictability thus indicating a good level of success in predicting the game or shot outcome. Furthermore, the similarities and differences indicate the coaches, players and support staff are able to adjust the decision of their players as well as the opposition. From the data presented in the chapter, it demonstrated that Great Britain made attempts to adjust their team strategies and aligned with four out of the seven CPVs which were identified to increase the odds of achieving success. In addition, the coaches, players and support staff made adjustments in line with the data provided to them regarding five out of the eight shooting strategies.

Although a shift in the team and shooting strategies has been observed, the similarities and differences could be due to the different situational variables. In comparison to the European Championships, the Paralympic Games had an increased amount of pressure due to the event being the pinnacle of the sport with the ‘best’ teams in the world competing and different opponents competing for a medal. There was increased media exposure and the tournament was played in a different country (Churton and Keogh, 2013; Pappous and Lange de Souza, 2016). These factors have been found to impact upon an individual’s psychological and physiological responses and thus could inhibit their performance (Andreato *et al.*, 2014; Arnold and Sarkar, 2014; Sarkar and Fletcher, 2014; Sarkar, Fletcher and Brown, 2015; Gill, Williams and Reifsteck, 2017). Although, these factors have not been incorporated into the models due to the collection of the video footage occurring following the event, no attendance figures per game being freely available nor psychological or physiological data being collected during and immediately after the event. Subsequently, future research should attempt to gather this information in an attempt to present a more holistic picture, develop a broader understanding of performance and understand how to assist player and coach learning decision making.

6.6 Conclusion

This chapter explored the team and shooting strategies adopted by the men's Great Britain wheelchair basketball team at the 2016 Paralympic Games in comparison to the 2015 European Championships, to determine whether a data-driven approach had been adopted by the coaches, players and support staff to inform the decision-making processes. By comparing the team CPVs and shooting CPVs a number of similarities and differences were observed between the two tournaments in relation to the data-driven recommendations provided in Chapter Four and Chapter Five:

1. Great Britain used a greater number of "Two" 3.0-3.5 players and fewer 4.0-4.5 players at the Paralympic Games in comparison to the European Championships, which according to the model in Chapter Four suggested the odds of winning would increase. However, Great Britain's win to loss ratio was the same across both tournaments.

2. A predominant Defensive System was not employed by Great Britain in line with the data-driven approach, however, the frequency in which a "Highline" Defensive System was used doubled, despite the coaching team and players being advised not to use this system because the odds of opponents winning a game increased.

3. A “10-90 Left” Shot Positioning was the superior percentage distribution at the 2016 Paralympic Games, which according to the model reduced the odds of shot success by 0.151. However, Great Britain’s shooting efficiency from this location increased from 10.45% at the 2015 European Championships to 46.47% at the 2016 Paralympic Games. Whereas, the model in Chapter Five found that shooting from a “Square to Basket” Shot Positioning was found to increase the odds of success by 2.064, although, at the Paralympic Games the shooting efficiency from this Shot Positioning was 9.69% less than at the European Championships.

4. “Towards Basket” still remained the dominant Shot Movement, which was found to decrease the odds of a successful basket (OR: 0.768). However, at the Paralympic Games, the shooting efficiency was 55.64% in comparison to 46.79% at the European Championships. The percentage distribution of “Stationary” and “Rotating Left” increased, which according to the model would increase the odds of achieving a successful shot. However, both these action variables produced lower shooting efficiencies at the Paralympics in contrast to the European Championships.

Despite the data suggesting some alignment, it is not possible to conclude that the coaches, players and support staff followed the advice as information regarding this matter was not collected. Thus, an exploration into how and why the coaches, players and support staff elected to acknowledge or partially acknowledge some information and not incorporate other data-informed evidence into their strategies requires consideration in the future. Overall, if the reasons as to why certain aspects of data were incorporated within the team’s strategy and other aspects neglected, further improvements can be made to the process used to feedback the collected and analysed data to the coaches, players and support staff to improve future learning, decision-making and performance.

Chapter 7 The analyst and the SPA provision

7.1 Transition

In the previous chapters of this thesis, it was highlighted that the process of SPA was a process used to record the complex actions and behaviour that occurred during sporting performance (Wright, Carling and Collins, 2014). The recordings were then expressed through statistical processes to present a mathematically articulated picture of performance that coaches, players and support staff understood and could be used to inform practice (Jones, James and Mellalieu, 2008; Gómez, Moral and Lago-Peñas, 2015). This approach aligned with a numerical reductionist perspective; whereby individuals attempt to explain complex phenomena by reducing the complex actions and behaviours into constituent elements (Jones, 2000). Generally, a performance analyst attempts to capture, understand and explain the complex actions and behaviours observed within a sporting performance through a set of variables that provide insights into identifying a cause and an effect relationship (Hughes, 2004). Analysts can then scientifically test these small parts and use objective evidence to explain the identified relationships. This is all for the sake of increasing sporting performance.

This approach was followed in Chapter Four and Chapter Five; through reducing wheelchair basketball team and shooting performances at the 2015 European Wheelchair Basketball Championships into a set of key constituent elements that were attributed to performance success. The results from these Chapters acknowledged the magnitude by which some factors could improve or negatively impact performance. For example, if a player "Rotated Left" during the shot, the likelihood of shot success was more than double. Referring back to the coaching process model developed by Franks, Goodman and Miller (1983) presented in Chapter One, once the variables that are attributed to performance success have been identified, coaches can use this data to inform practice, make adjustments to game plans and assist player learning (Middlemas, Croft and Watson, 2017). Here, complex actions and behaviours regarding wheelchair basketball performances from 2015 were reduced into a set of three key messages for team success and four key messages for shooting success.

During preparations leading up to the 2016 Paralympic Games, wheelchair basketball coaches, players and support staff associated with the Great Britain team were provided with these key messages. Through comparing BWB performances at the 2015 Championships with those at the 2016 Paralympic Games, data only aligned with the advice provided within the key messages for four out of the 10 CPVs. In Chapter Six, a number of interpretations and explanations for such results were identified and provided. Kline (1996) and Fardet and Rock (2014) suggested that through reducing the complex actions and behaviours into constituent elements, important and meaningful information could be lost and, therefore, the knowledge surrounding the cause and effect relationship could become unknown or misinterpreted. For example, through electing to remove information pertaining to the number of players in the 1.0-1.5 class and 2.0-2.5 class contextual information could have been lost that would have aided coaches' decision making regarding the involvement of these players within specific line-ups. Subsequently, through relying on the numerical comparison study (Chapter Six) to evaluate the impact of SPA data and the SPA provision, it remained unclear as to whether the findings indicated that the coaches, players and support staff attempted to use the data-driven approach to assist the team during the 2016 Paralympic Games or whether the changes observed in the CPVs were due to chance.

Kirkland (2016, p.10) alluded to the fact that coaches, players and support staff are hungry for knowledge informing "how [they] perceive, think, make decisions and act". However, these individuals can resist ideas, data and interventions that they perceive are logistically challenging or where a direct link to improved performance is not obvious (Kirkland and Webb, 2015). For example, through reducing performance information into constituent elements, the direct link in relation to what players need to do specifically to improve performance could become clouded. The discussion presented in Chapter Six indicated that a number of contextual factors were not controlled due to the process of attempting to present a mathematically articulated picture of performance and therefore ‘guess’ interpretations were made as to the reasons why patterns were observed regarding the adoption, partial adoption or rejection of data to inform practice.

Kirkland and Webb (2015) highlighted a collaborative approach could be more applicable than solely relying on a reductionist approach to establish knowledge; acknowledging the value of sharing thoughts, opinions and knowledge between researchers, coaches, players and support staff could result in a more impactful practice. Bampouras, Cronin and Miller (2012) supported this notion and highlighted that without gaining the perspectives of the players, who start and end the SPA process, the analysts, who collect the data, and the coaches, who review and feed the information back, lessons cannot be learnt regarding how to use or improve the provision, which would enhance the SPA process and performance. Booroff, Nelson and Potrac (2015) also found that moving towards this approach provided credence to illuminating the complex, everyday social realities of using SPA in practice. Sparkes and Smith (2014) have further highlighted the importance of collecting the views, opinions and thoughts of those individuals involved in sport. The insights gained by such an approach have been found to enable coaches and support staff to develop a deeper, broader and subtler understanding of the processes involved in developing players’ learning and decision-making skills (Mills, Denison and Gearity, 2017). Thus, if the multiple social processes inherent in sport are ignored, coaches and support staff do not consider the factors which could impact on a players’ ability to learn (Coalter, 2007). Subsequently, this approach could assist in making sense of the use of SPA data in high performance contexts and contribute towards understanding whether individuals have used SPA to assist their current practice.

7.2 Overview

Potrac and Groom (2014) suggested that collecting the perspectives of those individuals within the SPA process, regarding how they coped with new ideas and concepts presented to them as a result of the SPA provision, could assist with providing a valuable insight. Thus, to explore the reasons why there was no perfect alignment between the data provided to the BWB coaches, players and support staff, and the performances at the 2016 Paralympic games an alternative approach, in comparison to the initial study chapters, was undertaken. In doing so, in this chapter, a paradigm shift occurs to gain a deeper insight into the BWB sub-culture and the active application of relevant socio-political lenses to interpret coaches', players' and support staff's perceptions towards SPA. The methodological procedures which were used to gain insight into the opinions of key agents regarding the introduction and utilisation of SPA throughout the Paralympic Games cycle are outlined. The participants' narratives are then thematically analysed and the key themes discussed. It was interpreted that the coaches did not engage in SPA, whilst the players and support staff attempt to use SPA, due to socio-political reasons. Informed by the findings, this chapter concluded that the establishment of trust is key to cultivating relationships with coaches, players and support staff to increase awareness and buy-in of SPA. The arising power and micropolitical interplay between the coach, players and analyst can be softened through the development of rapport, which can, in turn, lead to an increase in the engagement with SPA by all stakeholders.

7.3 Introduction

Over the past two decades, research in SPA has typically focused on the analysis methods to augment subjective observations of previous performance (Mackenzie and Cushion, 2013; Nicholls et al., 2018; Fernandez-Echeverria et al., 2019). The knowledge acquired through these methods has contributed to a wider understanding of the actions and behavioural characteristics of individual players and teams during competitive situations (Butterworth, O'Donoghue and Cropley, 2013). These previous researchers within the field of SPA have adopted a reductionist approach, whereby the analysis of sporting performance has been viewed through a closed system, generalising the complex actions and behaviours into simple constituent elements (Mesquita et al., 2013). However, through this perspective key information is often lost, including various situational factors that have been attributed to affecting sporting performance (Jayal et al., 2018). Passos (2017) argued sporting performance should be viewed through a more dynamic lens to represent the complex nature of human behaviour which is structured from the constituent elements and the interactions between the constituent elements. In this manner, Araújo and Davids (2016) believed sporting performance should be considered a changeable and unpredictable phenomenon. Therefore, arguing a need to acknowledge variables such as space, time, personal characteristics, subjects motivation and the interactions between these variables in an attempt to present a more meaningful insight into previous and future performance (Seabra and Dantas, 2006; Grehaigne and Godbout, 2013).

Within the last few years, the discipline has begun to acknowledge the importance of analysing sporting performance in this manner (Fernandez-Echeverria et al., 2017). Seifert et al. (2017) suggested this would enable both researchers and coaches to understand the variables that describe the key events, the influence of opponents and the cooperation relation between players and teams during a sporting performance. Through viewing a sporting performance in this manner, Mesquita and Marcelino (2013) additionally argued that coaches, players and support staff are provided with more useful and meaningful information that demonstrates the variability of humans during a sporting performance. This information can then be used to facilitate an evaluation of previous performances (Jones, James and Mellalieu, 2008; Butterworth, O'Donoghue and Cropley, 2013), in which coaches, players and support staff are attempting to aid improvement, through enhancing the reviewing and feedback processes for performers (Franks and Miller, 1991; Baca, 2006; Francis and Jones, 2013; Middlemas, Croft and Watson, 2017). It has been documented that coaches have been making use of these SPA methods to assist their current practices and they have perceived it as a beneficial tool to aid the coaching process (Nicholls and Worsfold, 2016; Nicholls et al., 2018). However, few researchers have considered the extent to which this information and data is used in practice to assist the decision making processes and strategic approaches used by coaches, players and support staff to improve the performance of a team (Fernandez-Echeverria et al., 2017).

Of the studies completed to date, researchers have identified the importance of SPA for aiding performance recollection, developing game understanding, encouraging players to engage in self-reflection, highlighting methods to optimise feedback processes and improving player confidence (Groom and Cushion, 2005; Francis and Jones, 2014). However, what has been recognised as key to the importance of SPA, is how the information is transmitted to players (Fernandez-Echeverria et al., 2017, 2019). Coaches typically work with a performance analyst to analyse past performances in a collaborative and interdependent relationship (Bampouras, Cronin and Miller, 2012). The information is then presented in multiple different ways to individuals, groups of players or the team as a whole through numerical data and/or video footage (Bampouras, Cronin and Miller, 2012; Groom and Nelson, 2013; Taylor et al., 2014). Additionally, coaches use SPA as a tool for planning future training sessions and identifying tactical solutions to assist with preparations for upcoming games (Painczyk, Hendricks and Kraak, 2017; Kraak, Magwa and Terblanche, 2018). Players have also praised SPA as a beneficial learning tool for improving performance and enabling them to prepare better for competition (Reeves and Roberts, 2013; Francis and Jones, 2014). However, players have also highlighted that they want to have an active involvement within the SPA process, completing their own analysis and joining in with pre-game and post-game reviews (Bampouras, Cronin and Miller, 2012; Vinson et al., 2017).

There is initial agreement from coaches, players and support staff about the benefits of SPA in relation to learning, developing and preparing players to perform. However, researchers have highlighted that the learning environment, the social setting, relationships and motivation could all influence the application of SPA into practice. For example, Nelson, Potrac and Groom (2014) discovered, through a series of in-depth, semi-structured interviews, that the player's engagement and acceptance of SPA was affected by the coach-athlete relationship, specifically whether the player trusted the coach. In addition, through surveying performance analysts, Wright et al. (2013) believed that the coach’s ability to trust the analyst affected the use of SPA within football. However, the accounts from these expert analysts are limited due to their perceptions being collected through a closed-answer questionnaire which restricted responses to a set of pre-selected choices (Gillham, 2008).

Bampouras, Cronin and Miller (2012) argued that how SPA was currently being used could result in imbalanced power dynamics due to the specific role-configurations of the coach, analyst and players. Power was identified a key theoretical focus of Groom, Cushion and Nelson's (2012) work; the researchers reviewed a coach’s interactions during a series of video feedback sessions and identified that he attempted to exercise control over the players' involvement and organisation of the session. The players, through being exposed to this situation developed negative perceptions towards SPA, the coach and the club culture. However, by engaging players in collaborative activity, minimising power imbalances and developing culture, De Martin Silva and Francis (2019) found the players, the coach and the analyst held positive views towards the use of SPA in aiding learning and preparing players for competition. Similarly, Huggan, Nelson and Potrac (2015) provided a valuable insight into the experiences and viewpoints held by a performance analyst. The researchers interpreted that the analyst had to learn to act (micro)politically (Kelchtermans and Ballet, 2000) in order to navigate through the social-political realities of elite sport and ensure he was contributing to aiding player learning and development. Through these initial studies, the emic (from the perspective of the subject) and etic (from the perspective of the observer) perspectives provided by the coaches, players and support staff shed light on SPA and how it has been used to aid the coaching process. However, these studies did not sufficiently concern themselves with the social, political and emotional processes that influence the interpersonal relationships which have been highlighted as an important facet in regards to the application of SPA and lack the necessary theoretical underpinning to help make sense of the participant’s experiences.

In seeking to build on these initial exploratory and theoretically underpinned works critically addressing a SPA provision and the role an analyst fulfils, this chapter aims to (i) explore the personal and performance impact of SPA throughout the Rio de Janeiro Paralympic Games Cycle, (ii) identify the potential reasons why the coaches, players and support staff chose to disregard some of the data-driven advice during the Paralympic Games and (iii) uncover the potential mechanisms that might have encouraged individuals to use SPA evidence to inform future decision-making during training and games. How these two key sociological concepts are constantly (re)fashioned as individuals attempted to use SPA to aid performance is explored rather than viewing micropolitics and power as separate entities as the analyst, coach, players and support staff attempt to use the SPA provision. By adopting such an approach, previously unexplained issues surrounding the SPA process and the analyst are forefronted. It is hoped the insights gained from this chapter will contribute to a growing epistemology of SPA that challenges the historical ways of thinking, inquiring and delivering a provision.

7.4 Method

7.4.1 Researchers positionality and theoretical approaches

By adopting a positivist and reductionist approach in Chapter One to Chapter Six, the key technical and tactical determinants of wheelchair basketball success were identified. Whilst following this approach, the researcher remained detached from the participants ensuring objectivity (Lincoln and Guba, 1985). However, in reality, the lines between the dual role as both the BWB men's performance analyst and a PhD student researcher became blurred. Subsequently, the use of the first person is used within the chapter to provide a reflection and further details regarding the dual that was fulfilled, telling my own story regarding the struggles faced.

During the data collection periods, I was analysing training sessions and travelling with the team to provide SPA support at warm-up and major tournaments. I found myself spending large proportions of my time interacting with the coaches and players, providing them with objective evidence in an attempt to assist their learning and development almost on a daily basis. Subsequently, instead of not having regular contact with the participants, as positivist researchers often advise (Hunt, 1991; Macome, 2002; Gray, 2013), I was seeing and talking with each individual on an almost daily basis. It was through this process that I realised I had become solely concerned with the statistical results as opposed to understanding how the findings were being used and interpreted by the coaches, players and support staff. In essence, I had become too fixated on attempting to categorise beliefs and worldviews into numbers (Gray, 2013). Instead, I needed to understand how my role and the information I produced were impacting on individuals. Thus, by employing an interpretative approach, it could be possible to explore participants' perspectives and uncover explanations and meanings, instead of seeking the 'truth' and mathematical logic (Klenke, 2008).

The interpretative approach, I adopted here was aimed at developing an insider's perspective, attempting to understand participants 'from within' (Kakkuri-Knuuttila, Lukka and Kuorikoski, 2008). The relationship between the participants and myself could now be explored more closely (Denzin and Lincoln, 1998), unlocking personalised insights regarding the SPA provision. This process was key to exploring the contribution I had been making as the analyst. It was not only important to enhance the limited work exploring the perspective of coaches, players and support staff towards SPA, but also to provide key lessons for BWB to optimise SPA during the next Paralympic cycle. Furthermore, although the models and objective information I collected provided an insight and prediction into future performances, the realities of the sub-cultural environment were not recorded. These realities formed a key part of the community and assisted in understanding essential social interactions (Lincoln and Guba 1985).

Through adopting a dual role as a researcher and the team's performance analyst, I was placed 'within' the environment, observing the day-to-day activities and interacting with the coaches, players and support staff. Through this interaction, I started to make sense of the experiences of the community, understanding the reasons underlying the deployment of SPA. I began to explore and understand how their perspectives related to the complex situations and the multitude of realities which the coaches, players and support staff found themselves in. Through being embedded in the team environment, I, along with my participants, was able to construct meaning rather than extracting it (Ireland *et al.*, 2009), allowing me to make sense of our reality. It is the richness of my experiences and the time I spent in the field as both the researcher and the analyst which are key to this chapter.

Denora (2014) also highlighted that whilst an individual can experience something from the outside, e.g. watching sport on TV, their experience will be different to actually being placed within it, e.g., sitting in a stadium or playing the game. This reinforces the importance of the researcher's positionality. Through being within it, the researcher develops and disseminates their knowledge and an understanding of reality by discovering the participants' cultural and historical experiences (Pring, 2000). Within the context of this chapter, this relates to the coaches, players and support staff and their thoughts and opinions towards SPA that are dependent on the interactions and reflection of the actors involved. Through my role, I had time to learn their perspectives by engaging directly with them. It was through this engagement, that I was able to gain an in-depth understanding of how they perceived the use of SPA. Here, as the researcher, I interpret how the individuals have presented these multiple interlinked realities, helping me to pursue meanings within this specific research context.

7.4.2 Research design

Interpretive case studies provide "tools for researchers to study complex phenomena within their contexts" (Baxter and Jack 2008, p.533). They explore phenomena through a variety of lenses (Yin, 2003), allowing for multiple facets to be explored, revealed and understood (Hancock and Algozzine, 2016). Case studies, "provide an intensive, holistic description and analysis of a single, bounded unit situated in a specific context to provide insight into real-life situations" (Ponelis, 2015, pp.535-550). They aim "to create as accurate and as complete as possible description of the case" (Cronin, 2014, p.20). Seeking to present a contextually rich and holistic insight by engaging with research participants in their real-life settings (Crowe *et al.*, 2011). Summarising Yin's (2003) work, Baxter and Jack (2008, p.545) advised that a case study research design should be adopted if:

> *(a) the focus of the study is to answer "how" and "why" questions, (b) you cannot manipulate the behaviour of those involved in the study, (c) you want to cover contextual conditions because you believe they are relevant to the phenomenon under study, or (d) the boundaries are not clear between the phenomenon and context*

This research aligns with Yin's recommendations; the case was the perceptions of coaches, players and support staff towards the use of SPA, but without the context, who were part of BWB High Performance Programme, and more specifically, involved throughout the Rio de Janeiro Paralympic Games Cycle. It was during this four-year period that the SPA provision was introduced that the individuals' perceptions were developed. Therefore, as Denora (2014) highlighted if an individual had not experienced the use of SPA within this specific setting their thoughts and opinions would be different to those who had actually gained first-hand exposure to the specific setting. Thus, a 'true' picture of the coaches, players and support staffs' perspectives towards SPA would not have been gained without the participants having used SPA as part of BWB High Performance Programme during the Rio de Janeiro Paralympic Games Cycle. Alternative research designs were considered, namely action research (Somekh, 2005), cross-sectional design (Lillis and Mundy, 2008), experimental design (Cash, Stankovic and Storga, 2018) and exploratory design (Singh, 2007), however, given the research focus, environment and alignment to Yin's (2003) recommendations, an interpretive case study research design was selected.

7.4.3 Participants

Using players and staff in high performance sport for research purposes magnifies the importance of confidentiality and anonymity. Therefore, due to the small number of individuals within the men's high performance programme (six staff; 16 athletes), no personalised information regarding their age, backgrounds and sporting achievements are provided in an attempt to protect their identity. Only the category of their job role is included (coach, player and support staff). A purposeful sampling method was used to select participants. Consequently, two coaches and one member of support staff were interviewed, who had been in the programme for a minimum of one year. In addition, five players were approached for participation in the study with each individual having been involved in the programme for the entirety of the four-year cycle (2013-2017). However, only four players were available at the time of data collection. Subsequently, once ethical approval had been awarded and a completed written informed consent form was received (See Appendix 17), the seven participants were provided with a pseudonym to hide their identity (See Table 7-1).

Table 7-1: Pseudonym assigned to BWB coaches, athletes and support staff.

Pseudonym	Role	Elite Level Experience in Wheelchair Basketball
Andrew	Coach	10+ years
Bob	Coach	10+ years
Charlie	Support Staff	Less than 5 years
Dom	Athlete	5+ years
Ed	Athlete	5+ years
Frank	Athlete	15+ years
Gareth	Athlete	5+ years

7.4.4 Data collection tools

Although a number of data collection tools have been used by interpretive researchers, field notes and interviews are considered the most revealing instruments for gaining a personalised insight into a researcher's and the participant's thoughts, opinions and experiences (Alshenqeeti, 2014). Field notes, according to Schensul and LeCompte (2013, p.48), are used as "a general term for recording observations of any kind made in the field". The term referred to written records of observations, informal conversations or personalised reflections of key events. The process of writing field notes is a complex task (Hellesø, Melby and Hauge, 2015). It requires the researcher to accurately record the physical settings, acts, interaction patterns and activities that unfold in the field or manifest themselves in the presence of the researcher (LeCompte and Schensul, 2010). These notes act as a brief reminder and represent the researcher's own interpretation of the interactions and conversations with the participants. They are not only an illustration of community life but act as "a reflection of the researcher as a primary data-collection instrument" (Schensul and LeCompte, 2013, p.56). Over time, these field notes help to support the research direction as ideas emerge from the observations and field notes (Tessier, 2012).

Additionally, interviewing participants provide the researcher with an insight into how the interviewee perceives their world. Through questioning, the researcher can begin to unpick the participant's responses in an attempt to comprehend how the interviewee appreciates the social world (Drabble *et al.*, 2016). Here I adopted a semi-structured interview approach to bridge the gap between adopting a rigid structure and securing descriptive and rich data (Galletta, 2013). Semi-structured interviews allow the researcher to follow relevant topics in relation to the proposed research question and area of interest (Cohen and Crabtree, 2006). The interview type is accustomed to enabling "depth to be achieved by providing the opportunity on the part of the interviewer to probe and expand the interviewee's responses" (Rubin and Rubin, 2005, p.88). Thus, the use of an interview guide or schedule ensures the interviewers do not stray from the researcher's topics, whilst allowing for new means of seeing and understanding the topics to be expressed and explored in the participants' response (Galletta, 2013).

Through utilising my field notes, I was able to draw on my own personal experience, prior knowledge and informal discussions with the coaches and players, to formulate relevant and meaningful questions prior to interviews. During the semi-structured interviews, open-ended questions were used to probe for further information and gain clarity on their initial response. This approach still provided opportunities for new ways of seeing and understanding the topic that was being explored, to be identified (Corbin and Morse, 2003). Thus, through field notes and the semi-structured approach, I was able to probe, but also maintain the participants' responses towards the research question, achieving an in-depth insight into key sub-cultural interpretations (DiCicco-Bloom and Crabtree, 2006), in addition to that of my own (LeCompte and Schensul, 2010).

7.4.5 Research procedure

Building on my experiences, embedded in the field, whilst acknowledging the limited previous literature regarding the perceptions of coaches, players and support staff towards SPA, a specific interview schedule for each role (See Appendix 18) was developed to ensure the aims of this chapter were achieved. The interview schedules focused on three key areas:

1. The utilisation of SPA over the four-year period and the effect of the data on the individual's learning.
2. The barriers that inhibited or prevented the participant from utilising and engaging in the data.
3. The solutions to potentially increasing an individual's use of SPA information and data.

A pilot interview was conducted with another member of BWB staff who had existing knowledge of the four-year SPA provision that had been received by the men's BWB High Performance Programme. The pilot interview assisted in checking of the data collection tool and interview schedule, and understanding how the interview questions were revised over time due to the data collected (Kim, 2011). The pilot interview took 85 minutes and provided some rich and detailed insights into the participant's thoughts and opinions towards SPA. Although no adjustments were made to the interview schedule, the experience provided a useful learning opportunity regarding the types of responses gained from the specific wording of a question. For example, one of the questions I asked, "Have you used SPA in your coaching?" generated a single response.

Building on my own knowledge regarding the participant's existing use of SPA, the question was reworded ("During your entire coaching/playing/support experience how has performance analysis influenced your practice?"), removing the closed, restrictive nature of the initial question. I also became aware of the balance between allowing the participant to expand on a response and straying too far from the topic. Finally, the pilot interview was a useful platform to explore how I could make use of specific probing questions to gain further information and seek clarity on the participant's initial response.

Prior to undertaking each interview, the participants re-read their signed participant information sheet (See Appendix 17) outlining the study. Each participant was given sufficient time to re-read the information and ask any questions about the study. This process was undertaken to check that participants understood the aims and procedures of the study. The interviews started with broad questions (i.e. what is SPA, when did you first start using SPA?), and from there the conversation flowed around the three key areas. During the interview, I made notes to assist with upcoming interviews with a different participant (Hammersley and Atkinson, 2007b). As stated above, throughout the four-year period, I also maintained a reflective log of key events that had occurred. The documents were shared with the research team and discussed in supervision meetings to corroborate what the participants had said and what I had concluded (Bekhet and Zauszniewski, 2012; LeCompte and Schensul, 2013; Babones, 2015). The process of discussing and reflecting on my own personal experiences and a number of the participants' responses assisted in making sense of events that had occurred.

The seven interviews were conducted in convenient locations and times for the participants. However, due to the training and competition demands of high performance sport, only two interviews were conducted at the team's centralised training base and two preceding a men's training camp at a previously used location. The remaining three interviews were conducted over Skype with the interviewee and myself being located at their own residential addresses. Hanna

(2012) supported the use of Skype as a research medium as it enabled the research to reap the same benefits of face-to-face interviews but at a time and place suitable for the participants' life. Subsequently, the advancements in modern technology and the development of an open and honest relationship did not create any barriers to the interviewer or the interviewee's responses. This openness could be due to the fact there was no significant time delay when using Skype between question and answers; allowing for both individuals to engage in synchronous communication without an extended period of reflection (Opdenakker, 2006).

Interviews were recorded and transcribed verbatim using Microsoft Word, with no loss of audio recording being found with the Skype interviews. The face-to-face interviews were recorded using a digital voice recorder whereas the Skype interviews were recorded using the screen capturing software in QuickTime. Following completion of each participant's interview, their pseudonym was used to save their voice recording and the subsequent transcript. Interview times ranged from 15 minutes to 1 hour 45 minutes, although the majority lasted just under an hour. The differences regarding the interview duration mirrored the duration the individual had been part of the programme and the number of years playing the sport. The interviews that were conducted over Skype, with Dom, Ed and Frank, were the longer of the interviews. The Skype interviews were arranged when the interviewer and interviewee were not under time pressures to complete additional tasks, whereas the other interviews were conducted between or after training sessions. Hanna (2012) inferred that Skype provided a neutral yet personal location for both the interviewer and interviewee. Thus, it could be argued that the participants were more relaxed and willing to expand on the topics that they were discussing which could be the reason for the longer duration of the interviews.

7.4.6 Quality of qualitative research

In pursuit of establishing trustworthiness and academic rigour of the qualitative data, Guba's (1981) constructs of credibility, transferability, dependability and confirmability were addressed. Credibility is concerned with the accuracy of the phenomena under scrutiny (Shenton, 2004). Drawing on Sparkes and Smith's (2014) guidelines, I ensured the story I presented (a) acknowledged individuals and their lives, (b) demonstrated that I cared about their experiences, (c) enhanced the existing knowledge, (d) ensured that others cared about the findings, (e) uncovered existing assumptions, (f) provided information that reflected the readers' own personal experiences, and (g) provided beneficial information to coaches, players and practitioners. Through acknowledging these guidelines, I ensured that I had a specific inclusion criterion for the study and developed trust and rapport with the participants. Ideally, the participants that were interviewed would have been involved for the duration of the entire four-year cycle. However, due to the high turnover of coaching and support staff, only those that had direct day-to-day contact with the SPA provision for a minimum of one year were approached for an interview. The same inclusion criterion was applied to the group of players. The criterion was applied to ensure that I had been able to build trust and rapport through understanding the participant as an individual and not just another number on a spreadsheet.

I engaged in different methods (observations, participant interviews, and a personal reflective log) and made use of these multiple data sources to ensure that the phenomena were explored from multiple perspectives, a process referred to as triangulation (Casey and Murphy, 2009). Collecting and comparing multiple data sources enhanced the quality of data, converging and confirming the findings (Knafle and Breitmayer, 1991), in an attempt to exploit the individual benefits and compensate their limitations of each method (Shenton, 2004). In addition, I also drew upon the expertise of others (Baxter and Jack, 2008), in this case, my supervisor team. I used this means of triangulation to verify the participants' experiences and perspectives against those held by the supervisor team, seeking to generate a rich picture of the perspectives towards SPA held by the coaches, players and support staff who had been interviewed.

As the data collection processes continued and the participants' interviews were transcribed, each participant received a copy of their transcript for member checking. It acted as verification mechanism that ensured the narratives were representative of each participant's everyday actions and perceptions surrounding SPA (Yilmaz, 2013). However, Harvey (2015) has criticised the process because most participants simply agree with everything that is transcribed. This was the case in this research as responses from the seven participants confirmed their transcriptions provided an accurate account of their views and experiences of SPA. Subsequently, I conducted informal face-to-face discussions with each of the participants at a training camp. These discussions were an attempt for me to clarify any points that were made during the interviews that I felt needed to be further explored. These discussions, which occurred in November 2017, enabled me to add further detail surrounding the points made by Frank and Gareth. The processes outlined above that had been undertaken ensured that I understood the role of the participant in the community, placing the situation into a wider perspective, and ensured the credibility of the participant's narrative and the story that I was portraying.

Guba (1981) writes that transferability is the degree to which qualitative research results can be transferred to other contexts and settings. It was thus imperative that I provided future readers with the boundaries and context of this work to enable them to transfer these interpretations into their research environment. When creating this story, I followed Shenton's (2004, p.71) recommendations from the outset that included information pertaining to:

> *a) the number of organisations taking part in the study and where they are based; b) any restrictions in the type of people who contributed data; c) the number of participants involved in the fieldwork; d) the data collection methods that were employed; e) the number and length of the data collection sessions; f) the time period over which the data was collected*

Through considering these guidelines, I provided a contextually rich story. The reader would be able to establish a deep understanding of how the participants' experiences shaped their responses (Saini and Shlonsky, 2012). However, it should "be questioned whether the notion of producing truly transferable results from a single study is a realistic aim or whether it disregards the importance of context which forms such a key factor in qualitative research" (Shenton, 2004, p.71). Thus, it is the responsibility of the person who wishes to 'transfer' the findings from this study into a different context to judge how sensible the transfer is. Although, it was my responsibility to present a story that did not marginalise the importance of the context, which has impinged on the case, but has been shown to enable others to relate the findings of this work to other areas.

It was also important for me to consider the dependability and confirmability of the work that I conducted. Dependability, according to Koch (2006), referred to the processes of the research study to be audited. Miles, Hubermann and Saldaña (2014) suggested that ten elements contribute to dependability. These were acknowledged and followed. Thus, the study's research design and interview questions remained consistent with the research aims along with the role and status I adopted as the interviewer. In addition, each interview followed the same interview schedule, aims and design. Although I added in additional questions based upon the direction and responses from the previous questions and interviews, these were documented and recorded, and these can be found in the appendices (See Appendix 19). This process was to ensure meaningful parallelism (Rogers, 2005) could be made across the seven interviews and covered the entire four-year cycle. For example, I added notes to the participants' responses regarding the period of time during the cycle that they were discussing and another contextual information (See Appendix 20). It was my role as the researcher to describe any changes in the research context and setting, and how these changes could have affected the means by which the research was conducted (Yin, 2015). This process ensured the reader was able to understand how I accounted for the ever-changing context throughout the research process.

Confirmability refers to the inevitable biases that exist in the research process (Koch, 2006). Researchers bring their own unique perspective to the study and the interpretation of the data. However, Guba and Lincoln (1989) believed that confirmability is recognised when credibility, transferability and dependability are achieved by the researcher, thus, allowing a reader to see my own interpretation of the data. Throughout this work, I have detailed and signposted the research decisions that I made and the subsequent influences this had on the research process. For example, how Ben's (Huggan, Nelson and Potrac, 2015) and Andrew Butterworth's (Butterworth and Turner, 2014) stories drew parallels to the challenges I faced when designing and deploying a SPA provision and how the use of Bourdieu's (1984) and Kelchtermans and Ballet's (2002a, 2002b) work could assisted in my own interpretation of my own journey. The processes I have outlined above and undertaken address the credibility, transferability and dependability of the data and story that I presented. Thus, although a reader of the data may not share the same interpretation as the one that I have reached, they are able to at least understand the process through which the story has been reached (Koch, 2006; Houghton *et al.*, 2013).

7.4.7 Data analysis

As stated previously the interviews were transcribed verbatim and a thematic analysis was undertaken. This method was used recently by Nelson, Potrac and Groom (2014) and Reeves and Roberts (2013) to identify and provide an insight into the perceptions held by individuals involved within the SPA process. The thematic analysis should not be considered a linear model but viewed as a recursive process that involves six stages (Braun and Clarke, 2006). Through immersing myself in the participants' narrative, listening to the audio and re-reading the transcripts, I became familiar with the emerging statements relating to their experiences, opinions and thoughts towards SPA. I began identifying codes for these initial statements centred on their relationship to the research aims and around the people, events, and interactions that had affected the participants' perceptions.

To assist in making sense of these emerging themes, an abductive approach was adopted. Researchers have traditionally adopted either an inductive or deductive approach to analysing their qualitative data (Hyde, 2000). However, more recently, researchers have begun adopting an abductive approach. This approach begins with “a puzzle, a surprise, or a tension, and then seeks to explicate it by identifying the conditions that would make that puzzle less perplexing and more of a ‘normal’ or ‘natural’ event” (Schwartz-Shea and Yanow, 2012, p.27). Thus, it involves a creative process of interpretation (Edwards, Molnar and Tod, 2017). It moves constantly between everyday meaning and theoretical explanations, applying theory to the perceptions of the participants (Lipscomb, 2012). Thus, the abductive approach can be seen as combining elements of both inductive and deductive approaches to interpret the participant’s perceptions. It was adopted to provide a pragmatist perspective offering the chance to make logical inferences from the surprising events observed and the perceptions collected from the participants’ narratives that could not be explained by an existing range of theories.

In this initial phase, the process of identifying emerging themes in the data was not an attempt to reduce the data, but to capture the conceptual message portrayed in the data. Thus, each sentence or paragraph within the participant’s narrative was assigned a code (Braun and Clarke, 2006). For example, the following sentence from Andrew, “I think it is important for the analyst to understand what we as coaches want”, was identified as ‘role positioning’ as the coach’s comment was interpreted as him attempting to restore control over my interactions, drawing parallels to Raven's (2008) base of personal coercion and the legitimate position of power. The generated codes were subjected to an active process of searching for similarity in the data. Similar codes were collated and constructed into sub-themes. For example, Andrew’s comment above was placed into a theme entitled ‘Head Coach Led’.

At this stage in the process, the sub-themes I had assigned were reviewed. I held discussions with the supervisory team and the participants to ensure the themes and sub-themes reflected the actual participants' narrative as well as the other notes and reflective logs that I had maintained. This process of member checking helped to draw out the perspectives the individuals had held towards SPA as well as helping to further understand and interpret the narrative that the participants had told. Through this process, the participants engaged in triangulation, further aiding the verification of the participants' experiences and perspectives against those held by the supervisors and myself.

As a result of the cross-checking methods, the essence of each sub-theme was identified. Each sub-theme was refined and a definition of the sub-theme generated to ensure the overall story remained in relation to the research aims. As part of this process, the initial sub-themes were grouped into themes and key themes. For example, the sub-theme of 'Head Coach Led' was grouped into a theme entitled 'Individuals Involved in the Process' which was placed into a key theme called 'Drivers of the SPA process'. The key themes represented the main emerging topics that described how the participants viewed their experiences of SPA. The themes were "essentially themes-within-a-theme" (Braun and Clarke, 2006, p.92) grouped into associated sub-themes. The list of key themes and themes, with supporting examples, was shared with the participants and feedback was gained through a member checking processes. This final process ensured my representation of the coaches, players and support staff was reflective of their own experiences and perceptions towards SPA. The outlined data analysis procedures identified three key themes, seven themes and 40 sub-themes (See Table 7-2). Following this process, the narrative within the sub-themes, themes and key themes were extracted.

Table 7-2: Emerging sub-themes, themes and key themes from the participants' narratives.

Key Themes	Themes	Sub-Themes
Application of SPA into practice	Feedback	Content of feedback
		When was feedback delivered
		Duration of feedback
		How was feedback delivered
	Learning Tool	Planning
		Evaluation
		Reflection
	Uses	Identifying traits
		Identifying strengths
		Identifying weaknesses
		Enhancing decision-making
Drives of the SPA process	Individuals Involved in the Process	Head Coach
		Assistant Coach
		Analyst
		Players
		Support Staff
	Collaborative Approaches in the Process	Head Coach Led
		Head Coach-Assistant Coach Led
		Head Coach-Assistant-Analyst Coach Led
		Head Coach-Analyst Led
		Analyst-Head Coach Led
		Analyst-Player Led
		Analyst Led
Solutions to enhancing the SPA process	Trust	Knowledge of wheelchair basketball, SPA and analysis software
		Visibility
		Rapport
		Proactive and hard working
		Committed
		Personalised approach
		Similar personalities and interests
		Honest
		Approachable
	Improving the SPA Process	Employing a dedicated and knowledgeable analyst
		Prioritising the delivery of SPA
		Embedding the provision overtime
		Improving coaches willingness for new ways of thinking through an evidence-based approach
		Adopting an open and proactive approach
		Developing Coach-Analyst & Coach-Player relationship
		Education
		Holistic and collaborative approach

7.5 Discussion of results

The stories the coaches, players and support staff presented, focused on the socio-political interactions between them and myself, and how these affected their perceptions towards SPA over the four-year cycle. Specifically, three key themes emerged from the result of the data analysis: (a) employing a performance analyst to implement a SPA provision for the entire cycle, (b) the conflicts that arose due to the presentation of new ideas and data that challenged team and individual's beliefs, and (c) how conflicts could be managed to resist dominance, ensuring a SPA provision was able to assist the team post-Rio. Throughout these interactions, between the various social actors, three social settings were identified: (a) during training, (b) during matches, and (c) away from the team. These interactions reflected the views of those who had received the SPA provision that was developed to assist performance. What continues below is a discussion of the key themes that emerged from the multiple sources of qualitative data that focuses on the socio-political interactions mentioned by the coaches, players and support staff from 2013 to 2017.

7.5.1 Establishing myself and a SPA provision

Field note: 15th March 2013

> *My involvement with BWB began prior to the London 2012 Paralympic Games. I volunteered to provide a SPA provision to the men's team during a warm-up tournament in June 2012. The SPA provision involved filming all of the games and breaking down offensive and defensive components requested by the coaching team. The support I provided assisted the men's team at the tournament, only losing by a small margin to the 2008 Paralympic Gold Medallist, Canada. The team's success at the tournament provided momentum into the 2012 Paralympic Games, however, they failed to meet their specific medal target at the summer Paralympics. I still remember the phone call I received from one of the coaches towards the end of October 2012. The individual asked if I could conduct a performance review to assist in identifying why the team underperformed, as they had been impressed with the information I had*

compiled in the warm-up tournament. I jumped at the opportunity, spending a few weeks analysing and gathering objective evidence regarding technical and tactical components, which had been found to affect performance in wheelchair basketball. Although this work was voluntary, I saw this as an opportunity to produce work showcasing my skill set and abilities, whilst also promoting the role of SPA. On completion of the report, I was invited to attend a number of camps at the start of 2013. The coaches wanted me to get to know the players, staff and sport in more detail. Eventually, voluntary opportunities progressed into paid work. I became increasingly aware, as a Masters student at the time that this may lead to something else, something more permanent. I began working a few additional days a week for the team, analysing games in more detail and assisting the team in preparing for the 2013 European Wheelchair Basketball Championships in Frankfurt, Germany.

During these early stages of working with BWB, I gained an understanding of the asymmetrical power relationships that existed between coaches and other individuals. These initial experiences drew parallels to Ben's experiences that were explored by Huggan, Nelson and Potrac (2015). During Ben's initial employment by Socc Tech he learnt the importance of 'selling himself' when he was allowed to leave the office and go into the training ground. Through building relationships with the decision-makers in the company, Ben learnt that it was the head coaches who held the power to bring in, maintain or fire individuals. Kelchtermans and Ballet's (2002b) work assisted in understanding how Ben and I learnt and became aware of the power relationships. Through engaging in *micropolitical action* (Kelchtermans and Ballet, 2002b), I was attempting to establish myself as a professional and develop, maintain and protect these 'optimal' working conditions. I learnt that it was the senior coach who held the power, accepting or rejecting SPA as a tool to enhance performance and subsequently making or breaking the next stage of my career as an analyst. The ability to engage in micropolitical action ensured the establishment and protection of 'optimal' working conditions (Kelchtermans and Ballet, 2002a).

The senior coach held the keys to providing future opportunities and the resources required for me to develop and deploy a SPA provision. I knew if I put in some additional work, developing my *organisational interests,* which was seen by the senior coach, it could possibly lead to more work, advancing my position with BWB (Kelchtermans and Ballet, 2002b; Potrac and Jones, 2009; Huggan, Nelson and Potrac, 2015). Thus, to ensure I was successful in my role, I acknowledged the need to gain support from individuals in the team, specifically the senior coach. I ensured I promoted a positive image of myself and the discipline, whilst also ensuring the senior coach's working conditions were not disturbed (Kelchtermans, 2009a). Through engaging in *micropolitical action*, I was protecting my working conditions, ultimately making my role as the analyst a valuable asset (Cushion and Jones, 2006; Huggan, Nelson and Potrac, 2015). I was seen as doing 'a good job' by the staff, thereby achieving my desired working conditions (Purdy, 2016).

Through acknowledging the need to appease the senior coach, to protect my own working conditions and personal agenda, I began to tailor the SPA provision around his requests. This involved showing video clips before training and games to allow the players to observe what the coaches wanted the players to achieve in training or in games. Subsequently, during the build-up to the 2013 European Wheelchair Basketball Championship, where I had complied with the coach's requests, the coaches and players perceived the information useful. Bob, one of the coaches, said:

> *Through watching it [training sessions and warm-up games] back we can help our players make better decisions…If they can see what they are doing, and it really makes an effect, if they look at themselves and say I am doing this it can really make a difference. If you then show them what they are actually doing, does that relate to what they are thinking and how they are playing? It is a learning tool for them and a learning tool for us as coaches.*

In other words, through working towards what the coaches wanted, I employed political actions (Kelchtermans and Ballet, 2002a). The coaches were able to use the video recordings to visually highlight what they wanted the players to do and the players were able to visualise what they were expected to do. I made it easier for the coaches to communicate their messages and expectations. I was utilising SPA and my role as a mechanism to potentially allow me to control my own future and that of the coaches and players (Bourdieu, 1986). I was making use of the video clips as cultural goods (Bourdieu, 1986), presenting them to the coaches as they attempted to enhance performance and protect their working conditions whilst also demonstrating my acknowledgement of the formal and informal social hierarchy between the coaches and myself as the analyst. Thus, my actions allowed me to gain social recognition and cemented myself and SPA in the team (Kelchtermans, 1996). This allowed me to undertake a 'good' performance and ensure my working conditions were suitable (Kelchtermans and Ballet, 2002b; Potrac and Jones, 2009; Huggan, Nelson and Potrac, 2015). My micropolitical actions during the initial period of working with the team, resulted in the coaching team asking, in April 2013, if I could attend the 2013 European Championships and expand the SPA provision.

Field note: 15th April 2013

> *I was over the moon that the coaches had asked me to head out to the Euros and said I would go without knowing much about the event. I saw this as a reward for the hard work that I had put in so far to illustrate my worth to both the senior coach and the entire programme. The element of not knowing left me feeling slightly anxious about what it was going to be like. For example, I had never worked with both the men's and women's squads at the same time. Potentially filming all of the games then breaking down into specific areas the coaches wanted. I knew that the next few months would be very busy. But, this was a great opportunity to continue learning the sport, to explore areas where I could potentially find those hidden or secret ingredients to success and continue building*

my relationship with the coaches, players and other support staff. Also, if I did a good job and the team did well, future opportunities may come my way and I would be the first person to be asked.

The senior coach's decision could be associated with an act of either personal reward power or a legitimate power of reciprocity (Raven, 1992). Potrac and Jones (2009, p.223) argue "a coach's effectiveness and longevity may depend on a favourable win-loss record but also on an individual's ability to gain the approval of contextual power brokers (e.g. athletes, other coaches, or owners)". Thus, the senior coach's actions were deemed to be in recognition of the information I had presented to him, making his role easier, increasing his value and worth to the players, support staff and senior personnel. Whilst this protected his position and his role, it also increased my cultural and symbolic capital (Bourdieu, 1986) by increasing the players' and support staff's buy-in to the SPA provision. Additionally, it assisted in protecting and advancing my own working conditions in line with my own micropolitical agendas (Kelchtermans and Ballet, 2002a, 2002b).

During the months leading up to the tournament, my workload and visibility with the team increased. I was away from home for extended periods of time. The coaches and players became a second family, as I spent more time with them enabling me to engage in work and non-work related social activities. This opportunity to work on the ground and interact with the individuals within the BWB High Performance Programme allowed me to understand the individuals on a personal level, important factors in developing trust (Sztompka, 1999). For Sztompka (1999, p.25) trust can be viewed as "a bet about the future contingent actions of others". It is not one-dimensional, but comprises of four foundations of trustworthiness: primary trust (i.e. reputation, performance and appearance), secondary trust (i.e. accountability, pre-commitment and situation), the trusting impulse (i.e. if an individual perceives a person to be less trusting than other individuals) and the trust culture (i.e. the ability of society to develop and nurture individuals who are able to elicit trust in others) (Sztompka, 1999). Thus, through increasing my visibility, others were able to assess my track record and status within the field of SPA (reputation) along with my knowledge and experience (performance) and how I manifested myself in conversations (appearance). I was subsequently able to establish primary trust (Sztompka, 1999). The bet associated with trusting me and SPA would not result in a violation of moral standards in the working relationship and the appearance of distrust (Weber and Carter, 2003). Within sport, Purdy, Potrac and Nelson (2013) indicated that trust plays a central role in developing, maintaining and advancing working relationships between coaches, players and support staff. The ability to establish trust can be viewed as a strategy for dealing with uncontrollable and uncertain future actions (Sztompka, 1999). For example, when new ideas and concepts are introduced as I outlined below.

Before the 2013 European Championships, I was also aware that I did not want to unsettle the existing programme, my working conditions and the relationships I had formed. I began working closely with the coaches, focusing on specific aspects that they had previously requested regarding the style of play BWB should adopt and the trends of specific opposition. I gradually disseminated my findings to the coaches. This allowed them to consider the data and information I was presenting regarding their team's performance. During this period of time, I became aware that through my actions, the coaches had the ability to reward as well as punish my actions (Rylander, 2015). However, I also acknowledged that change was necessary for the team to improve on their current underperformance at major internationals. Informed by my Master's studies, I determined that the less disruption I caused, the less attention I would bring to myself and the safer my position would be in the future (Kelchtermans and Ballet, 2002b). This gradual period of change would help the coaches, players and newly employed support staff adjust to the role I was fulfilling. It was important to me that I was making a positive contribution to the team but also adopting a low profile. Thus, I did not challenge the coaches' decision-making whilst beginning to incorporate additional information I had previously presented in boxing, gymnastics and rugby union.

The micropolitical actions I had undertaken during the build-up to and at 2013 championships continued to generate positive perceptions towards the SPA data and information due to the improvements in players' on-court performance. In particular, Gareth, a player, perceived this was particularly apparent in the final of the 2013 European Championships:

> *I think the introduction of the analysis was really positive post-London…If I remember correctly before Frankfurt [2013 European Championships] it was very good…We focused on the aspect of how the team should play and the things we needed to work on. Even during the tournament, it was critical for us in winning that final; as the game plan that we came up with was aided by the analysis, in terms of identifying the specifics of the opposition… We were starting every session with a clear idea of the goals and the tasks that we were trying to achieve or simulate or work on.*

During the tournament and the remainder of 2013, I witnessed the coaches, players and support staff discussing the information I had presented and how it assisted their decision-making processes. The conversations surrounding the contributions I made further cemented my working conditions, increasing my cultural and symbolic capital (Bourdieu, 1986). The individuals' perceptions helped me to fulfil my micropolitical agenda (Kelchtermans and Ballet, 2002a). I was viewed as a competent, hardworking and valuable asset, helping to further build trust between the coaches and myself. I believe this provided me with leverage to negotiate a part-time paid position. As well as being financially rewarded for my contribution, in an act of impersonal reward power by the senior leadership team at BWB, the coaches and players were also excited about what I would be able to do for them. These feelings of excitement were captured in a coach's and player's narrative below (Andrew and Ed).

When you came in, we started to get more detailed about what are we looking for and why. With your help, it was good, as you knew what you wanted to do and achieve and help out. It then helped us understand how effective that analysis could be. We could then start going into more detail about offensive sets and defensive sets, shots taken, shots missed, rebounds, basically a whole bunch of things that we could do (Andrew).

I liked what you were implementing...You also made it known and didn't hide behind it that you were from a rugby background and didn't know much about basketball, you said that from the get-go. I was excited about the stuff that you were doing at the start (Ed).

This 'employment' and the excitement allowed me to "advertise [my] professional competence" (Kelchtermans and Ballet, 2002b, p.113) and continue to introduce some of my ideas. Huggan, Nelson and Potrac (2015) also found that through a collective agreement to appoint Ben at the new club, the players appreciated what the analyst could offer them in terms of enhancing performance. The recognition Ben felt resonates with my own feelings entering into 2014. I felt I could begin to implement these new ideas, fulfilling my role as the analyst due to the security of my role, for the remainder of the Paralympic Games cycle, and the confidence I had in the information I had previously presented. Additionally, being an 'employee' resulted in me spending more time with the coaches, players and support staff, forming new and strengthening existing relationships, and increasing the level of interest towards SPA. This period of time and the changes the individuals experienced were important in developing trust (Sztompka, 1999).

I was now confident that the hard work I had completed to write myself into the landscape and protect my working conditions was acknowledged by the coaches, players and support staff. In the build-up to the 2014 World Championships, the SPA data and information I was generating, was in my view, was basic. My willingness to comply with the coaches' ideas and not unsettle the programme resonates with Bourdieu's (1991) discussion regarding the *complicity of the dominated*. Bourdieu believed complicity is necessary for the achievement of symbolic subjugation, explaining that one can only be hooked if they are embedded in the landscape (Bourdieu, 1984). My willingness to go along with coaches' requests to keep focusing on specific aspects that they had previously requested was due to my limited wheelchair basketball knowledge. I engaged in their requests ensuring my working conditions were not threatened and I continued to build trust. My relationship with the coaches developed into a strong bond. I thus viewed the coaches as individuals who I could rely on for assistance and subsequently respected their knowledge. It can be argued that I trusted them. However, my decision to comply with the coaches' requests at this stage in the development of the provision could have set a precedence in that I was there as an individual to 'go with the flow'. Purdy and Jones (2011) also found that athletes perceived there was no point in suggesting new ideas, providing new information or complaining about a decision as coaches are not going to change. Subsequently, when athletes did introduce new ideas or complained about something they perceived that they were digging themselves a hole. Therefore, my actions to comply with the coaches' requests could explain some of the future tensions that I perceived to have surfaced when I felt dissatisfied with the level of provision I was providing following the 2013 European Championships.

I subsequently began making extra efforts (Kelchtermans, 2005). I wanted to introduce new ideas and assist in advancing the team towards their Paralympic cycle goal of returning a gold medal in Rio de Janeiro. My response was based on the previously received comments and positive reaction from the information I had presented during the 2013 European Championships. In addition, this was in accordance with my own personal agenda (Kelchtermans and Ballet, 2002a). I believed that these new ideas and searching for new information would be supported by BWB. Gareth, a player, reiterated this point when reflecting on my attempts to introduce new ideas and enhance the SPA provision in April 2014:

I think the whole point of performance analysis is to get the whole scope, trying to get the view of the whole court, trying to get as much information of that. If you're confident enough and only do stuff off what the coach is wanting you to look at in the basic form, then that means you are not doing your job. The whole point of performance analysis is to find the small details that might have been overlooked. As you are watching so much video your views are probably as valuable as the coach.

I started to drip feed new ideas through informal and non-formal conversations with the coaches, players and support staff two months prior to the World Championships in July 2014 and continued through 2014 and into 2015. These included (i) developing a new SPA template to objectively measure team performance, (ii) introducing a live feedback system, and (iii) advertising for a performance analyst intern. It was whilst I was compiling information to assist the coaches' and players' decision making processes at the 2014 World Championships, that I began the initial work for the three proposed ideas in May 2014. This also happened to be at the same time I was beginning my PhD research. These ideas and changes informed the initial studies presented earlier in this thesis (see Chapter Three and Chapter Four).

Up until this point, the coaches and players relied on the CBGS to assess the team's and individual's performances. However, as alluded to in Chapter Two and Chapter Three this data collection method had been heavily criticised because it did not consider team performance variables. Thus, the reading I was undertaking as part of the PhD as well as my previous and current SPA experiences exposed the current SPA provision's limitations. In addition, the feedback approach the coaches had adopted resulted in players receiving delayed feedback with unclear messages. According to a player, Dom, on occasions the feedback was "almost a hindrance, there are no aims or objectives from what the coach wants you to do as a player". Thus, it became clear to me that I had to start presenting ideas on how to improve the feedback process and provide more meaningful performance metrics.

The initial feeling of wanting to learn, please and trust the coaches I had felt in 2013, began to decline. These feelings aligned with the findings from Jones, Glintmeyer and McKenzie's (2005) work. I started to feel the need to challenge the coaches' thinking in an attempt to advance the SPA provision throughout the remaining two years of the Paralympic Games cycle, focusing on contributing towards the team's long term-goal and my own personal agenda (Kelchtermans and Ballet, 2002b, 2002a). I was now beginning to realise that my decision to comply with the coaches' requests early on in the process instead of questioning aspects was not aligned with the players' expectations of my role in relation to providing support to assist their player learning and development. Within recent years, Paralympic sport has become a serious sporting endeavour (Kohe and Peters, 2017), coaches and support staff should thus be striving to identify marginal gains, assisting on-court performance improvements and providing individuals and the team with a performance edge over other nations. This did not, however, seem to be the case here because conflicts began to emerge regarding the use of SPA and the role I was fulfilling as I was presenting new information and ideas to provide a performance edge for the team.

7.5.2 Emerging conflicts

Whilst my micropolitical actions helped me to introduce ideas, propose changes and achieve more security, these actions could also possibly impact on the feelings of others. As I undertook strategies that would protect my working conditions, I became aware of the strategies others were using to protect their own position and their goals. For example, when asked to reflect on 2014 and the introduction of new ideas, one of the coaches, Bob, stated:

> *…it is important for the analyst to understand what we as coaches want… What you have to be careful of is that the analysis is so detailed that you take responsibility for that and show us a whole load of things and then it is just too much information to take in and use. We then get to the point where you are going beyond the realms of what we wanted. We have got*

our determinants and principles and we want information that supports this.

The introduction of new ideas and concepts has been shown to destabilise others' working conditions (Kelchtermans, 2009b), which could have potentially threatened the coaches' working conditions. Bob also wanted the information and data to support his perception of what was required of the establishment and the programme. This drew parallels to Terry, the coach in Booroff, Nelson and Potrac's (2015) study, who used the SPA data as a tool to please the club owners. Thus, the coaches could have chosen to use a variety of strategies to protect and enhance their position (Kelchtermans and Ballet, 2002b, 2002a). This is illustrated in the below field note and the narrative from one of the players during the interview (Dom), regarding a situation that occurred in a team meeting at a warm-up tournament in the USA during July 2016:

Field note: 13th July 2016

I had observed on the video a key point that the coaches were trying to address and improve in terms of the team's defence. As usual, I had sat down with the coaches before the meeting to check the clips were still applicable to the session. We discussed the key points at length during the coaches' meeting. However, when I played the specific clip during the team meeting the coaches did not make the points we discussed. I was unsure as to whether they had forgotten the conversation we had previously had 30 minutes prior to the session. I played the clip again in an attempt to make the coaches recall the specific points. The coaches still did not mention the points. I thought the discussed points were important for the players to hear and gain clarity on what the coaches had discussed with me beforehand. I began to mention these key points, pausing the video at stages where the players had made the defensive decisions. Each time I allowed sufficient time for the coaches to comment but they did not. It was at this point that one of the players asked a

> *question. I expected the coaches to answer, gain clarity for not only the player but the whole team. But again nothing. I commented on the trends and patterns I had observed which were all highlighted in this clip. The player and I continued to discuss the clip, engaging directly in a back and forth conversation with no one else joining in. I left the meeting confused, frustrated and let down by the coaches, to the extent that I had been hung out to dry. The relationships over the past few years and the knowledge I had gained had suggested that they were happy for me to input into sessions but on this occasion nothing. Had my actions to go above and beyond their requests been a step too far and been seen as a threat to their position.*

Dom reflecting on the above-described event in the USA:

> *You showed him [Head Coach] the video one day and he didn't like what you showed him. As in he became aware of the fact that you know what you're talking about and I guess he felt in danger...Everyone, there was agreeing with your comments, but the only people who can say that are the two coaches. If there is any disagreement, which will always occur, when it comes to watching the video there is always a difference of opinion. As there is always someone defending themselves or some else or telling someone they are wrong but it has to be a right answer. That right answer can only come from the coach as it is what he wants… Rather than coming away from that discussion and the player thinking he is right and doing the same again or next time the coach says the analyst you are wrong and therefore knowing that you wouldn't say it. You have both gone away from that situation thinking that you were right*

Despite my attempts to share my interpretation of the data with the players during the team meeting, based on the previous information I had shared with the coaches, it appeared to not be supported by the coaches. Additionally, the players' input during the discussion and meeting were not welcomed, conclusions were not reached and thus the individuals present possibly left feeling confused and were unsure of the resolution. The player described how his and my comments and perspectives were subsequently disregarded. I interpreted these actions to be the coaches erecting barriers to restrict the data and also the other individuals' input during decisions and team meetings. This act of almost 'shutting shop' was possibly an attempt to exert personal coercive power and negative expert power as well as illustrate their legitimate position of power as coaches (Raven, 1992, 1993), whilst also avoiding conflict (Purdy, Jones and Cassidy, 2009; de Dreu, 2014). The strategies the coaches were attempting to possibly use would help safeguard their personal agendas (Kelchtermans and Ballet, 2002b) and cultural capital (Bourdieu, 1988), ultimately protecting their positions as coaches. However, if others perceived the coaches were attempting to exert power for their own personal gain these individuals were likely to resist any proposed ideas from the coaches (Petress, 2003). Hence, the strategies the coaches adopted "are concerned with the preservation or improvement of their own positions with respect to the defining capital of the field" (Jenkins, 1992, p.86). Booroff, Nelson and Potrac (2015) found parallels to the coach's practices in their study, whereby his behaviours were not solely due to "the deterministic consequences of role expectations" (Callero, 1994, p.239) but the promise of future rewards through 'getting the job done'. In this case, the coaches did not want their authority and perspectives to be undermined or challenged by others.

As a result, I perceived the relationship that had existed between myself and the coaches to have deteriorated after this situation. I did not want to cause further conflict and risk my promised opportunity to attend the Paralympics and thus I elected to not broach the situation with the coaches further. My confusion and frustration with the coaches went further than the simple dislike of the strategies they were attempting to employ to restrict others input. Rather, their seeming reluctance to engage and listen to the data had been removed without explanation. This was also demonstrated by the coaches, agreeing in a performance meeting for me to adopt a dual role at the 2016 Paralympics:

Field note: 27th July 2016

> *I was called in for a meeting a few days ago at the training base regarding the provision at the Paralympics. We needed to revise and make adjustments due to changes in staff attending the event. The women's team who I had been supporting as well throughout the cycle quickly pointed out the fact that they could now get me in the village and maximise my role. However, the men's coaches requested that I would become the men's team manager. They did not consider the implications of the wider SPA provision that I had been making but wanted a water carrier and someone to tell them when and where to be at specific times during the day. Feeling frustrated, I finally challenged the men's coaches' decision during the meeting. I received a response which I did not like nor appreciate; one of the men's coaches responded along the lines of "we will be fine with just the video, that's all we need". I felt undervalued by the men's coaches but also aware that the women's coaches would now be inadvertently affected by my reduced ability to continue their provision.*

The actions highlighted above by the coaches, both in the USA and at the training base, left me feeling frustrated and confused. I did not know what had happened in the previous months and years to change the coaches' perspective as to what had been working and what I had been delivering. I was left with so many unanswered questions. The working relationship I had spent forging since 2012 had broken down. The long hours and additional tasks I had been completing to not only protect my own personal agenda and capital but also contribute to the team's long-term objective did not appear to be valued. The coaches seemingly appeared adamant in adhering to what had enabled them to progress to the bronze medal match in London 2012, disregarding the SPA provision that had been developed and designed around their needs and the emerging trends in the analysed data to enhance learning and performance (see Chapter Four and Chapter Five). The players acknowledged the need for SPA and the wider sport science benefits being critical to enhancing their knowledge and developing their understanding sporting performance. Burkett (2008, p.116) also stated "Paralympic athletes depend on this knowledge as part of their pursuit of excellence at their respective games". Thus, through the coaches electing to rely on the players' natural talent and 'togetherness' to assist them in achieving the end goal, a key performance advantage could have been missed. This was divulged to me by a player during the Paralympic Games. The coaches' apparent decision to disregard the players', support staff's and my own input left a collective feeling of dissatisfaction. These findings echoed those contained within ethnographic work conducted by Nelson, Potrac and Groom (2014); whereby an ice-hockey players' perceptions of SPA became dysfunctional when the coaches did not see the value in the information and did not involve him directly in the learning process. In agreement with Purdy, Potrac and Jones (2008, p.328), the point I am making here is "not to unquestioningly criticise a hierarchical coaching structure, but to raise awareness of the social consequences of such manifest actions on human relationships".

The use of power to control the interactions and use of SPA can introduce distrust into an environment. Sztompka's (1999) theorising of trust culture, inferred cultures are derived from collective and shared experiences of societal members over long periods of time often generating a system of rules. Thus, if the results of a series of bets of trust (i.e. expectations about the actions of others) are positive, a rule of trust could appear. However, distrust could arise if the actions are negative. In this context, the actions to disregard the SPA data, despite the players wanting the information, resulted in the breakdown of trust between the coaches and myself. Additionally, this also resulted in a breakdown of trust between the players and the coaches. Raven (1992) argued if individuals' attempt to exert negative expert and negative referent power, the subordinate other could work in the opposite direction.

The players and support staff become motivated by a desire to regain control of their own personal agenda and oppose the individuals' decisions (Petress, 2003). The wheelchair basketball coaches' decision to attempt to restrict the use of SPA in favour of relying on previous thoughts during the Paralympic Games, resulted in players feeling disenchanted. Both the players and support staff perceived this was the case following the 2014 World Championships through to the Paralympic Games. Gareth, a player, explained:

> *…some of the performance analysis data and lessons learnt in the department, in the last three years, seemed to be opposing to what the coaching staff believed was the best way to play…there did seem to be a clear shift in what the coaching staff felt was our best approach for success. I felt that it had disregarded the previous three years….it stopped being done… In the lead up to Rio, there seems to have been a contrast to the certain principles that we had to…what the coaching staff felt was useful for the direction of the team…I suppose if performance analysis is relying on information gathered and presenting information that opposed the coaches' views, I think it would make it problematic…For me, just in terms of results, at the very least it played a role in us not making the final in Rio...Not having that level of information directly affected how we played at the Games and how we prepared. That had a direct negative impact on us. The context provided by performance analysis to raw data and the eye test is massive.*

Ed's perspective as a player can be explained within this passage:

> *…it went past his [Head Coach] natural implementation of it and when it was conflicting with his thoughts he abandoned it…It was quite obvious that the coach couldn't be bothered with half the stuff which you were intending.*

Whilst Dom's perspective as another player reflected the previous comments:

> *…people are scared of what it [the SPA data and information] might say… People can be too scared to rely on numbers and would prefer to*

act on feel (Interview extract from Dom reflecting on the selection choices for the 2016 Paralympic Games)

In addition, the key messages that I provided to the coaches, players and support staff, included in Chapter Four and Five, since February 2016 were perceived by the players and support staff to be too complex for the coaches to conceptualise and conflicted with their own coaching beliefs and philosophies. Coaches historically have elected to adopt the safer decision to reduce risk (Cassidy, Jones and Potrac, 2009). In comparison, Eddie Jones (England Rugby Union Head Coach), in a recent presentation, discussed the importance of creating a challenging and conflicting environment. He stated, "In high performance sport you have to keep creating conflict but it has to be positive conflict. That leads to performance. And if you don't have that conflict within your organisation you're probably not going to get that performance." (England Institute of Sport, 2017). Despite Eddie Jones suggesting that conflict has to be positive in environments when an individual is making a decision, it might not always be positive. Negative conflict can result in disagreements, affecting an individual's calculation of the risk versus the reward of their outcome (Farrell, 2004). The risks associated with the wheelchair basketball coaches relying on what allowed them to get to a position to medal in the past could have outweighed the risk of using SPA data.

7.5.3 Resisting dominance and managing conflicts

The combination of the players and support staff feeling frustrated and opposing the coaches' decisions to not take calculated risks, resulted in them listening to the data. Despite being restricted by the coaches' decisions in terms of line-up choices, the players and support staff attempted to apply the data-informed evidence in training and during warm-up games in USA, Spain and England a few months prior to the Paralympics. A player, Frank, highlighted the process of incorporating the key findings in his comments:

When we [the players] were talking to you about where we shoot well from and our percentages. That conversation definitely affected how I trained before Rio. It affected my shot selection in training sessions knowing that if I was going to a position where I felt comfortable or shooting well all of the time then I was going to be improving and I could apply the practice then into a game.

Frank's extract is one of the examples of himself and other players approaching me for advice. As a result, he adjusted his training, benefited from an improved performance and was awarded more minutes during the Paralympic Games. The players and support staff approaching me and by-passing the coaches for objective data could be argued to further cement the coaches' reluctance to use the SPA data. These actions align with those found by Purdy and Jones (2011), whereby athletes attempted to covertly resist the coaches' decisions. However, their decision to do this out of the coaches' earshot and view demonstrated their continued dependence on the coach (O'Brien and Kollock, 1991).

I interpreted the actions of the coaches not to use the data as an attempt to re-establish and protect their working conditions, due to their position feeling challenged. I perceived that there had been a power shift, whereby I had become a more useful resource to the players and support staff in relation to the long-term performance goal these individuals were working towards. Bampouras, Cronin and Miller (2012) highlighted SPA processes have been seen as a mutually exclusive relationship between the coach and the analyst to collect and interpret data, with the players taking an inactive role in the processes. Thus, the coaches seemingly removing themselves from the SPA process, due to a loss of trust in the data and myself as the analyst, and my actions indirectly involving the players through tasks, could have directly questioned the coaches' authority (Purdy, Potrac and Jones, 2008) and continue to let our coach-analyst relationship deteriorate.

Coaches historically dictate and control aspects of performance, shaping the way the players interact and behave (Cushion and Jones, 2006). Therefore, through my role and the information I was able to provide, the players were able to exercise some form of power over the coaches. Not only were they able to transform aspects of training based on the objective SPA data, resulting in net gains in on-court performance, but they also began conducting their own and unit analysis to assist in preparing for upcoming competitions and informing game strategies. For example, whilst on a warm weather training camp in Lanzarote (June 2016) the players began preparing for a training tournament later in the month against a number of the top teams by conducting opposition analysis on individual players. They began independently and in small groups completing tasks I had to devised to identify common strengths and weaknesses within opposition players' skill sets to inform potential game strategies. The actions of the players, through the developed analyst-player relationship, resulted in the players becoming dependent upon the information I continued to provide. However, as the coaches became aware of the players' actions to engage in SPA and my willingness to support this behaviour, the coaches could have interpreted this as another attempt to undermine their power and position.

During the Paralympics the players came to view the coaches as a structure to work against, viewing me and the data I was providing as a means of coping with the oppressive social environment (Purdy and Jones, 2011). Additionally, the players, in particular, Dom, were aware of the coaches' disinterest and perceived this was due to not trusting both the data and the analyst.

> *I don't know if the coach trusts the evidence that the individual is putting forward. So if the coach doesn't trust the evidence that you are putting forward then he is not going to sit down with the players…From my perspective, the coach doesn't trust you as the information you have provided doesn't fit with his coaching philosophy and style of play, which has ended up being a barrier to the coaches' engagement with performance analysis.*

The players mentioned previously that there was a shift in the coaches' thinking and perceptions towards SPA two years into the provision. However, I only began to realise this shift at the start of 2016.

Field note: 31st March 2017

> *My discontent with the coaches and the entire programme had deepened since I returned from Rio. There was no review, no reflection of the challenges that we faced. The experience had been masked by the fact that the men's team had returned a bronze medal and the women had improved dramatically from London. There was almost a complete shift in focus to the next cycle. When I discussed aspects of the SPA with a new member of the support staff, I was continually told not to discuss the Rio cycle but look ahead by this new member of support staff. For me, this appeared strange and added to my confusion and frustration. To move on and develop the provision further to assist the coaches, players and support staff it was of paramount importance to explore the challenges that had surfaced throughout the previous four years, identify aspects that had worked and devise strategies and actions to manage and resolve conflicts that had surfaced. It was during the conclusion of the interviews with the players and the discussion with the new member of support staff that I came to question what impact and progress I could make in the next four years. I turned down the opportunity to continue providing support to the programme at the 2017 European Championships and apply for a full-time paid position that was being advertised. The challenges that I had faced throughout the four years had tainted my experiences. Whilst at the same time I felt I was letting down the players by not continuing to provide the SPA provision.*

During the interview, Ed reflected on the impact of my role throughout the cycle:

> *We will look back and say that it's quite a good result getting a bronze medal but it's a load of bollocks. So we are the three times defending*

European Championships, we smashed teams all summer and beat our nearest rivals last year…but he [the Head Coach] didn't want to use any objective evidence to inform his decision…I loved it when you got involved in the programme you could see the extra things that I was bringing to the table…I felt that there was so much to be gained by having you as part of the squad…[but] I felt that you were completely undervalued and underappreciated regarding what you could bring to the squad and it made me personally angry and pissed off that we couldn't do it and that others couldn't see the value in it. Simply because it would go against the coaches thinking

The feelings that surfaced in 2016, during and proceeding the Paralympics, and shared by the players, led me to question whether I could have made a different impact. Although these thoughts and perceptions could be seen as rather one-sided, they were shared by all of the players who were interviewed as well as the member of support staff. I began wonder whether, if I had behaved differently, the players would have returned with a different colour medal. It was through reflecting, interpreting and writing this work that the impact I had made on the players' performance surfaced. This led me to understand the importance of developing an effective coach-player-analyst-support staff relationship, as a solution for managing the conflicts that had emerged and resisting dominance. The relationships I had developed with the players and the support staff provide supporting evidence as to why those individuals bought-in to the SPA process. Whereas, the breakdown of the coach-analyst relationship, due to distrust, resulted in the coaches' unwillingness to listen or use the data that I was collecting and presenting. The response of the players and support staff to buy-in to the SPA provision was considerable. Purdy, Potrac and Jones (2008) highlighted the importance of 'pleasing' these individuals and maintaining their respect. It was also here that I reflected on my initial behaviour in complying with the coaches' requests in comparison to making a decision to engage in discussions to gain their perspectives and voice my vision. This decision by me could also explain the reason for the breakdown of the coach-analyst relationship which then potentially explains the reason why the coaches did not buy-in to SPA.

The development of effective coach-athlete, coach-support staff, athlete-support staff and athlete-athlete relationships have been seen as a key component of enhancing players' performance (Unruh *et al.*, 2005; Lorimer and Jowett, 2009; Jackson and Beauchamp, 2010; Sinotte, Bloom and Caron, 2015). However, a lack of equality typically exists within these relationships. Consequently, conflicts of interest present because the individuals involved in the relationship attempt to seek their own or shared goal (Drewe, 2002). Jowett and Meek (2000), Jowett and Ntoumanis (2004), Jowett and Timson-Katchis (2005) and Jowett (2007) believe effective relationships are established through the constructs of closeness, commitment, complementarity and co-orientation (Jowett, 2007). A concept Jowett referred to as the 3+1C's.

Jowett (2007, p.17) defined closeness as reflecting a mutual feeling of "trust, respect, and the like that result from appraisals of coaches' and athletes' relationship experiences" (Jowett, 2007, p.17). Whilst, commitment represented the coaches' and athletes' long-term thoughts and intentions to stay attached to one another and thus maintaining their relationship (Jowett, 2007). Whereas, complementarity referred to the coaches' and athletes' reciprocal and corresponding behaviours that are evident because the coach and the athlete attempt to establish a friendly attitude. Jowett and Cockerill (2002) believe the final 'C', co-orientation, is uncovered when disagreement, dissimilarity or misunderstanding occurs in a relationship across closeness, commitment and complementarity. These dimensions refer to the degree in which an individual assumes the way in which they feel, think and behave is shared by other individuals (assumed similarity), the degree in which relationship members share how they feel, think and behave (actual similarity) and the degree in which one individual understands the feelings, thoughts and behaviours of another individual (empathic understanding) (Jowett, 2006). Thus, if a coach and an athlete acknowledge each other's feelings of closeness, commitment, complementarity and co-orientation an emphatic understanding and an effective relationship can be developed.

However, as Carron and Brawley (2012) suggested, conflicts can threaten effective relationships if not dealt with constructively. Conflicts can be prevented from erupting by using an array of relationship maintenance strategies (Rhind and Jowett, 2010). These can include mutual assurance, working towards a shared goal, having lines of open communication and/or using collaborative problem-solving activities (Rhind and Jowett, 2012). The work by Wachsmuth, Jowett and Harwood (2017) regarding conflict prevention, management and resolution in coaching draws similarities to the explanations provided by the players and support staff as to why they perceived an effective analyst-player relationship was developed and how it had assisted them with buying-in to the SPA process. Gareth, a player, believed key events had contributed to our relationship:

> *Going through that Frankfurt tournament can't be overstated. We had just gone through a four-year cycle with the old coach and everything else. That team there was the most special team I have been part of. The fact that you were part of that team, just meant that you automatically became one of us instantly. I think that just because you had been through that battle with the rest of us brought us together. You were always going to be welcomed with open arms because you had been in the trenches with us.*

Whilst two other players, Dom and Ed, believed our relationship was built on the manner that I wanted to contribute to their on-court performance by providing meaningful SPA data and information:

You're not trying to do crazy things; you're trying to do your job. You're not trying to push anyone else out. For me, it felt like you were a genuine person trying to do your job

You were coming from where I am coming from anyway…I would give you the time of day and liked what you were implementing but it was very obvious…I see our relationship as a binary system, in terms of I was listening to you collecting the data and I was curious as to what you were finding. So I was trying to interpret it as I could see where it was going. To then by the end, it wasn't just you collecting data you were then passing the data, suggesting things that I could do. For example, in a game at halftime, you gave me a point from the information you had seen. I could see the development of you from collecting to interpreting to feeding back

The three quotes highlight the constructs of closeness, commitment, complementarity and co-orientation implying an effective relationship, and the ability to manage conflicts, between the players and myself had been developed. Through being embedded within the team, I experienced the same situations the players experienced. This enabled me to develop close relationships formulated on mutual respect. The players could also see I wanted to assist them towards their goal, potentially illustrating my commitment to the task at hand. In addition, they saw how over time the data and information that I was collecting was and could complement their on-court performance. Thus, my involvement with the team and the development of an effective relationship was viewed as being beneficial to assist their development and learning through using SPA. Furthermore, I had taken the time to understand the individual as a person instead of viewing each player as just a number. This not only further developed my relationship and resolved conflicts but also allowed me to enhance and tailor the provision towards their own needs. As the player Frank describes:

> *…if someone else is nice to you or you are close to you on a friend basis, you're more inclined to help them and listen to what they have to say. So if you were to ask me a question, I am more likely to help you than some else*

Thus, through attempting to present myself as a genuine individual, drawing on my previous expertise in rugby and showing my value to the team I had developed an effective relationship with the players. The players and support staff drew parallels to the narrative of the performance analyst within Huggan, Nelson and Potrac's (2015) study, highlighting the importance of developing effective relationships. If negative conflicts surfaced a relationship between individuals and the performance analyst could not be formed and the SPA provision could not progress. This is illustrated by Bob, one of the coaches, who states that he is:

> *…a firm believer that relationships are the foundation of everything that you do. If you don't have a relationship it is not going to go far…If I can get that relationship with you then it is going to be a major benefit to the programme*

The passage by the coach above suggested that an effective relationship between him and me did not yet exist. Thus, if I had been able to develop an effective coach-analyst relationship and manage any emerging conflicts, each individual would feel comfortable in being challenged (Douglas, 2014). Through challenging an individual's pre-conceived idea in a positive manner, new knowledge could be unearthed (Jowett and Cockerill, 2003). This new knowledge might provide an insight and assistance with an individual or team towards their goal (Vella, Oades and Crowe, 2013). However, if the emerging conflicts were not managed, a breakdown in relationships would occur along with the onset of distrust (Carron and Brawley, 2012; Wachsmuth, Jowett and Harwood, 2017). I attempted to outline within the data and insights that I had discovered the positive implication for overall performance. However, the means by which I delivered this information could have been interpreted as a challenge, in relation to undermining the coaches' knowledge, and the potential source of conflict. The players' and support staff's comments reinforced the presence of conflict. As a result, the identified benefits of SPA towards learning and performance were not passed on to the players because the coaches attempted to restrict my involvement with collecting, analysing and interpreting performances. When I asked why the coaches restricted my involvement during the Paralympic Games, I was informed that accessing just the video was sufficient and there was not a need for any further evidence to support the players' preparations for the upcoming games.

However, if an effective relationship between the coach-player-analyst-support staff and an understanding of the power balances and micro-politics with an environment had been developed, potential steps towards optimising the SPA provision could have been made. This is reconfirmed by a number of academics. For example, Bampouras, Cronin and Miller (2012) suggested that when a power-imbalance exists between the coach and the analyst within the SPA process, this could result in one individual adopting a subordinate status or attempting to protect their own interest. This feeling of an inferior status, according to Potrac and Jones (2009b), could result in a disengagement with the SPA process and a breakdown of previously established relationships. This disengagement could be an attempt by the coaches to protect their working conditions (Kelchtermans and Ballet, 2002a). These findings are supported by Nelson, Potrac and Groom's (2014) study, which explored an ice hockey player's utilisation of SPA. The researchers identified that when an athlete had an efficient relationship with the coach, the athlete engaged in the SPA process. However, when the athlete did not have mutual respect and trust for the coach, the player began to disengage and attempted to remove himself from receiving SPA information and data. Nelson, Potrac and Groom's (2014) work also explains why the coaches within my exploration appeared to disengage with SPA due to the breakdown of our working relationship.

Despite the players and support staff perceiving the relationship between the coaches and myself had broken down, it could be argued that they bought into the SPA process due to an effective relationship being formed. The formation of the player-analyst-support staff relationship could have been perceived by the coaches as further attempts to undermine their role. It could also be argued that the relationship between the players and the analyst was interdependent. Where without the analyst providing the data and information to assist their learning, they would not be able to develop and fight for a position at the Paralympics (Stirling and Kerr, 2009; Bampouras, Cronin and Miller, 2012). However, relationships can break down if conflicts are unable to be managed and distrust surfaces (Holt, Knight and Zukiwski, 2012), as it did in my situation. These interpretations from my work as well as that of Nelson, Potrac and Groom's (2014) work aligned with Jowett's (2007) analysis of the coach-athlete relationship. Whereby, the relationship between the coach and the analyst becomes less interdependent because a member of the relationship experiences a lack of trust and mutual respect. This results in a breakdown of the relationship over time, a lack of cooperation interaction and a disengagement in the SPA process. Through extracting the comments from the coaches, players and support staff, it was found that by presenting data and information that challenged and conflicted with the coaches' beliefs they attempted to exert impersonal coercion power (Raven, 2008) due to the development of distrust. This resulted in a further breakdown of relationships between the players/support staff and the coaches, which affected the use of SPA.

Wright (2015) also highlighted the importance of trust in a SPA provision. He placed trust as a foundational building block that affected the introduction and buy-in of individuals to the utilisation and engagement of SPA. The work of Sztompka (1999) supported this notion, outlining that the establishment of trust between individuals "becomes the crucial strategy to deal with [the] uncertain, unpredictable and uncontrollable future" (Sztompka, 2003, p.47). For example, if coaches, players and support staff are presented with new information that potentially challenges their thinking. The formation of a supportive trusting relationship becomes a key component in stabilising the potential turbulent environment. Charlie, the member of the support staff, emphasises this by stating:

> *I trust you because I know what you are on about and I give you the space, the autonomy and resources that you need to do what you do and because we do that everything seems to be fine…I think that's the biggest thing, and I think if you can have that in any professional relationship then you have got professional trust which definitely makes everything a hell of a lot easier.*

Through the establishment of trust with the players and support staff, Charlie had confidence in my ideas and ability to execute these into practice. The players shared this perspective as well, in particular, Frank believed:

> *…we should have used you more, especially going into the last three games. I think we should have gone in better tactically prepared, understanding what the other teams were doing in black and white terms. I believe there were times when, if they are going to use you, you have to have more of a say. You have to tell us what the other teams are doing. You are witnessing it and collecting the numbers so your voice has to be heard by the coaches.*

The two extracts above highlight that this ability to trust me and the processes that I was attempting to implement resulted in a greater buy-in to the SPA process by the players. Sztompka's perspective of trust aligned with a number of comments made by the players and the member of support staff. In particular, Sztompka's concept of the trusting culture. The players perceived that due to the data conflicting with the coaches' beliefs and beyond their requests, I could have affected the coaches' ability to trust me due to inadvertently challenging their knowledge base. The balance between risk and reward through their eyes could have been too large a risk for them to take. However, Phillips *et al.* (2010) argued that if you are continuing to present the same data, you are not challenging historical perceptions and not generating new knowledge. The entire purpose of high performance sport is to achieve success. Thus, as teams are developing and progressing it is important to stay one step ahead of the opposition (Jones, 2012), implementing and testing new ideas and concepts to unearth the marginal gains that could help a team to achieve their long-term goals. The players and support staff were aware of the need to stay one step ahead and as a result, bought into the SPA provision.

Therefore, the reason the players and support staff bought into the SPA provision was due to (i) their ability to trust me and the data that I was producing, (ii) the potential power the data held in illustrating their performance, and (iii) the notion that negative conflicts did not emerge. The players were aware that natural talent would only assist them so far and thus calculated risks needed to be taken to enable them to advance further in the competitions. The objective data assisted as a tool to provide evidence to support their decision. Thus, my ability to produce accurate and reliable data further strengthened my relationship with the players and their ability to trust me. However, it was also the reason why the relationship with the coaches broke down, conflicts emerged and were not resolved, resulting in the reduction of SPA in the men’s programme. Despite this, the players were able to listen to the data whilst still being constrained by the coaches’ decision regarding who to play and when to make rotations as they held a superior position of power. This interpretation of the participant’s narratives could explain why the data from Chapter Six demonstrated partial alignment with the data. For example, the coaches did not play with three 4.0 players in 2016, which aligned with the data, however, the reason behind this was due to the availability of only one 1.0 classified player. Whilst, a demonstration of the players attempts to listen to the data can be highlighted through alignment with the shot types and how they chose to relieve shooting pressure. Therefore, the players' comments and the comparison data from 2015 to 2016 found in Chapter Six, highlight that the processes and work completed in developing a SPA provision was not redundant as the players used this data to inform their learning.

7.6 Conclusion

Within this chapter, I presented a story that portrays the perspectives of the players, coaches and support staff as well as my own towards the use of SPA throughout the four-year Paralympic Games cycle. Drawing upon work by Bourdieu (1977, 1984, 1986, 1988, 1989, 1990, 1991), Kelchtermans and Ballet (2002a, 2002b), Raven (1992, 1993, 2001, 2008), Jowett (2007) and Sztompka (1999) among others, I attempted to understand the socio-political challenges that surfaced as I delivered a SPA provision. It was through the process of being embedded in the field and having lived through the same experiences as the coaches, players and support staff that I became aware of the importance of relationships and trust. I, therefore, opted for an overview of the events that occurred, illustrating these in a chronological order, instead of presenting an in-depth analysis regarding a specific point in time. This enabled me to highlight the complex and messy realities that are apparent when designing, deploying and advancing a new SPA provision within a Paralympic Sport.

The power and political dynamics between individuals, as each attempts to fulfil their own micropolitical agenda, provided insight into the fluid measures of compliance, cooperation and resistance (Locke, 1985). At the heart of the matter lay the ability for one another to trust each other and the data. Although initially, it appeared as if the coaches trusted the data and the analyst, my subsequent behaviour to go above and beyond their requests threatened and undermined their position and the developing relationship. According to Raven (2008), my actions could have been perceived by the coaches as an act that challenged their legitimate position of power. My actions could have been viewed as a refusal to comply and led to the onset of distrust. In response to the breakdown of trust with the coaches, the players, support staff and myself resisted their attempts to restrict the flow of SPA data, by engaging further in the provision and attempting to transform aspects into training and game strategies. This decision could have been interpreted as another attempt not to comply and I should have engaged in alternative actions to discuss the reasons for my actions in relation to demonstrating the broader picture.

Subsequently, it became apparent that to advance the SPA provision it was important to develop effective relationships that are built on trust and acknowledge the ever apparent and changing micro-political and power dynamics between the social agents within the environment. Through creating stronger relationships between the coaches, players and support staff a wider and holistic understanding of how SPA can assist the players further would be generated. Although these interpretations align with Wright's (2015) work in relation to the importance of trust and relationships regarding buy-in, I have presented the perspectives of one team towards the impact of a SPA provision throughout a Paralympic Games cycle, providing a longitudinal exploration of how the socio-political factors influenced coaches', players' and a support staff member's perceptions of SPA over a four-year period.

The models and theoretical concepts that I referred to provide a useful lens to assist in interpreting my own experiences and the individuals' narratives regarding power, politics, relationships and trust. The four components of trustworthiness provide evidence in developing a trusting relationship built on closeness, commitment, complementarity and co-orientation. These relationships make it possible to function and introduce new ideas, without personal agendas and adverse power strategies that result in confrontation through forging collaborative approaches to achieving long-term goals.

Kelchtermans and Ballet's (2002a, 2002b) work provides a useful insight into how individuals navigate themselves through various 'fields'. Whilst Raven's (1992, 1993, 2001, 2008) bases help to understand how individuals use a variety of strategies to exert power and control their own future, as well as the future of others ('capital'). Whereas, Sztompka's (1999) notion of primary and secondary trust incorporates aspects of 'habitus', whereby how the individual's cultural and sociological history assisted in calculating the trustworthiness of an individual. Thus, the interplay between habitus, field and capital affects trust and how the relationship between power and trust provides insights into the role of commitment in both enabling and undermining coach-player-analyst-support staff relationships. Hence, the inter-related concepts of power, politics, relationships and trust assists in explaining and making sense of "the behaviour of actors in the real world" (Farrell, 2004, p.26). The behaviour of an individual, i.e. the coach, the player, the member of support staff or the analyst, can be further explained by the consistency in what individuals find gratifying in interpersonal relationships (Porter, 1976). Therefore, if we are aware of the goals that individuals are working towards and the implications of power struggles and political challenges, through engaging in direct conversations, individuals can then open themselves to feedback resulting in a change of behaviour, a willingness to learn and the avoidance of unwarranted conflict (Porter, 1976; Sucher, Nelson and Brown, 2013).

In this case, these lenses have assisted my interpretations of the journeys completed by the staff, players and myself. The story I have presented provides an exploration of the personal and performance impact of a SPA provision throughout the Rio de Janeiro Paralympic Games Cycle. It has assisted in identifying the potential reasons why the coaches, players and support staff chose to regard/disregard some of the data-driven advice during the Paralympic Games and uncovered the potential mechanisms that might have encouraged individuals to use SPA evidence to inform future decision-making during training and games.

Chapter 8 Discussion

8.1 Overview

This thesis has documented the processes conducted to develop and deploy a SPA provision for BWB. It began by identifying the key determinants attributed to team and shooting success. The key findings from this initial work assisted in the development of a SPA provision. BWB's performances during the 2015 European Wheelchair Basketball Championships were then compared to the 2016 Paralympic Games to explore whether practices and game plans had been adjusted as a result of the SPA findings. Through being embedded within the BWB High Performance Programme, the socio-political factors affecting individuals' ability and willingness to listen to SPA information surfaced. As I reflected on my own journey, and those who received the SPA provision during the Rio de Janeiro Paralympic Games cycle (2013-2017), it became evident that regardless of how accurate the SPA data was at identifying the key determinates of success, without the buy-in of the coaches and the foundation of trust between individuals within the SPA process, the marginal gains that SPA could unlock would not surface. Thus, within this chapter, the overall contribution this thesis has made to interpreting how SPA is used and understood within wheelchair basketball is discussed. Additionally, the use of the first person is used later in the chapter to provide a reflection on my own personal journey, telling my own story regarding the struggles faced and how these have shaped the research.

8.2 SPA: A tool for marginal gains

With the cost and pressure of winning competition increasing, sports teams and individuals around the world have been using SPA to further enhance players' performance and expand the narrowing performance gap (see Chapter One). SPA was presented as a process of labelling and recording sports specific actions and behaviours (Sampaio, McGarry and O'Donoghue, 2013). The data and information extracted from SPA provide an objective lens to an individual's subjective perception of a performance (Laird and Waters, 2008). Coaches and support staff use this information to provide feedback to players to improve their decision-making processes and implement a positive change in their performance (O'Donoghue, 2014; Fliess-Douer *et al.*, 2016). However, unlike association football, basketball and rugby union, disability sports have only recently turned to SPA as a tool to complement the work and understanding of coaches, players and support staff. As a result, the knowledge and understanding of the key determinates of success and how SPA is used in disability sports was seen as limited. It was highlighted that there was a call from both staff and players involved in disability sport to have access to SPA to assist in their learning and development.

8.3 SPA: What had been completed in wheelchair basketball?

Through the initial stages of this thesis, the existing research pertaining to SPA in wheelchair basketball was limited to seven studies Although each study's aims were slightly different, they assessed the effect of a player's classification on performance through the CBGS (see Chapter Two). These studies found the higher the classification of a player, the greater the CBGS score they would achieve. Hence, coaches adopted line-ups with three 4.0 players to maximise the chances of winning the game. However, the validity and reliability of the CBGS as an observational tool for assessing performance has been questioned (Ziv, Lidor and Arnon, 2010). Furthermore, when Vanlandewijck *et al.* (2004) attempted to use a wheelchair basketball specific CBGS, which included the variable 'pick-back', researchers were unable to accurately record this event and removed the data from the findings.

Subsequently, the existing research in wheelchair basketball and coaches' current practices were questioned, due to the discrete action variables being adopted from able-bodied basketball, and no valid and reliable sport-specific observational tool/SPA template was identified. Wheelchair basketball coaches, players and support staff had very limited objective data to assist their augmented feedback. Thus, the existing action variables did not provide the answer to how or why the player performed in the manner in which they did (O'Donoghue, 2014), potentially ignoring key information which could assist in the players' or teams development (Nelson, Potrac and Groom, 2014). As a result of the narrowing performance gap between men's wheelchair basketball teams and the lack of valid and reliable data to inform coaches' feedback, a SPA provision for the men's BWB High Performance Programme was designed and delivered, ultimately with the aim of achieving a gold medal for the men's team at the 2016 Rio de Janeiro Paralympic Games.

Previous research indicated how each player in a situation is dependent upon the behaviours of the opposition and their own teammates. The success of a player is dependent upon and altered by the emerging actions and behaviours of the other players currently on the field of play (Passos, Araújo and Davids, 2013). The decisions and actions made by a player and/or a team are constrained by the previous outcomes and will affect the decision and actions made in future interactions (Reed and Hughes, 2006). The previous evidence demonstrated the CBGS did not account for these interactions. Additionally, the BWB coaches were relying on this data to provide players with non-valid and unreliable feedback that largely focused on their on-ball actions in isolated instances. Although this allowed researchers to highlight the total number of shots taken per game and the total number of rebounds achieved in isolation, it adopted a reactive approach rather than a proactive approach, thus, having a delayed and isolated impact on performance. Furthermore, the research findings had limited application into the real world and subsequently provided a limited on-court performance advantage. Garganta (2009) and Lebed and Bar-Eli (2013) suggested to find the marginal gains, which separate the successful from the very successful performer, a proactive approach of modelling real-world actions and behaviours needed to be adopted.

With the continual development of computerised SPA systems, it is now quicker and easier to collect large quantities of data than previous manual notation systems. These data can be used to model previous performance and predict future performances (O'Donoghue and Holmes, 2015; Nibali, 2017). Although Gómez *et al.* (2014) used the CBGS, his research team attempted to use a linear regression approach taking into consideration comments from Pedhazur (1982) regarding advanced statistical methods. This was an attempt to acknowledge the need to adopt a proactive approach for exploring wheelchair basketball performance. Coaches would, therefore, be able to provide accurate, reliable and contextually relevant feedback, allowing for improved decision-making processes to enhance performances.

8.4 Moving beyond the CBGS

James, Mellalieu and Jones (2005) and Thomson, Lamb and Nicholas (2013) work was built on to ensure a valid and reliable wheelchair basketball template was created through a nine-phase process. The strengths and limitations of existing wheelchair basketball research and emerging theoretical perspectives in SPA were acknowledged, whilst drawing on the opinions and knowledge of elite wheelchair basketball coaches and support staff, to develop a SPA template, which assessed team wheelchair basketball performance (see Chapter Three). In doing so, three focus groups provided opportunities to discuss and develop action variables and operational definitions associated with assessing team performance. The development of the action variables was underpinned by DST principles. However, to 'please' the coaches and not threaten their or my own personal agendas (Kelchtermans and Ballet, 2002a), some key variables were removed regardless of the potentially meaningful insights the findings might provide due to my limited wheelchair basketball specific knowledge at the time. To overcome the limited number of available wheelchair basketball 'experts' and progress the work, individual video clips of each action variable were created and shown to each staff member to establish content and construct validity. This provided an opportunity to gain confirmation surrounding what was communicated in the focus groups, to what could be observed through video recordings.

Making use of computerised SPA software, SportsCode V10, a template that included 110 action variables clustered into 17 categories was developed. This allowed information to be collected regarding how and where a possession began, what occurred during the possession and how the possession ended. Unlike box-score data and the CBGS, this new SPA template recorded information surrounding team-components instead of individual contributions. This process, therefore, allowed for more meaningful data and information to be captured regarding a performance. The data that the template was capable of capturing would be more meaningful and addressed the issue of the previously adopted CBGS template.

The accuracy of each individual possession in a randomly selected game was subjected to intra-observer and inter-observer reliability testing. Following the completion of two intra-observer tests, an agreed observation was then compared; first, to an observation completed by a wheelchair basketball coach and second, to an observation by the performance analyst intern. The process of developing an agreed observation, rather than using the first or second observation completed by the first observer, ensured any inaccuracies had been checked. Unlike previous studies within SPA, this new approach, instead of using an observer's first observation, overcame any errors within their observation and thus presented a more reliable baseline for further comparisons.

The intra-observer and inter-observer reliability processes allowed for the identification of any types of error (Choi, O'Donoghue and Hughes, 2007) when recording actions between individuals with various levels of sport-specific and SPA knowledge. Informed by existing research (Vinson *et al.*, 2017), it was important to involve individuals in the reliability procedures who would be directly involved in the wider SPA process to enhance understanding of SPA. Previous researchers have typically drawn on other researchers who have no direct practical application for the existing template and data, however, involving the end users was considered a novel but important approach for educating the individual regarding the importance of reliability within the SPA data collected. Although the coach bought in to the use of SPA he subsequently left the programme before the four-year cycle had concluded and did not attend the Paralympics.

The template's reliability was explored through two reliability measures: Weighted Kappa coefficients and percentage error. The multiple reliability assessment measures allowed the magnitude of the error to be identified, in addition to non-random observer errors, factoring in the degree of chance within an individual's observation of events (James, Taylor and Stanley, 2007; Robinson and O'Donoghue, 2007; Williams *et al.*, 2007). Previous research largely adopts only one reliability statistic to test systems, neglecting the limitations of a specific test. However, through using two statistical tests, this approach overcame the limitations of either reliability measure and is recommended for future reliability tests with SPA. The processes completed in Chapter Three illustrated how the first valid and reliable sequential wheelchair basketball SPA template for assessing team performance was developed and the stages undertaken should be used when developing new SPA templates.

8.5 Unlocking the determinants of team success

Towards the end of 2015, the developed team-specific SPA template was used to analyse wheelchair basketball games from the 2015 European Championships and identify the key determinates of team success in men's elite wheelchair basketball (see Chapter Four). The binary logistic regression team model illustrated the magnitude of a change in an action variable on the chance of winning a wheelchair basketball game. This equated to ascertaining the optimum sequence of actions the five on-court players should complete during a possession to enhance a team's chances of winning a game.

In line with previous work in team sport (e.g. Jones, 2009), the odds of winning a wheelchair basketball game were found to be more than doubled when a team began a possession in the status of "Winning" in comparison to "Drawing" (OR: 2.137) (see Chapter Four: Table 4-6). Basketball studies have identified similar findings regarding momentum, for example, LaRow, Mittl and Singh (2015, p.5), discovered "momentum is a factor of not just scoring but the overall state of the game". Thus, drawing parallels to the findings presented in Chapter Four and implying the phenomena of momentum is apparent in both basketball and wheelchair basketball.

Previous basketball research also highlighted opponents found it statistically more challenging to score against zonal defensive systems set-up around the key and easier to score when defences were set-up outside the three-point zone (see Gómez, Tsamourtzis and Lorenzo, 2006). Similar results were also produced by the team-specific binary logistic regression model (see Chapter Four: Table 4-6), inferring the odds of winning were greater than one when the team in possession faced a “Highline” Defensive System (OR: 1.603), but were less than one when facing a “Zone” Defensive System (OR: 0.949). The findings, therefore deduce, as the space between the shooter, defender and basket decrease, in both basketball and wheelchair basketball, so does the likelihood of a team achieving success. The ability to identify this relationship only occurred due to accounting for the attacker-defender dyad in the SPA coding template, which was underpinned by DST.

The most striking and contradictory finding was regarding player classification. As outlined in Chapter Two, the research identified players who are classified as either a 4.0 or a 4.5 accumulate the highest CBGS score. The advice generated from previous studies inferred coaches should use line-up combinations, which comprised of two or three of these players to improve their chances of team success. In contrast, the model demonstrated the odds of winning were less than one when the offensive line-up comprised of “Two” 4.0 or 4.5 players (OR: 0.787) and likewise when there were “Three” 4.0 or 4.5 players (OR: 0.257) within a line-up. However, when the line-up comprised of either “Zero or One” 4.0 or 4.5 player and “Two” or “Three or More” 3.0 or 3.5 players the odds of success were greater than one (“Two”: OR: 1.072; “Three or More”: OR: 1.653). This finding conflicted with the advice generated from the previous studies.

The findings from this study highlighted that playing with a greater number of 3.0 or 3.5 players and fewer 4.0 or 4.5 players allow coaches to play with fewer 1.0

or 1.5 players. Thus, informing coaches which alternative line-ups they could use to improve the odds of winning. Although this advice potentially makes 1.0 classified players redundant, due to their limited on-ball skill set (Skucas *et al.*, 2009), and challenges the Paralympic Games value of equality (International Paralympic Committee, 2018). Performing on the world stage drives the notion of a win at all costs mentality (Watson and White, 2016) and thus coaches, players and support staff are looking for marginal gains to enhance performance. The findings in Chapter Four, therefore, provided a useful insight for staff and players regarding what it would take for teams to win wheelchair basketball games. Coaches, players and support staff could use the data as a framework to identify the existing performance gap and devise training sessions and game strategies to narrow the gap.

8.6 The key variables of shooting success

The findings from Chapter Four highlighted the importance of momentum. In agreement with the coaches, it was decided to explore the key determinates of field-goal shooting success to provide SPA data to inform decision-making processes. Previous game results at major competitions indicated the teams typically took in the region of 55 to 65 field-goal shot attempts per game (Gómez, Molik, *et al.*, 2015). Building on this knowledge, the same coaches and support staff completed the same nine-stage process to develop a new valid and reliable SPA template, as had been completed in Chapter Three, albeit for field-goal shooting. During the template development phase, defensive variables, which the coaches believed were not important, were maintained. The final field-goal shooting specific SPA template was developed in SportsCode version 10 and comprised of 69 action variables, clustered into 21 categories. This developed template was the first wheelchair basketball field-goal shooting specific SPA template and incorporated novel components in an attempt to collect a dynamic and contextually meaningful picture of an individual's action during a shooting attempt.

Through analysing 1,144 field-goal shot attempts, during games when a top-five team played another top-five team from the 2015 European Championships, a binary logistic regression model was developed. The large sample size and post-game analysis using actual game footage in comparison to Goosey-Tolfrey, Butterworth and Morriss (2002) previous work regarding free-throw shooting allowed for a more extensive examination of shooting. The model included eight CPVs which were found to statistically ($p<0.05$) affect field-goal shooting success. The players' classification CPV was removed from the final model, due to being non-significant, despite a player's classification and their core function being identified as an important factor to consider in previous studies (Limroongreungrat, Jamkrajang and Tongaim, 2010). The final model indicated the odds of shooting success increased when the ball was released from a higher release point, i.e. "Post-Up" Shot Type (OR: 1.304), reducing the distance between the basket and the shooting player. Optimum shooting locations were also identified, within the charge circle ("Near") or at 45-degree locations ("2 Point – Left – 45" and "2 Point – Right – 45"), to improve the likelihood of shot success. Additionally, the model's findings agreed with basketball data that, as Defensive Pressure increases, shooting success decreases. In addition, an optimum defensive strategy was identified to reduce a shooter's efficiency by restricting 90-180 degrees of the player's cylinder and utilising the three remaining players to protect the remainder of the court.

Although the data draws parallels to a number of studies within basketball and the BWB coaches' previous thoughts and ideas, the model produced some conflicting information. One aspect, in particular, was in relation to a player's Shot Positioning. BWB coaches advise players to shoot at an off-centre position (Gordon, 2013), left-handed players slightly turned to the right and vice versa for right-handed players. This advice forms part of the coaching development programme run by BWB. However, the findings from the model highlighted the odds of success decreased when players shoot from an off-centred position. This finding is in agreement with recent able-bodied basketball shooting data, which emphasises the importance of adopting a "Square to Basket" Shot Positioning

(Williams *et al.*, 2016). Thus, the findings presented in Chapter Five provide the first technical and tactical insight into field-goal shooting for coaches, players and support staff to consider. In particular, these findings could assist in identifying areas for development within training sessions and creating game strategies, which allow players to arrive at optimum locations under optimum conditions.

8.7 From Worcester to Rio: Data-driven approach or chance?

The performances completed by BWB during the 2016 Rio de Janeiro Paralympic Games draw a number of parallels to the advice generated and provided to the coaches, players and support staff from the analysed performances at the 2015 European Wheelchair Basketball Championships. Despite receiving SPA data and advice, BWB's win-to-loss ratio was the same across the two tournaments. Here the findings revealed, BWB followed the data and advice generated from the models regarding Offensive Unit - 4.0-4.5, Start of Possession, Shot Type and how to reduce defensive pressure whilst shooting and partially followed the advice for the Offensive Unit - 3.0-3.5, Defensive Unit - 3.0-3.5 and Shot Location CPVs. However, the opposite was found for Game Status, the Defensive System and Shot Positioning players, whilst no differences were identified for the Number of Hands on the Ball, Defender Marking Space and Defender In Front.

The identified similarities could indicate the coaches, players and support staff attempted to follow the advice. Their decision to focus on the variables that would increase the odds of success could have been driven by the need to adopt a win-at-all-cost mindset (Watson and White, 2016), to not only protect the team's funding but their own jobs (Kelchtermans and Ballet, 2002a, 2002b). However, the emerging differences in the advice and performances could be explained by the opposition Great Britain faced during the Paralympics. The models and advice were generated from games against European teams and thus the devised strategies could not have followed the data when facing non-European teams. Kerr (2015) supported this idea, suggesting different continents adopt different playing strategies due to differing anthropometric data and on-field and off-field organisational nous. This was essentially the case, as during the Paralympic

Games, Great Britain only played one European team in the pool stages before facing two European teams in the knock-out stages. Therefore, alternative key determinants of success may need to be identified when facing non-European teams and different game strategies may need to be implemented. Further research, regarding shooting and team performance against different opponents, need to be explored to inform the field and future generations of coaches, players and support staff.

The differences that were identified could be explained by exploring the content of the training sessions. Coaches could have elected to work with variables that were shown to decrease the odds of success in an attempt to improve their odds. Subsequently, with the belief that this would improve overall performance. Lloyd *et al.* (2015) supported this perspective believing coaches, players and support staff should continue to work on areas of weaknesses in an attempt to minimise any potential negative impact on performance. This was identified in a player's quote presented in Chapter Seven, whereby they attempted to adjust their technique to enhance their performance as well as continuing to work on their strengths. In addition, the time frame in which the data was presented and the ability to implement these into practice could have been an insufficient time frame. Smets (2007) suggested it can take longer for individuals to adjust their practices and warm to new ideas if they conflict with previously held beliefs. This could have been applicable regarding some of the shooting data presented to the players and staff.

Through considering a different perspective, the similarities and differences could simply be explained by the individuals playing wheelchair basketball but at two different performance levels. The Paralympic Games is the pinnacle of an elite athlete's career and brings different social and psychological pressures that could impact performance (Williams and Andersen, 2012). Thus, the combination of the event and different opposition could result in the decision-making process being affected. It could, therefore, be argued that any similarities and differences occurred by chance. However, further exxamination is also needed to explore how competition type effects performance of wheelchair basketball players, both technically and tactically but also from a psycho-socio perspective.

Although Chapter Six highlighted that Great Britain's performances at the Rio de Janeiro Paralympic Games partially aligned with the models developed in Chapter Four and Chapter Five, it was difficult to ascertain whether the coaches, players and support staff attempted to listen to any of the SPA data. A variety of different perspectives were presented to interpret whether the coaches, players and support staff listened to and attempted to implement the findings from the model to adjust training and game strategies. However, without exploring the opinions of those involved in the SPA processes it was difficult to decipher whether the SPA data was used to inform practice. These elements were addressed in Chapter Seven through gaining the perspectives of coaches, players and support staff towards SPA, who had been in the programme and received the provision, in addition to reflecting on my own experience.

8.8 SPA: The analyst, the provision and wheelchair basketball

The theoretical lenses of Bourdieu (1977, 1984, 1986, 1988, 1989, 1990, 1991), Kelchtermans and Ballet (2002a, 2002b), Raven (1992, 1993, 2001, 2008) and Sztompka (1999) were used to interpret and critique the personal and performance impact of a SPA provision (see Chapter Seven). As new ideas and concepts were introduced, I relied on my previous knowledge and experiences (habitus) to establish and protect my micropolitical environment (Kelchtermans and Ballet, 2002a, 2002b) within the field (Bourdieu, 1984). It became apparent that after two years of laying the foundations for the SPA provision the players and support staff believed the coaches had begun to disregard the SPA data and information. The players and I perceived the information conflicted with the coaches' ideas and threatened their own micropolitical agendas (Kelchtermans and Ballet, 2002a, 2002b) and positions within the organisation (Bourdieu, 1977). This could have also been due initially complying with their requests for information instead of discussing their needs and where SPA could be used to provide future insights.

The coaches possibly, in an attempt to retain their position of power, made use of a number of bases of power (positive expert power, legitimate power of responsibility and direct informational power (Raven, 1992, 1993, 2001, 2008), restricting my involvement and input during the build-up to and including the Paralympic Games. This included me perceiving the coaches 'hanging me out to dry' during a SPA video session a few months prior to the Games and requesting me to fulfil multiple roles at the Paralympic Games, knowing that I would not be able to provide the SPA data the players wanted. The coaches' actions and decisions surrounding the use of SPA were in contrast to Booroff, Nelson and Potrac's (2015) work. The coach, Terry, in Booroff, Nelson and Potrac's (2015) study used his role and his interactions with SPA as a tool to advance his position within the structural social positions and the broader sub-cultural expectations in which he was placed (Bourdieu, 1977). SPA has historically been used as a tool to assist coaches' and players' decision-making processes. It, therefore, supported individuals in fulfilling a win-at-all-costs mentality, unlocking the minute differences which separate the successful from the very successful (Hutchins, 2016). However, the BWB coaches' attempts to restrict my ability to present data and information draws parallels to the actions of the coach in Groom, Cushion and Nelson's (2012) work, where the use of direct informational power (Raven, 1992, 1993) by the coach restricted the players' contributions to the SPA sessions. I argued, with the support of the players, that the coaches' decision to disregard the SPA information could have inadvertently affected their and the team's ability to return a gold medal. This disregard to attempt to achieve marginal gains through SPA continued to be the case because it was viewed by the organisation and the wider government-funded organisation, that the men's team achieved success by returning a medal.

Despite the coaches' use of a variety of power strategies, I continued to protect my landscape by engaging in micropolitical action (Kelchtermans and Ballet, 2002a, 2002b) and producing data and information for the players. The players relied extensively on the SPA information during training and games. The process of players approaching me rather than the coaches for information and feedback was possibly due to (i) a loss of confidence, trust and respect regarding the coaches' decisions, and (ii) the ability for me to provide a clear picture through the presentation of objective evidence. The actions of the players approaching me and working with them to meet their needs could have further resulted in the onset of distrust due to the coaches feeling threated. However, I perceived my ability to continue to produce information for the players, not only increased my cultural and symbolic capital (Bourdieu, 1986) but assisted in maintaining my analyst-player relationships. My further attempts to involve the players directly in the SPA process was welcomed by the players. However, my actions might have caused the coaches to use additional power strategies to protect their landscape, due to feeling threatened (Kelchtermans and Ballet, 2002a, 2002b; Raven, 2008), but resulted in further conflict (Wachsmuth, Jowett and Harwood, 2017). Over time the players and support staff saw me as a valuable asset to the team's long-term goal, subsequently trusting me and the information (Sztompka, 1999; Jowett, 2017), increasing my symbolic capital (Bourdieu, 1986), regardless of how conflicting the SPA data and information was to their pre-held beliefs.

To frame the participants' narratives and my own experiences, I interpreted that regardless of how accurate the SPA data and information were at supporting the decision-making practices, without a coach-player-analyst-support staff relationship these objective findings did not achieve their potential. Despite the players and my own micropolitical agenda, the coaches ultimately had the final decision regarding what happened during games. The coaches exerted power in an attempt to protect their own micropolitical agendas in accordance to what they perceived the organisation required of them within their role (Bourdieu, 1986; Kelchtermans and Ballet, 2002a, 2002b). The players appeared much more willing to listen and use the SPA data as their position within the team was continuously challenged because other players improve their own performances over time. Nevertheless, I would argue that through the development of an open, honest and trusting relationship with the coaches, players and support staff, conflicts can be managed, resolutions formed and the SPA data and information can be used to support their decision-making processes, learning and development (Wachsmuth, Jowett and Harwood, 2017). However, it is of utmost importance to establish and maintain a coach-analyst relationship because without the ‘buy-in’ of the coaches the SPA process will gradually decline regardless of the players, support staff’s and analyst’s best intentions.

As a result of the information and findings presented within this thesis, the initial SPA process model presented in Chapter One by Franks, Goodman and Miller (1983) required adapting to acknowledge some of the findings. Although the core principles of performing, observation, evaluation and planning remained, the thesis along with more recent research findings have highlighted the importance of the formation of trust and the involvement of coaches, players and support staff within the process. Therefore, the new model (see Figure 8-1) introduced a period of player reflection following performances whilst the coaches are watching the footage and the analyst is recording key actions and behaviours. Jordet (2015) highlighted the importance of reflection for players to assist in their self-regulation of learning. Renshaw, Oldham and Bawden (2012) elaborated further by highlighting that through reflection player(s) are able to develop new skills and further strengthen the understanding of their existing skills. Thus, incorporating a period of reflection prior to the evaluation of performance is a key component to further develop player(s) learning and decision-making skills (Knowles *et al.*, 2001; Faull and Cropley, 2009; Williams and Ford, 2009; Rohleder and Vogt, 2018).

In addition, the findings from this thesis have also highlighted that without the development and maintenance of a trusting relationship between the coaches, players and support staff the evaluation, planning and feedback process cannot and does not include SPA data and information. Wright *et al.* (2013) emphasised the central importance of 'trust' and 'respect' within the SPA process to ensure the learning and development of players and coaches when reviewing past performances and planning for upcoming games. Fernandez-Echeverria *et al.* (2019) most recently supported this notion, stating that trust was essential to establish between the coach, analyst and players for optimal learning conditions. With McKenna *et al.* (2018) previously stating that trust can affect an athletes buy-in and willingness to use SPA as part of the learning and preparing for upcoming performances. The new model (see Figure 8-1) illustrated the key considerations taken from the work within this thesis, acknowledging that without trust the adoption of SPA within a coaches, players or support staff approaches to promote players' own learning and development is restricted (Wiltshire, 2014; Perla *et al.*, 2016; Fernandez-Echeverria *et al.*, 2017, 2019). Thus, the model highlights that through a collaborative approach, built on trust, between the analyst, coaches and players, the route highlighted in green) a more positively impactful performance should be achieved.

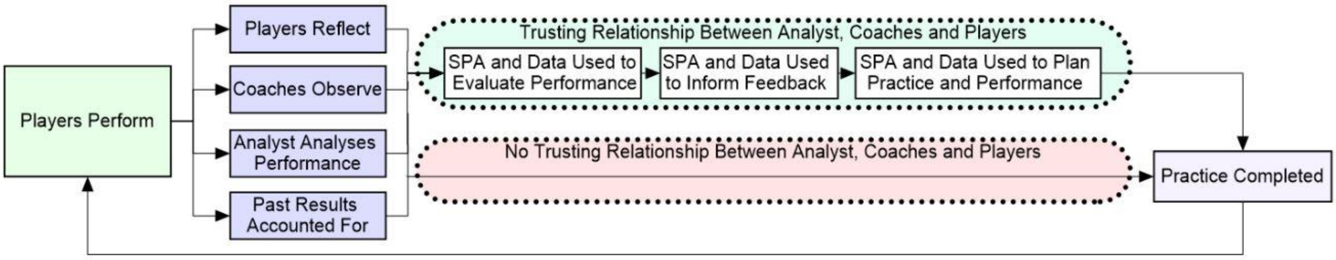


Figure 8-1: A new model to illustrate the coaching process highlighting the importance of a trusting relationship between the analyst, coaches and players.

8.9 Looking beyond Rio: Learning experiences and identified development

8.9.1 My learning experiences and development as an applied researcher

Through the process of compiling this thesis, I have undoubtedly undertaken a unique and invaluable learning experience. Early on in the process, I spent time learning a new sport, becoming aware of the challenges disabled players face on a daily basis and developing the skills to conduct advanced statistical techniques to unlock key performance insights. I continued to build on my existing SPA knowledge regarding the key determinants of success in team sports and how DST could be used to assist our understanding of how and why a player or team acted in the manner in which they performed. I began feeding back my findings to the staff and the players in an attempt to show my value and what I could add to the programme.

Through my direct involvement and the opportunities to travel with the team to numerous tournaments, I gained an exclusive insight into how high performance disability sport operated. I became aware of the importance of how the information and data I had gathered was impacting on performance. More specifically, I realised I had focused on collating reams of data to illustrate my ability to do what I perceived to be my job. Instead, I should have been focusing on the impact I was making and understanding how I could present meaningful messages to those involved with the team to assist them in their long-term goal. This meant tailoring the provision I had introduced to each individual, in an attempt to make meaningful performance gains. In doing so, I realised that I needed to transition from a positivist to an interpretive approach to gain a deeper insight and understanding of how each individual understood and perceived SPA. As a result, I believed I was in a better position to support the players during the Rio de Janeiro Paralympic Games, despite the socio-political factors that emerged which were highlighted in Chapter Seven.

The initial research proposal I presented focused solely on exploring the role of the analyst through an auto-ethnographic approach. However, due to an extended period of illness and uncertainty regarding my ability to travel to the Paralympics, the current thesis structure was adopted. Despite the new structure, the learning experiences and the journey I have undertaken has assisted in my transition from fulfilling a Head of Performance Analysis role to becoming a Lecturer and Consultant in Performance Analysis. Through my role as the Head of Performance Analysis and working as a Sessional Lecturer alongside my PhD, I started to consider the developmental journey I had gone through and those of students who wanted to follow similar paths. This meant sharing my journey during lectures and seminars with students, to not only inspire but also educate them to the challenges they might face. I found myself in a better position to support the students I was teaching and the intern I was mentoring through their own doubts and challenges (Meyer and Land, 2005). As a result, this process also helped me to reflect on the unfolding findings from my research and make sense of the coaches', players' and support staff's use and perceptions of SPA. The experiences I have gained through this journey and the findings I uncovered have assisted in developing my own professional identity as I transition towards a consultant and lecturer. I have found the opportunity to share and inspire future and current performance analysts, and apply my PhD findings to different contexts to improve learning and practices within the field, to be incredibly rewarding.

8.9.2 Practical implications for coaches, analysts, educators and high performance programmes

The findings from this thesis present different implications for coaches, performance analysts, performance directors and educators to consider. The findings highlight further work is required to educate coaches in wheelchair basketball regarding the use and application of SPA in their practice. The data and information SPA provided should become an addition to their already equipped toolkit (Robinson, 2010; Gilbert, Dubina and Emmett, 2012; Potrac, Gilbert and Denison, 2013). It should not be seen as making the coach's role redundant but as supporting and providing an additional perspective to aid their own decision-making processes (Groom and Nelson, 2013). However, this is not restricted to wheelchair basketball but nearly all disability sport (Kohe and Peters, 2017). Thus, a greater awareness of how SPA can complement wheelchair basketball coaches' and disability sports coaches' knowledge is required. For example, in BWB's current coach education pathway, the use of SPA is only introduced when a coach enrols on to a Grade Three Coaching Award (British Wheelchair Basketball, 2013b). The work in this thesis illustrates awareness of SPA and other disciplines need to be embedded earlier in a coach's developmental journey. It is therefore recommended that coach educational programmes should begin to lay the foundations of sports science, sports medicine and SPA from entry-level coaching qualifications to ensure coaches are able to use the available tools to holistically develop players and teams.

In addition, the research here has highlighted the importance of social skills to complement the performance analyst's technical skills, regarding capturing and recording key events. These social skills are required to ensure the end users understand the key SPA findings that have been presented to the coaches, players and support staff (see Chapter Four and Chapter Five). Consideration is also required by the analyst when working with individuals who have only received a limited SPA provision, ensuring new ideas do not cause negative conflicts (Wachsmuth, Jowett and Harwood, 2017), but enable a collaborative approach to be adopted (Vinson *et al.*, 2017).

It, thus, seems important that university SPA degree programmes and national governing bodies' coaching awards should include both the technical and social skills required of a performance analyst within modules. Current modules at universities focus on teaching students how to record data, with limited opportunities to undertake yearlong work placements. Thus, through short work placements, they receive limited direct experiences in dealing with coaches and players. The students are therefore not exposed to potentially challenging situations and are not provided with the required time to formulate effective working relationships (Francis and Jones, 2014; Jowett, 2017). Additionally, students and future analysts should not undertake placements or internships where they are tasked with just coding games, they need to be gaining applied experiences working alongside coaches, players and support staff to gain a holistic insight into how SPA can aid practice. Thus, to inform the field and future generations of performance analysts, university and education programmes should allow students to gain hands-on experience through extended work placements whilst also teaching the fundamental technical skills required.

Over a two or three-year undergraduate degree with specific modules covering SPA, the fundamental technical skills of designing templates, notating valid and reliable data, and developing an understanding of how to identify key trends and patterns should be completed in an initial undergraduate module. The following year, the students should then be provided with suitable learning opportunities for them to begin to apply these technical skills in sporting environments and gain experience and exposure to working with coaches, players and support staff. I have used these recommendations within my current practice, amending module content on both undergraduate and Masters' degree programmes to ensure the students have an awareness and understanding of the socio-political factors that will surface when working as a performance analyst and providing coaches, players and support staff with information from their analysis of performance. Specifically, within the Master's programme, I have revalidated the programme to ensure students are able to develop the critical understanding and awareness of the theoretical concepts of power, politics, relationships and trust. Relating the content to the role of the analyst when entering a new environment, dealing with conflicts and developing trust to ensure the data that they have captured could be used to inform learning, decision-making and future practice.

Finally, performance directors, high performance sporting organisations and clubs need to acknowledge the role of the analyst (Burkett, 2008; Kohe and Peters, 2017). In particular, the time it can take to compile the information and data to support players' development. This equates to providing paid opportunities to gain experience and offering salaries that represent the hours of work completed by the individual. This is an area of concern for myself. The current number of graduating students far exceeds the number of full-time performance analyst roles, and thus future employers still deem it acceptable to advertise full-time unpaid internships. For example, in April 2018 the Irish Rugby Football Union advertised for a 40-hour per week six-month unpaid internship as a performance analyst. Applicants were required to have a masters or a doctoral qualification, "a record of published research, experience in building neural network models and working with databases and a verifiable record of delivering sport science support for a high-performance professional rugby team" as essential requirements (RTE, 2018), skills which take a considerable number of years to obtain. According to the Irish Rugby Football Union, the job had been withdrawn due to being released before final approval (RTE, 2018); however, the huge criticism the advert received from media could be another reason due to the resistance against current practices (Taylor and Garratt, 2010). Job adverts and positions like this are not uncommon within the discipline, but the future ramifications to the discipline could be significant. If similar positions continue to be advertised, I foresee the number of future performance analysts beginning to decline because the ability to pay rent and afford food far outweighs the rewards of working with coaches and players. However, this is a problem that does not just manifest itself to SPA but to the wider sporting landscape and thus government solutions need to be embedded to address these issues. It, thus, questions the place of elite sport in society. The impetus for using elite sport as a platform to enduring legacy and promoting widening participation in sport of young people could subsequently decline. If the players are unable to continually challenge other nations and be used as role models, elite sport will no longer be seen "as a vehicle through which issues of community involvement and corporate social responsibility may be addressed" (Taylor and Garratt, 2010, p.124).

8.9.3 Future research

During the completion of this thesis, studies have continued to be published in SPA, disability SPA and perceptions regarding SPA. These works have been critically evaluated and used to inform the direction of this thesis. Despite an initial increase in the number of SPA wheelchair basketball studies in 2014 and 2015, no other research has been published to further enhance our understanding and awareness of the sport and SPA. Although unknown, the rationale behind this could be due to the increased use of SPA by elite wheelchair basketball teams and their reluctance to share their findings, potentially providing teams with an additional performance advantage. However, with the number of wheelchair basketball games being available through the public domain, there is potential to overcome a number of limitations with the findings presented in Chapter Four and Chapter Five and provide further insights to a variety of wheelchair basketball areas.

Further research should, therefore, analyse a wider pool of games from different international level competitions to identify any competition or zonal differences, explore the female game and increase the number of action variables recorded, specifically regarding what teams do during the possession and the offensive movement patterns teams make to locate themselves in a scoring position. With the ability to access more video recordings and obtain more data, further research should make use of modelling techniques to assist coaches, players and support staff in adopting a proactive approach to performance. These proposed research areas would enable researchers, coaches and support staff in disability sport to move away from relying on able-bodied research to inform their practice. Additionally, the insights gained could enable coaches and support staff to educate and better prepare their players for performance, whether this is at the grassroots or elite level.

The research surrounding the perceptions of coaches, players and support staff towards SPA has continued to grow. Despite the continual growth of SPA perceptions, researchers have focused on able-bodied sports, predominately association football and rugby union. Hence, future research should focus on examining how individuals involved in disability sport perceive the use of SPA to inform the field. Although this thesis has provided an insight into how one elite wheelchair basketball team perceived the use of SPA during a Paralympic cycle, highlighting the importance of trust, relationships and social skills, the area still requires further exploration to enhance our knowledge and understanding to guide future practice. The benefits of being embedded in the field allowed for a unique insight to be gained as to what it is like to work as a performance analyst. The use of different data collection tools in Chapter Seven to explore the perceptions of those delivering and receiving SPA is suggested as a future research consideration. These multiple perspectives provide different viewpoints, allowing for data to be collected from each individual's perspective and at different stages of the Paralympic Games cycles. However, not all of the individuals involved directly in the men's SPA provision were interviewed and thus future studies should attempt to overcome this limitation. Through considering these limitations and the findings of this thesis, I am continuing to build the existing understanding and knowledge surrounding how coaches, players and support staff engage and use SPA as a learning tool to support their practice. Recently, I have begun to undertake a research project, through my current involvement working as a performance analysis consultant with an international deaf futsal team, exploring the team's perceptions of the SPA provision I have delivered and how the coach-analyst-player relationship has progressed over an eight-month period leading towards a major competition.

Chapter 9 Thesis conclusion

The overall aim of this thesis was to interpret the impact of a SPA provision for the BWB men's team and the role of the analyst throughout the Rio de Janeiro Paralympic Games cycle (2013-2017). To achieve this research four main objectives were established (see section 2.8). These objectives were achieved by designing two SPA templates (objective 1) and deploying a SPA provision for the men's BWB team during the Rio de Janeiro Paralympic Games cycle. The templates were used to analyse video recordings, discovering a number of key team and shooting determinants of wheelchair basketball performance (objective 2). Importantly, these determinants of success contributed to establishing and maintaining momentum through a game and a tournament to achieve success. Through the binary logistic regression models (see Chapter Four and Five), the effect of a change in an action variable within a CPV can be calculated and its subsequent impact on the outcome of the game can be extrapolated (objective 3). Additionally, an interpretation of how the coaches, players and support staff's understanding and perceptions of SPA and the analyst changed over time due to power imbalances and arising conflicts between individuals, resulting in the provision's potential performance impact fluctuating over the four-year cycle was presented (objective 4).

Through conducting the research in this thesis, a number of major contributions have been made for academics, researchers, coaches, players, support staff and sport governing bodies to consider and introduce within their practice. These contributions are listed below:

- Introduced a new nine-stage method for developing a valid and reliable sequential SPA template.
- Identified the key determinants of team and shooting success in wheelchair basketball.
- Demonstrated how, through modelling previous performance, the magnitude of a team's action on the impact of game outcome can be identified.

- Generated information which indicates what players and teams should continue to develop in an attempt to enhance performance.
- Widened the current understanding of how to apply SPA theoretical perspectives in practice.
- Provided an account of the role the analyst fulfils when working with disability sports teams and highlighted aspects to consider for effectively embedding a SPA in a High Performance Programme.

As outlined through the research aim, objectives and the original contributions to knowledge presented above, the research concludes it is clear that the role of the analyst, regardless of how accurate the SPA data are at identifying the key determinates of success, without the buy-in of the coaches and the foundation of trust between all individuals within the SPA process, the marginal gains which SPA can assist performance improvements will not surface. Similarly, this research has highlighted that it is important to acknowledge that performance analysts should not just be seen as individuals who work and produce numbers but people who work with people and thus the analyst can play an important role in making a direct and important impact on performance.

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Appendices

Appendix 1: Summary of existing SPA research in sledge ice hockey, wheelchair rugby and wheelchair basketball.

Sport	Aim	Methodological Considerations	Findings
Sledge Ice Hockey **Beckman, Kudláček and Vanlandewijck (2007)**	To develop a skill observational protocol for sledge ice hockey	- 12 games from the 2006 Winter Paralympic Games - Individual player video tracking of 22 players - Validation process included a coach, a player and a manager each with 10 years' experience. - Points scoring system developed subjectively out of 10 - Individual player specific action variables (total 14) - Reliability was not calculated - Mann-Whitney U-test was used for comparisons	Players from the top teams (Norway and Canada) achieved higher scores than teams from Great Britain and Italy
Sledge Ice Hockey **Kudláček *et al.* (2009)**	To determine the differences in the level of individual sledge ice hockey skills among players	- 12 games from the 2006 Winter Paralympic Games - Used a previously developed sport-specific observation tool - No validity or reliability procedures presented - Hand notation system using video recordings - Player performance calculated expressed using an equation - Seven aspects of performance are recorded. - One-way analysis of variance (ANOVA) was used to identify differences	Players from a winning team achieved better scores and demonstrated a superior skating ability.
Sledge Ice Hockey **Hayrinen *et al.* (2011)**	To describe match actions on a team level and identify the differences between successful and less successful teams	- Eight games from the 2010 Winter Paralympic Games - No exclusion criteria - Dartfish TeamPro 5.5 used to code all eight games - Validity procedure used in previous studies, then the list was shown to one elite coach but the study did not state their experience - Team specific action variables (total 38) in 13 categories - Intra-observer reliability on one game expressed in Kappa	Differences observed between winning and losing teams. Goals were achieved from a shot at a close distance off a dribble or following receiving the puck and achieved from possessions starting in the attacking zone or a turnover

		- Mann-Whitney U-test was used for comparisons	
Sledge Ice Hockey **Molik *et al.* (2012)**	To compare player disability against game efficiency measures.	- 20 games from 2010 Winter Paralympics - 54 athletes of the 114 met the requirements of participating in a total of 45 minutes over two games - Hand notation used to record actions in Game efficiency sheet - Post-event analysis completed by five observers - Individual player specific action variables (total 14) - Intra- and inter-observer reliability (Pearson's r Correlation) - Validity established by correlating team ranking with each variable - Multivariate analysis of variance (MANOVA) was subjected to the data	There were no statistical differences observed between a player's disability and their game efficiency.
Wheelchair Rugby **Molik *et al.* (2008)**	To examine the offensive game efficiency of elite wheelchair rugby players with regards to their International Wheelchair Rugby Federation (IWRF) classification	- 42 games from the 2005 European Championships - Players excluded if played less than one quarter (5 players) - No validity - Inter-observer reliability procedures were outlined (Pearson's r Correlation) and 3 variables excluded in further analysis. - Two operators - Game Efficiency Sheets used hand notation to record individual variables - Individual player specific action variables (final total 11) - Operational definitions provided - ANOVA was used to identify differences	High-point class players performed better than low-point class players. The study suggested amalgamating the 2.0 to 3.5 class into one class, but only one comparison between 2.0 and higher class players was reported as statistically significant.

Wheelchair Rugby **Morgulec-Adamowicz *et al.* (2010)**	To assess the game efficiency of wheelchair rugby players representing different IWRF classifications	- 20 games from 2008 Paralympics - Players excluded if played less than one quarter (11 players) - No explanation of how data was collected - No validity or reliability procedures presented - Operational definitions provided - Individual player specific action variables (total 6) - Mann-Whitney U-test was used for comparisons	High-point class players performed better irrelevant of playing time
Wheelchair Basketball **Vanlandewijck, Spaepen and Lysens (1995)**	To determine whether overall wheelchair basketball performance in a game situation is related to the functional ability level of the participant	- 18 men's games from the 1992 Paralympic Games - Players were excluded if they had not played more than 10 minutes consecutively (52 players used in final analysis) - Boxscore data was collected on 13 action variables - Data were combined and presented using the Comprehensive Basketball Grading System (CBGS) to evaluate players' performances post-game. - No validity procedure as using a pre-existing template - Inter-observer reliability procedures used Pearson's r Correlation - Two observers completed the analysis	ANOVA found CBGS values increases in relation to a player's classification, i.e. the higher the player's classification the higher the CBGS score.

Wheelchair Basketball **Vanlandewijck *et al.* (2003)**	To examine the relationship between player classification and performance ability.	- 18 men's games from the 1998 World Championships - Players were excluded if they had not played more than 10 minutes consecutively and had to play in an undisputed position (144 players used in final analysis) - Boxscore data was collected on 14 action variables - Data were combined and presented using a modified CBGS to evaluate players' performances post-game. - Players were divided into guard, forward and centre in addition to their classification (Class I, II, III and IV) - No validity procedures but validity was assessed (Spearman correlation) comparing CBGS score and final team ranking. - Inter-observer reliability was calculated for the five observers from all games - Observers were basketball players who were now physical education teachers with experience in adapted sports - Five observers completed the analysis	Two-way analysis of variance identified that wheelchair basketball CBGS scores represented the player classification values achieved by each player, however, Class II and Class III players were slightly underestimated.
Wheelchair Basketball **Vanlandewijck *et al.* (2004)**	To determine if the wheelchair basketball player classification system reflects the existing differences in the performance of elite female players	- 12 women's games from the 1998 World Championships - The same exclusion criteria were followed with 59 of the 95 players being retained - Boxscore data was collected on 14 action variables - Data were combined and presented using a modified CBGS to evaluate players' performances post-game. - Players were divided into groups: Class I, II, III and IV - No validity procedures - Inter-observer reliability was calculated for the five observers from all games but no background details of the observers	Two-way analysis of variance identified an incremental relationship existed between player class and performance values. In addition, significant differences are noted in only 10 of the 42 comparisons.

Wheelchair Basketball **Molik *et al.* (2009)**	To describe the effect of game efficiency in relation to team ranking and functional classification	- 24 women's games from the 2006 World Championships - Players had to have played a total of 40 minutes across the tournament and played in at least four games - Boxscore data was collected using 19 action variables, but three were not included in the final data due to a misunderstanding by the observers - Two observers analysed all games and a third observer analysed four games - Inter-observer reliability procedures were outlined (Pearson's r Correlation) - Cross-referenced against official game score sheets and game statistics produced by the tournament organisers for validity - Teams divided into three groups depending upon their final ranking	ANOVA identified athletes who played for the highest ranked teams accumulated better CBGS scores and demonstrated higher shooting statistics in comparison to athletes from the lower ranked teams.
Wheelchair Basketball **Skucas *et al.* (2009)**	To evaluate the playing skills of playmakers, forwards and centres.	- Six games from the 2006 Lithuanian Championships and 14 games from a tournament in Lithuania and Poland - Mixed tournament level - 32 player's performances were evaluated against 16 action variables - No players excluded but had been playing wheelchair basketball for a minimum of five years - No validity or reliability procedures and observe details outlined - Did not take into account players functional classification	ANOVA identified the centre position is the most active position in comparison to the other two positions and complete more passes, dribbles, and shoots. However, dribbles are not recorded and the activity rate is not recorded.

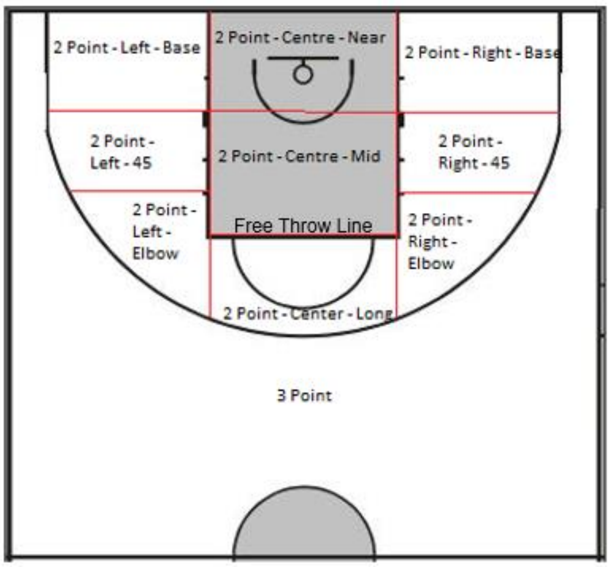
Wheelchair Basketball **Gómez *et al.* (2014)**	To identify which game-related statistics discriminate winning and losing men and women wheelchair basketball teams.	- 88 men's games from the 2008 Paralympic Games and 2010 World Championships - 66 women's games from the 2008 Paralympic Games and 2010 World Championships - Individual player action variables (14) were collected and used to calculate team effectiveness - Data were normalised according to ball possessions to account for ball rhythm - Game-types were identified using K-means clustering – balanced (1-12 points) v unbalanced (13+ points) - 10 games were subjected to intra-observer reliability procedures and agreement levels were shown using intraclass correlation coefficients - Two-stage statistical analysis procedure (discriminant analysis and linear regression modelling) - Model building process not explained	Athletes playing in winning teams during unbalanced games reported more 2-point field goal attempts and in balanced games, men's players recorded more field goals, assists and free throws whereas the women achieved more 2-point field goal attempts.

Wheelchair Basketball **Gómez *et al.* (2015)**	To analyse game-related statistics which best differentiate between women's players according to team strength, playing time and players' classification	- 33 women's games from the 2010 World Championships - 27 players were excluded as they played less than five minutes per game - Inter-observer reliability (Kappa) was conducted on four games - 14 action variables were collected and presented in a modified CBGS - Referred to Gil-Agudo, Del Ama-Espinosa and Crespo-Ruiz's (2010) review article to determine validation of the modified CBGS - Did not use modified CBGS variables - K-means clustering was used to group data into team strength (strong and weak) and playing time (32.2±5.4 minutes and 14.2±5.2 minutes). - MANOVA was applied followed by Scheffé and Bonferroni post hoc tests	MANOVA showed differences between classifications for the majority of game-related statistics. Stronger teams accumulated better values for assists, fouls received, successful free-throw attempts and turnovers. Interactive effects were found for defensive rebounds and unsuccessful 3-point field goal attempts when classification, team strength and play time were explored.

Appendix 2: Operational definitions for the action variables in each category.

<table>
<tr><th>Category</th><th>Action Variable</th><th>Definition</th></tr>
<tr><td rowspan="5">Quarter</td><td>Q1</td><td rowspan="4">A possession which occurs during the stated quarter of the game. The time in the game is indicated on the scoreboard. Each quarter lasts 10 minutes, with the clock stopping when the ball is dead (out of bounds, foul or the referee stops play).</td></tr>
<tr><td>Q2</td></tr>
<tr><td>Q3</td></tr>
<tr><td>Q4</td></tr>
<tr><td>Over Time</td><td>Once all four quarters have been played, a five minute period of overtime will be played if the teams are drawing.</td></tr>
<tr><td rowspan="3">Game Status</td><td>Winning</td><td>At the start of a possession, the team with the ball are currently leading on the scoreboard.</td></tr>
<tr><td>Drawing</td><td>At the start of a possession, the team with the ball are currently drawing on the scoreboard.</td></tr>
<tr><td>Losing</td><td>At the start of a possession, the team with the ball are currently losing on the scoreboard.</td></tr>
<tr><td>Home Team Player Number</td><td colspan="2" rowspan="2">The vest numbers of the on-court players, ranging from 0 to 99. For every possession, there will be five “Home Team” numbers and five “Away Team” numbers.</td></tr>
<tr><td>Away Team Player Number</td></tr>
<tr><td>Home Classification</td><td colspan="2" rowspan="2">The classification of the on-court players according to the International Wheelchair Basketball Federation classification system (International Wheelchair Basketball Federation, 2014a). For every possession, there will be five “Home Classification’’ numbers and five “Away Classification” numbers.</td></tr>
<tr><td>Away Classification</td></tr>
<tr><td rowspan="3">Start of Possession</td><td>Inbound - Baseline</td><td>The referee will take the ball to either side of the backboard in the defensive half of the court where the play will begin. One player on the offensive team will push out of bounds behind the baseline and is given 5 seconds to pass the ball to a teammate.</td></tr>
<tr><td>Inbound - Endline</td><td>The referee will take the ball to either side of the backboard in the offensive half of the court where the play will begin. One player on the offensive team will push out of bounds behind the baseline and is given 5 seconds to pass the ball to a teammate.</td></tr>
<tr><td>Sideline - Front</td><td>The referee will take the ball to the location near the half-court line where the play will begin. One player on the offensive team will push out of bounds behind the sideline and is given 5 seconds to pass the ball to a teammate from within the offensive half of the court.</td></tr>
</table>

	Sideline - Back	The referee will take the ball to the location near the half-court line where the play will begin. One player on the offensive team will push out of bounds behind the sideline and is given 5 seconds to pass the ball to a teammate from within the defensive half of the court.
	Defensive Rebound	The defensive team gains possession of the ball after a missed shot that is not gathered by an offensive player.
	Offensive Rebound	Possession starts when the offensive team retains possession of the ball after a missed shot.
	Free Throw	An unopposed shot behind a line 15 feet from the basket, typically awarded to an offensive player who is fouled while in the act of shooting. Each free throw made is worth one point. A free throw is also known as a "foul shot".
	Other Start	Any other possession start, e.g. start of the game.
	Turnover	A turnover occurs when the offensive team loses possession of the ball to the opposing team, resulting from a handling error.
Shot Taken	Shot	During the possession, the ball is propelled in an upwards direction towards the basket in an attempt to score.
	No Shot	During the possession, the ball is not propelled towards the basket or if the ball is propelled towards the basket when the shot clock is past 0.1 seconds resulting in a Violation Against.
Shot Point	One	Following the awarding of a free-throw attempt, the ball is propelled towards the basket from the free-throw line.
	Two	The ball is propelled towards the basket from inside the three-point zone and the referee will raise one hand in the arm and holds up two fingers.
	Three	The ball is propelled towards the basket from outside the three-point zone and the referee will raise one hand in the arm and hold up three fingers.
	No Shot	During the possession, the ball is not propelled towards the basket or if the ball is propelled towards the basket when the shot clock is past 0.1 seconds resulting in a Violation Against.
Shot Outcome	Successful	A shot that falls through the ring and is awarded the relevant points by the referee, indicated by the number of fingers held up by his/her hand.

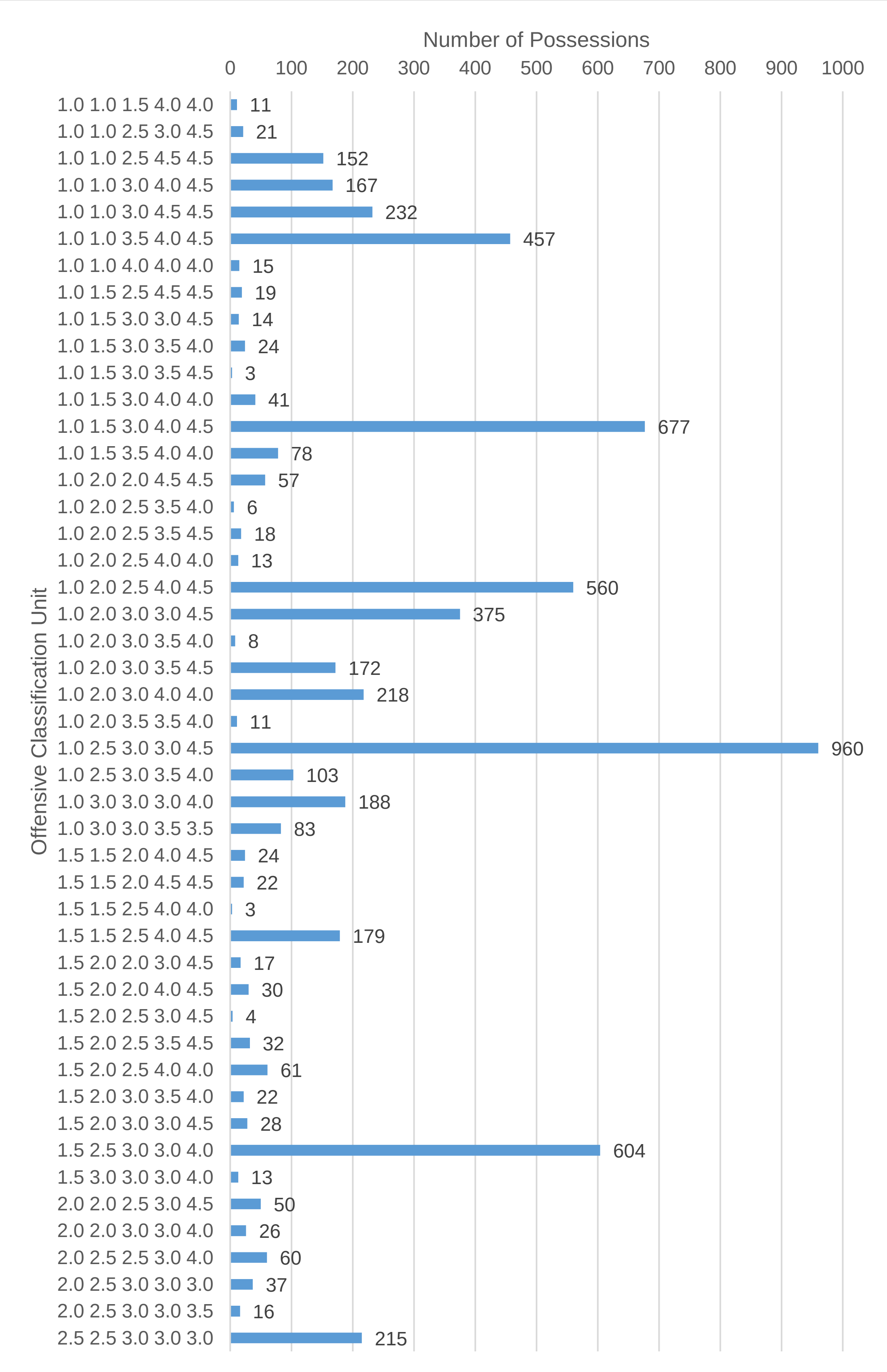
<table>
<tr><td rowspan="2"></td><td>Unsuccessful</td><td>A shot that does not fall through the ring and is rebounded by a player or a player is stopped due to a foul/violation or the ball goes out of bounds.</td></tr>
<tr><td>No Shot</td><td>During the possession, the ball is not propelled towards the basket or if the ball is propelled towards the basket when the shot clock is past 0.1 seconds resulting in a Violation Against</td></tr>
<tr><td rowspan="6">Shot Clock Remaining</td><td>6 – 0.1 Seconds</td><td rowspan="4">The time remaining on the shot clock when the offensive player propels the ball towards the basket. The time is recorded when the ball is released from the shooting player’s hands and not when the ball hits the ring, backboard or when the basket is scored. 17 - 13 Seconds is also triggered when a player’s free-throw attempt (successful or unsuccessful) would result in the shot clock counting down from 14 seconds.</td></tr>
<tr><td>12 - 7 Seconds</td></tr>
<tr><td>17 - 13 Seconds</td></tr>
<tr><td>24 - 18 Seconds</td></tr>
<tr><td>Dead</td><td>The time on the shot clock is stopped. This only happens when an unsuccessful free-throw attempt results in an additional attempt.</td></tr>
<tr><td>No Shot</td><td>During the possession, the ball is not propelled towards the basket or if the ball is propelled towards the basket when the shot clock is past 0.1 seconds resulting in a Violation Against.</td></tr>
<tr><td rowspan="2">Shot Location</td><td colspan="2">

The location on the court where the shot attempt is taken from, this is measured from the position of the wheelchair’s front castors. When a Free Throw attempt is taken this is from the Free Throw Line.</td></tr>
<tr><td>No Shot</td><td>During the possession, the ball is not propelled towards the basket or if the ball is propelled</td></tr>
</table>

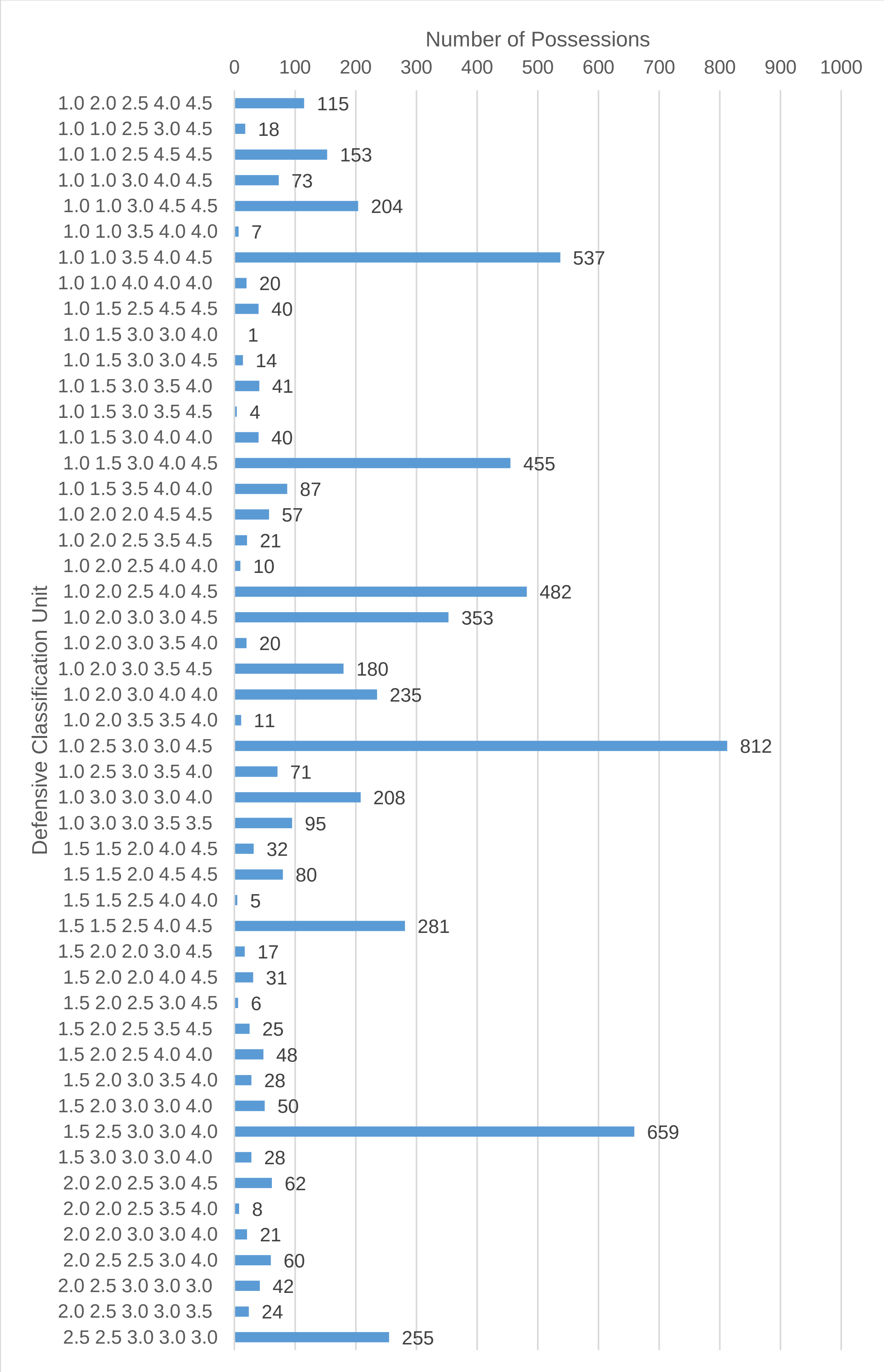
		towards the basket when the shot clock is past 0.1 seconds resulting in a Violation Against.
Man Out Offence	Equal Numbers	The number of offensive and defensive players in the front-court is equal.
	Numbers Advantage	The number of offensive players is different from the number of defensive players in the front-court.
End of Possession	Foul Against	The referee penalises the team with the ball for infringing the rules of the game, resulting in a loss of possession.
	Foul For	The referee penalising a player from the team without possession of the ball for infringing the rules of the game.
	Violation Against	The referee awards the defensive team with a throw-in at the place nearest to the infraction of the rules.
	Defensive Rebound	The defensive team secure possession from an unsuccessful shot.
	Offensive Rebound	The offensive team maintains possession from an unsuccessful shot.
	Basket Scored	The referee awards the offensive team with either a one-point, two-point or three-point score dependent on the location and circumstance of the shot.
	Other	The possession ends by another means, e.g. referee stopping play due to a player out of their wheelchair.
	Out of Bounds	The ball goes crosses the field of play and results in the offensive team losing possession.
	Free Throw	The referee awards a player with an unhindered shot in basketball made from behind a set line due to being fouled by an opponent.
	Handling Error	A player from the offensive team loses possession through a backcourt violation, travelling or the opposition stealing the ball.
Defensive System	1 Man Press	The stated number of defensive players applying pressure in the backcourt at the point when the ball is inbounded.
	2 Man Press	
	3 Man Press	
	4 Man Press	
	5 Man Press	
	Highline	The defensive players initially set up above the free throw line in a straight line between each sideline and force offensive players towards the sideline.
	Zone	The defensive players initially drop back to around the key before either staying put or pushing out towards the three-point line.

	No Defensive System	The defensive players are unable to adopt a system as the offensive team attack the basket too quickly, e.g. from a turnover or the defensive system adopted when a player is taking a free-throw attempt
Defensive Outcome	Successful Defence	The defensive team stop the offensive team from scoring and secure possession. If the team stop the offensive team from scoring but fail to secure possession the Defensive Outcome is Unsuccessful.
	Unsuccessful Defence	The defensive team are unable to stop the offensive team from scoring or from re-securing possession.
Possession	Maintained	The offensive team re-secure possession.
	Lost	The defensive team are unable to secure possession.
	Basket Scored	The offensive team score a basket.

Appendix 3: Number of possessions each Offensive Classification Unit occurred in during the 31 games.



Appendix 4: Number of possessions each Defensive Classification Unit occurred in during the 31 games.



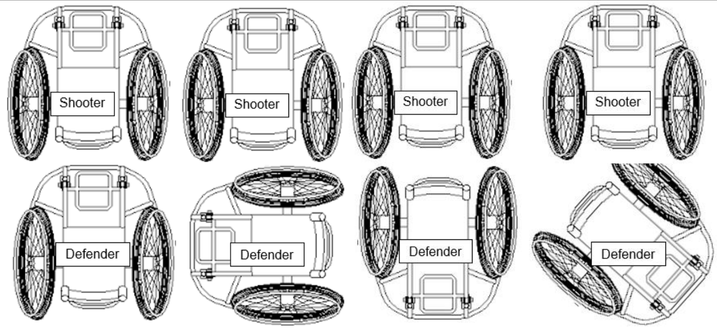
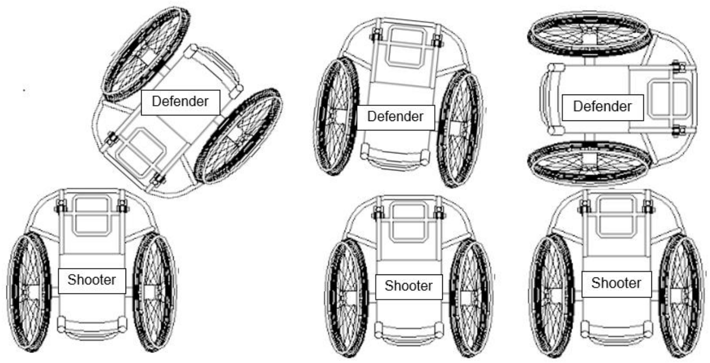
Appendix 5: Team data sample of the 2015 Men's European Wheelchair Basketball Championships

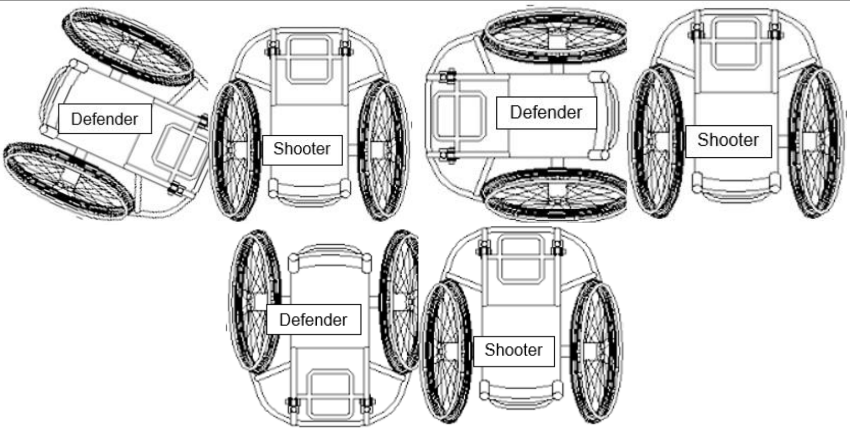
Game Outcome	Stage	Quarter	Offensive Unit 4-0 or 4.5	Offensive Unit 3-0 or 3.5	Defensive Unit 4-0 or 4.5	Defensive Unit 3-0 or 3.5	Game Status	Start of Possession	Man Out Offence	Shot Taken	Shot Point	Shot Outcome	Shot Location	Shot Clock Remaining	End of Possession	Defensive System	Defensive Outcome	Possession
Win	Pool	Q1	Two	Zero	Zero or One	Two	Drawing	Defensive Rebound	Number Advantage	Shot	Two	Unsuccessful	2 Point - Left - 45	12 - 7 seconds	Defensive Rebound	Zone	Successful	Lost
Loss	Pool	Q1	Three	Zero	Zero or One	Two	Drawing	Defensive Rebound	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Mid	17 - 13 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
Win	QF	Q1	Zero or One	Two	Two	One	Winning	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	12 - 7 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
Loss	Pool	Q1	Two	One	Zero or One	Two	Losing	Inbound - Endline	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Long	6 - 0.1 seconds	Out of Bounds	Highline	Successful	Lost
Loss	QF	Q2	Two	Zero	Zero or One	Two	Losing	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	12 - 7 seconds	Basket Scored	2 man Press	Unsuccessful	Basket Scored
Win	Pool	Q4 & OT	Two	One	Zero or One	Two	Losing	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Left - 45	12 - 7 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
Win	QF	Q2	Two	One	Zero or One	Two	Winning	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot or Dead	Foul For	Highline	Unsuccessful	Maintained
Win	Pool	Q1	Two	Zero	Two	Zero	Drawing	Other Start	Equal Numbers	Shot	Three	Unsuccessful	3 Point	24 - 18 seconds	Defensive Rebound	Zone	Successful	Lost
Win	SF	Q1	Two	Zero	Zero or One	Two	Winning	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Left - 45	12 - 7 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
Loss	MM	Q1	Zero or One	Two	Zero or One	Two	Winning	Free Throw	Equal Numbers	Shot	One	Unsuccessful	No Shot Loc	12 - 7 seconds	Defensive Rebound	No Def Sys	Successful	Lost
Loss	SF	Q2	Two	One	Zero or One	Two	Losing	Inbound - Baseline	Number Advantage	Shot	Two	Unsuccessful	2 Point - Centre - Near	24 - 18 seconds	Offensive Rebound	Zone	Unsuccessful	Maintained
Win	Pool	Q4 & OT	Two	One	Two	Zero	Winning	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot or Dead	Handling Error	1 man Press	Successful	Lost
Loss	SF	Q2	Two	One	Zero or One	Two	Losing	Turnover	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot or Dead	Foul For	Zone	Unsuccessful	Maintained
Win	Ranking	Q3	Zero or One	Two	Two	One	Drawing	Free Throw	Equal Numbers	Shot	One	Successful	No Shot Loc	No Shot or Dead	Basket Scored	No Def Sys	Unsuccessful	Basket Scored
Win	QF	Q4 & OT	Zero or One	Two	Two	One	Winning	Defensive Rebound	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	6 - 0.1 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
Win	Pool	Q3	Zero or One	Two	Three	Zero	Losing	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot or Dead	Out of Bounds	No Def Sys	Unsuccessful	Maintained
Win	Pool	Q1	Zero or One	Two	Three	Zero	Losing	Defensive Rebound	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Near	17 - 13 seconds	Defensive Rebound	Highline	Successful	Lost
Win	SF	Q4 & OT	Two	One	Zero or One	Three or More	Winning	Offensive Rebound	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Near	12 - 7 seconds	Offensive Rebound	Zone	Unsuccessful	Maintained
Loss	QF	Q2	Two	Zero	Two	One	Losing	Inbound - Baseline	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot or Dead	Other	3 man Press	Unsuccessful	Maintained
Win	Pool	Q3	Zero or One	Two	Zero or One	Two	Losing	Inbound - Baseline	Equal Numbers	Shot	Three	Unsuccessful	3 Point	17 - 13 seconds	Defensive Rebound	Zone	Successful	Lost

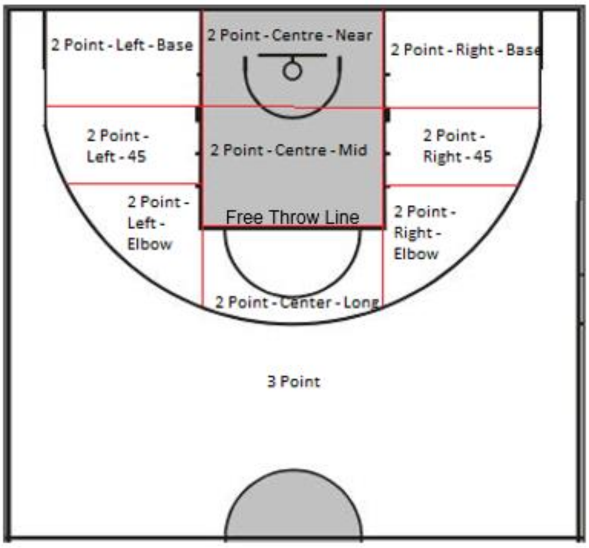
Appendix 6: Original list of action variables created and presented to the three coaches and the member of support staff.

Category	Action Variables				
Classification	High-Point	Mid-Point	Low-Point		
Defender Behind	Yes	No			
Defender In Front	Yes	No			
Defender Marking Non-Shooting Hand	Yes	No			
Defender Marking Shooting Hand	Yes	No			
Defender Marking Space	Yes	No			
Defender On Side	Yes	No			
Defensive Pressure	No	Low	Moderate	High	
Game Status	Winning	Drawing	Losing		
Number of Defenders	Zero	One	Two	Three	Four or More
Number of Hands on the Ball	One Hand	Two Hands			
Number of Passes	One-Two	Three-Four	Five or More		
Pre-Shot	Catch and Shoot	Dribble and Shoot	Curl	Pick and Roll	
Quarter	Q1	Q2	Q3	Q4	
Shot Clock Remaining	6 – 0.1 seconds	12 – 7 seconds	17 – 13 seconds	24 – 18 seconds	
Shot Hand	Left-Handed	Right-Handed			
Shot Location	2 Point – Centre - Near	2 Point – Centre - Mid	2 Point – Centre - Long	2 Point – Left - Base	2 Point – Left - 45
	2 Point – Left - Elbow	2 Point – Right - Base	2 Point – Right - 45	2 Point – Right - Elbow	3 Point
Shot Movement	Away from Basket	Rotating Left	Rotating Right	Stationary	Towards Basket
Shot Outcome	Successful	Unsuccessful			
Shot Point	Two	Three			
Shot Positioning	10-90 Left	100-90 Right	Square to Basket	Reverse	
Shot Type	Set-Shot	Post-Up	Lay-Up		

Appendix 7: Operational definitions for the agreed list of categories and action variables.

Category	Action Variable	Operational Definition
Classification	High-Point	The shooting player has a classification of 3.5 or above.
	Mid-Point	The shooting player has a classification of 2.0, 2.5 or 3.0.
	Low-Point	The shooting player has a classification of 1.0 or 1.5.
Defender Behind	Yes or No	If the defending player's chair is positioned towards the shooting player's rear castors or backrest and is within one metre of the shooting player (see figures below) he is Defending Behind and the action is awarded a Yes.
		
Defender In Front	Yes or No	If the defending player is positioned facing the shooting players small castors at the front of the chair and is within one metre of the shooting player (see figures below) he is defending in front and the action is awarded a Yes.
		
Defender Marking Shooting Hand	Yes or No	If the defending player is a chairs distances away from the player and is able to apply pressure to the main shooting hand through raising his hand to disrupt the vision or flight of the ball, he is Defender Marking the Shooting Hand and the action is awarded a Yes.
Defender Marking Non-Shooting Hand	Yes or No	The defending player is within a chairs distances away from the player and is able to apply pressure to the non-shooting hand through raising his hand to disrupt the vision or flight of the ball, the defender is marking the Non-Shooting Hand and the action is awarded a Yes.
Defender Marking Space	Yes or No	The defending player is within a chairs distances away from the player and is able to apply pressure by being in close proximity and is not raising his hand/s, the defender is marking the Space and the action is awarded a Yes.

Defender On Side	Yes or No	If the defending player's chair is positioned towards the shooting player's large wheel and is within one metre of the shooting player (see figures below) he is Defending On Side and the defensive action is awarded a Yes.
		
Defensive Pressure	Zero	There are no defensive players within a one-metre radius of the shooting player's sphere.
	One	The defensive player/s are using their hand/s to enter a 90-degree radius of the shooting player's sphere.
	Two	The defensive player/s are using their hand/s to enter a 180-degree radius of the shooting player's sphere.
	Three	The defensive player/s are using their hand/s to enter a 270-degree radius of the shooting player's sphere.
	Four	The defensive player/s are using their hand/s to enter a 360-degree radius of the shooting player's sphere.
Game Status	Winning	At the start of a possession, the team with the ball are currently leading on the scoreboard.
	Drawing	At the start of a possession, the team with the ball are currently drawing on the scoreboard.
	Losing	At the start of a possession, the team with the ball are currently losing on the scoreboard.
Number of Defenders	Zero	The number of players within one metre of the shooting player who is either making physical chair contact or visually engaged in the shooter.
	One	
	Two	
	Three or More	
Number of Hands on the Ball	One Hand	When a player used his left or right hand to take a shot, with the other hand on the chair/wheel.
	Two Hands	When a player used both his hands to propel the ball towards the basket.
Pre-Shot	Catch and Shoot	The first action following catching the ball is to make a shot attempt.
	Curl	Primary threat dives into the defence and seals off, the secondary threat comes high or low with speed as the primary threat pushes the secondary threat.
	Dribble and Shoot	Following possession of the ball, the player dribbles the ball and makes a shot attempt.

	Pick and Roll	The creation of the pick leads to a player making an unmarked cut to the basket and a shot.
Quarter	Q1	A possession which occurs during the stated quarter of the game. The time in the game is indicated on the scoreboard. Each quarter lasts 10 minutes, with the clock stopping when the ball is dead (out of bounds, foul or the referee stops play).
	Q2	
	Q3	
	Q4 & OT	
Shot Clock Remaining	6 – 0.1 Seconds	The time remaining on the shot clock when the offensive player propels the ball towards the basket. The time is recorded when the ball is released from the shooting player's hands and not when the ball hits the ring, backboard or when the basket is scored. 17 - 13 Seconds is also triggered when a player's free-throw attempt (successful or unsuccessful) would result in the shot clock counting down from 14 seconds.
	12 - 7 Seconds	
	17 - 13 Seconds	
	24 - 18 Seconds	
Shot Hand	Left-Handed	When a player used his left hand as the main hand to project the ball, with his right hand being used as a guide.
	Right-Handed	When a player used his right hand as the main hand to project the ball, with his left hand being used as a guide.
Shot Location	 The location on the court where the shot attempt is taken from, this is measured from the position of the front castors.	
Shot Movement	Away from Basket	When the shooting player is extending the distance between him and the basket at the point of release.
	Rotating Left	One second before and up to the point of release, the chair is rotating left increasing the angle between the basket and his release position.
	Rotating Right	One second before and up to the point of release, the chair is rotating right increasing the angle between the basket and his release position.
	Stationary	The player attempting to make the shot is in a stationary position and the chair is not moving at the point of release.
	Towards Basket	When the shooting player is closing the gap down between him and the basket at the point of release.

Shot Outcome	Successful	A shot that falls through the ring and is awarded the relevant points by the referee, indicated by the number of fingers held up by his hand.
	Unsuccessful	A shot that does not fall through the ring and is rebounded by a player or player is stopped due to a foul/violation or the ball goes out of bounds.
Shot Point	Two	The ball is propelled towards the basket from inside the three-point zone and the referee will raise one hand in the air and holds up two fingers.
	Three	The ball is propelled towards the basket from outside the three-point zone and the referee will raise one hand in the air and hold up three fingers.
Shot Positioning	10-90 Left	At the point when the ball is released the player's shoulders are facing an angle in the region of 10-90 degrees to the left with 0-10 degrees being Square to Basket.
	10-90 Right	At the point when the ball is released the player's shoulders are facing an angle in the region of 10-90 degrees to the right with 0-10 degrees being Square to Basket.
	Square to Basket	At the point when the ball is released the player's shoulders are facing parallel (10-0-10 degrees) to the basket in which he is shooting.
	Reverse	At the point when the ball is released the player's shoulders are facing an angle greater than 90 degrees to the basket in which he is shooting.
Shot Type	Set-Shot	A shot is taken with the ball extending from the chest or shoulder towards the basket from a range of locations.
	Post-Up	A shot is usually taken in or near the edge of the key, where the player holds the ball directly above their head and directs towards the basket.
	Lay-Up	A player is in motion towards the basket at a 45-degree angle taking a shot, with a release point of the shoulder/head, whilst close to the basket and using the backboards.

Appendix 8: Intra-observer and inter-observer reliability test results for the shooting SPA template developed in Chapter Five.

	Ob1 v Ob2		Ob3 v Ob4		Ob3 v Ob5		Ob3 v Ob4 v Ob5	
Outcome	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Point	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Quarter	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Game Status	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Shot Location	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Time	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Classification	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Shot Hand	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Number of Hands on the Ball	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Shot Type	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Pre-Shot	1.90%	K0.967	1.90%	K0.968	0.00%	K1.000	3.80%	K0.957
Shot Movement	3.80%	K0.936	1.90%	K0.967	1.90%	K0.967	1.90%	K0.978
Shot Positioning	3.80%	K0.924	1.90%	K0.961	0.00%	K1.000	1.90%	K0.974
Number of Defenders	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000
Defensive Pressure	3.80%	K0.943	1.90%	K0.972	3.80%	K0.944	3.80%	K0.963
Defender In Front	3.80%	K0.923	1.90%	K0.961	1.90%	K0.961	1.90%	K0.974
Defender On Side	3.80%	K0.907	0.00%	K1.000	3.80%	K0.903	3.80%	K0.935
Defender Behind	1.90%	K0.948	3.80%	K0.885	3.80%	K0.885	3.80%	K0.925
Defender Marking Shooting Hand	1.90%	K0.961	1.90%	K0.961	0.00%	K1.000	1.90%	K0.974
Defender Marking Non-Shooting Hand	1.90%	K9.440	1.90%	K0.948	1.90%	K0.950	3.80%	K0.932
Defender Marking Space	3.80%	K0.903	0.00%	K1.000	0.00%	K1.000	0.00%	K1.000

NB: Ob1: Researcher’s first observation; Ob2: Researcher’s second observation; Ob3: Researcher’s agreed observation; Ob4: Coach’s observation; Ob5: Performance analyst intern’s observation

Appendix 9: Frequency counts of each action variable within a CPV.

Category	Action Variable	Frequency Count
Classification	High-Point	690
	Mid-Point	323
	Low-Point	131
Defender Behind	Yes	161
	No	978
Defender In Front	Yes	725
	No	419
Defender Marking Shooting Hand	Yes	673
	No	471
Defender Marking Non-Shooting Hand	Yes	143
	No	1001
Defender Marking Space	Yes	245
	No	899
Defender On Side	Yes	246
	No	898
Defensive Pressure	Zero	210
	One	649
	Two	165
	Three	112
	Four	17
Game Status	Winning	532
	Drawing	51
	Losing	561
Number of Defenders	Zero	210
	One	686
	Two	219
	Three or More	29
Number of Hands on the Ball	One Hand	131
	Two Hands	1031
Pre-Shot	Catch and Shoot	732
	Curl	16
	Dribble and Shoot	366
	Pick and Roll	30
Quarter	Q1	295
	Q2	274
	Q3	289
	Q4 & OT	286
Shot Clock Remaining	6 – 0.1 Seconds	243
	12 - 7 Seconds	447
	17 - 13 Seconds	354
	24 - 18 Seconds	100
Shot Hand	Left-Handed	76
	Right-Handed	1068
Shot Location	2 Point - Centre - Long	21
	2 Point - Centre - Mid	148

	2 Point - Centre - Near	500
	2 Point - Left - 45	87
	2 Point - Left - Base	36
	2 Point - Left - Elbow	39
	2 Point - Right - 45	96
	2 Point - Right - Base	26
	2 Point - Right - Elbow	42
	3 Point	149
Shot Movement	Away from Basket	127
	Rotating Left	64
	Rotating Right	31
	Stationary	371
	Towards Basket	551
Shot Outcome	Successful	497
	Unsuccessful	647
Shot Point	Two	995
	Three	149
Shot Positioning	10-90 Left	360
	10-90 Right	95
	Square to Basket	19
	Reverse	670
Shot Type	Set-Shot	202
	Post-Up	418
	Lay-Up	524

Appendix 10: Shooting data sample from the 2015 European Wheelchair Basketball Championships.

Shot Outcome	Shot Point	Quarter	Game Status	Shot Location	Shot Clock Remaining	Classification	Shot Hand	Number of Hands on the Ball	ShotType	Pre-Shot	ShotPositioning	ShotMovement	Defender Marking Shooting Hand	Defender Marking Non-Shooting Hand	Defender Marking Space	Defender In Front	Defender Behinf	Defender On Side	Number of Defenders	Defensive Pressure
Unsuccessful	Two	Q1	Losing	2 Point - Left - 45	12 - 7 seconds	High-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	Square to Basket	Away From Basket	Yes	Yes	No	Yes	No	No	Two	Three
Unsuccessful	Two	Q1	Winning	2 Point - Centre - Mid	6 - 0.1 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	10-90 Left	Towards Basket	No	No	No	No	No	No	Zero	Zero
Unsuccessful	Two	Q4	Winning	2 Point - Centre - Near	17 - 13 seconds	Mid-Pointer	Right Hand	Two Handed	Lay-Up	Pick n Roll	Square to Basket	Towards Basket	No	Yes	No	No	No	Yes	One	One
Unsuccessful	Two	Q1	Losing	2 Point - Centre - Near	24 - 18 seconds	Low-Pointer	Left Hand	One Handed	Lay-Up	Catch & Shoot	Square to Basket	Towards Basket	No	No	No	No	No	No	Zero	Zero
Unsuccessful	Three	Q1	Winning	2 Point - Centre - Long	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	10-90 Left	Rotating Left	No	No	Yes	Yes	No	No	One	One
Successful	Two	Q3	Winning	2 Point - Centre - Mid	12 - 7 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Square to Basket	Towards Basket	No	No	No	No	No	No	Zero	Zero
Unsuccessful	Two	Q4	Losing	2 Point - Right - Base	17 - 13 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Square to Basket	Towards Basket	No	No	No	No	No	No	Zero	Zero
Unsuccessful	Three	Q3	Losing	3 Point	6 - 0.1 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	Square to Basket	Towards Basket	Yes	No	No	Yes	No	No	One	One
Successful	Two	Q1	Drawing	2 Point - Centre - Near	6 - 0.1 seconds	Low-Pointer	Left Hand	One Handed	Lay-Up	Catch & Shoot	Reverse	Away From Basket	Yes	No	No	Yes	Yes	No	Two	Two
Successful	Two	Q1	Losing	2 Point - Centre - Near	24 - 18 seconds	Mid-Pointer	Right Hand	One Handed	Lay-Up	Dribble & Shoot	10-90 Right	Towards Basket	No	No	No	No	No	No	Zero	Zero

Appendix 11: Great Britain team data sample from the 2015 European Championships.

Offensive Team	Defensive Team	Game Outcome	Stage of Competition	Possession Number	Time	Offensive Unit - 3-3.5	Offensive Unit - 4-4.5	Defensive Unit - 3-3.5	Defensive Unit - 4-4.5	Game Status	Start of Possession	Man Out Offence	Shot Taken	Shot Point	Shot Outcome	Shot Location	Shot Clock Remaining	End of Possession	Defensive System	Defensive Outcome	Possession
GBR	TUR	Win	MM	52	Q3	Zero	Two	One	Two	Winning	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot	Foul For	Zone	Unsuccessful	Maintained
GBR	TUR	Win	MM	34	Q2	One	Two	One	Two	Winning	Defensive Rebound	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Mid	12 - 7 seconds	Defensive Rebound	Zone	Successful	Lost
GBR	TUR	Win	MM	28	Q2	Two	Zero or One	One	Two	Winning	Free Throw	Equal Numbers	Shot	One	Unsuccessful	No Shot Loc	Dead	Defensive Rebound	No Def Sys	Successful	Lost
GBR	TUR	Win	MM	38	Q2	One	Two	One	Two	Winning	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	12 - 7 seconds	Basket Scored When Fouled	Zone	Unsuccessful	Maintained
GBR	TUR	Win	MM	42	Q2	Two	Zero or One	One	Two	Winning	Inbound - Baseline	Equal Numbers	Shot	Three	Unsuccessful	3 Point	17 - 13 seconds	Offensive Rebound	Zone	Unsuccessful	Maintained
GBR	TUR	Win	MM	29	Q2	Two	Zero or One	One	Two	Winning	Sideline - Front	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot	Violation Against	Zone	Successful	Lost
GBR	TUR	Win	MM	24	Q2	Two	Zero or One	One	Two	Winning	Defensive Rebound	Number Advantage	Shot	Two	Unsuccessful	2 Point - Centre - Near	17 - 13 seconds	Offensive Rebound	Zone	Unsuccessful	Maintained
GBR	TUR	Win	MM	5	Q1	Zero	Two	One	Two	Drawing	Turnover	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	24 - 18 seconds	Basket Scored	No Def Sys	Unsuccessful	Basket Scored
GBR	TUR	Win	MM	44	Q2	Two	Zero or One	One	Two	Winning	Sideline - Front	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	17 - 13 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
GBR	TUR	Win	MM	55	Q3	Zero	Two	One	Two	Winning	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot	Foul For	Zone	Unsuccessful	Maintained

Appendix 12: Great Britain team data sample from the 2016 Paralympic Games.

Offensive Team	Defensive Team	Game Outcome	Stage of Competition	Possession Number	Time	Offensive Unit - 3-3.5	Offensive Unit - 4-4.5	Defensive Unit - 3-3.5	Defensive Unit - 4-4.5	Game Status	Start of Possession	Man Out Offence	Shot Taken	Shot Point	Shot Outcome	Shot Location	Shot Clock Remaining	End of Possession	Defensive System	Defensive Outcome	Possession
GBR	USA	Loss	Pool	1	Q1	Two	Zero or One	Two	Zero or One	Drawing	Other Start	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Left - 45	12 - 7 seconds	Defensive Rebound	Zone	Successful	Lost
GBR	USA	Loss	Pool	2	Q1	Two	Zero or One	Two	Zero or One	Losing	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	6 - 0.1 seconds	Basket Scored	Highline	Unsuccessful	Basket Scored
GBR	USA	Loss	Pool	3	Q1	Two	Zero or One	Two	Zero or One	Drawing	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Location	No Shot	Foul For	Zone	Unsuccessful	Maintained
GBR	USA	Loss	Pool	4	Q1	Two	Zero or One	Two	Zero or One	Drawing	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Mid	12 - 7 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
GBR	USA	Loss	Pool	5	Q1	Two	Zero or One	Two	Zero or One	Winning	Defensive Rebound	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Right - 45	6 - 0.1 seconds	Defensive Rebound	Zone	Successful	Lost
GBR	USA	Loss	Pool	6	Q1	Two	Zero or One	Two	Zero or One	Drawing	Inbound - Baseline	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Right - Elbow	6 - 0.1 seconds	Defensive Rebound	Highline	Successful	Lost
GBR	USA	Loss	Pool	7	Q1	Two	Zero or One	Two	Zero or One	Drawing	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Location	No Shot	Foul For	Highline	Unsuccessful	Maintained
GBR	USA	Loss	Pool	8	Q1	Two	Zero or One	Two	Zero or One	Drawing	Sideline - Front	Equal Numbers	Shot	Three	Unsuccessful	3 Point	12 - 7 seconds	Defensive Rebound	Zone	Successful	Lost
GBR	USA	Loss	Pool	9	Q1	Two	Zero or One	Two	Zero or One	Losing	Inbound - Baseline	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Near	17 - 13 seconds	Defensive Rebound	Highline	Successful	Lost
GBR	USA	Loss	Pool	10	Q1	Two	Zero or One	Two	Zero or One	Losing	Inbound - Baseline	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Mid	17 - 13 seconds	Defensive Rebound	Zone	Successful	Lost

Appendix 13: Great Britain shooting data sample from the 2015 European Championships.

Shot Number	Outcome	Point	Quarter	Game Status	Shot Location	Shot Clock Remaining	Classification	Shot Hand	Number of Hands on the Ball	Shot Type	Pre-Shot	Shot Movement	Shot Positioning	Defender Marking Shooting Hand	Defender Marking Non-Shooting Han	Defender Marking Space	Defender In Front	Defender Behind	Defender On Side	Number of Defenders	Defensive Pressure
1	Successful	Three	Q1	Losing	3 Point	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Towards Basket	Square to Basket	No	No	No	No	No	No	Zero	Zero
2	Successful	Three	Q1	Losing	3 Point	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Towards Basket	Square to Basket	No	No	No	No	No	Yes	One	One
3	Successful	Two	Q1	Losing	2 Point - Centre - Long	24 - 18 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Towards Basket	Square to Basket	Yes	No	No	No	No	Yes	One	Three
4	Successful	Two	Q1	Losing	2 Point - Right - 45	17 - 13 seconds	Low-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	Towards Basket	Square to Basket	Yes	No	No	No	No	Yes	One	One
5	Successful	Two	Q1	Losing	2 Point - Centre - Near	24 - 18 seconds	Mid-Pointer	Right Hand	One Handed	Lay-Up	Dribble & Shoot	Towards Basket	10-90 Right	No	No	No	No	No	No	Zero	Zero
6	Successful	Two	Q1	Losing	2 Point - Centre - Near	6 - 0.1 seconds	High-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	Stationary	Square to Basket	Yes	No	Yes	Yes	Yes	No	Three or More	Two
7	Successful	Two	Q1	Losing	2 Point - Centre - Near	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Lay-Up	Catch & Shoot	Towards Basket	Square to Basket	No	Yes	No	Yes	No	No	One	One
8	Successful	Two	Q2	Losing	2 Point - Centre - Near	17 - 13 seconds	Mid-Pointer	Right Hand	One Handed	Lay-Up	Catch & Shoot	Towards Basket	Square to Basket	No	No	No	No	No	No	Zero	Zero
9	Successful	Two	Q2	Losing	2 Point - Left - 45	12 - 7 seconds	Low-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	Stationary	Square to Basket	No	No	No	No	No	No	Zero	Zero
10	Successful	Two	Q2	Losing	2 Point - Right - Elbow	6 - 0.1 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Towards Basket	Square to Basket	Yes	No	No	No	No	Yes	One	One

Appendix 14: Great Britain shooting data sample from the 2016 Rio de Janeiro Paralympic Games.

Shot Number	Outcome	Point	Quarter	Game Status	Shot Location	Shot Clock Remaining	Classification	Shot Hand	Number of Hands on the Ball	Shot Type	Pre-Shot	Shot Movement	Shot Positioning	Defender Marking Shooting Hand	Defender Marking Non-Shooting Han	Defender Marking Space	Defender In Front	Defender Behind	Defender On Side	Number of Defenders	Defensive Pressure
1	Successful	Three	Q1	Drawing	3 Point	12 - 7 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	10-90 Left	Rotating Left	No	No	No	No	No	No	Zero	Zero
2	Successful	Two	Q1	Winning	2 Point - Left - Base	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	10-90 Left	Away From Basket	Yes	No	No	Yes	No	No	One	One
3	Successful	Three	Q1	Winning	2 Point - Right - Elbow	24 - 18 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	10-90 Left	Rotating Left	No	No	No	No	No	No	Zero	Zero
4	Successful	Two	Q1	Winning	2 Point - Centre - Near	24 - 18 seconds	Mid-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	Reverse	Stationary	Yes	Yes	No	Yes	Yes	No	Two	Three
5	Unsuccessful	Two	Q1	Winning	2 Point - Left - 45	6 - 0.1 seconds	Low-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	10-90 Left	Rotating Left	Yes	No	No	Yes	No	No	One	One
6	Unsuccessful	Two	Q1	Winning	2 Point - Right - Base	12 - 7 seconds	High-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	10-90 Left	Stationary	Yes	No	No	Yes	No	No	One	One
7	Successful	Two	Q1	Winning	2 Point - Right - Base	17 - 13 seconds	Mid-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	Square to Basket	Away From Basket	Yes	No	No	Yes	No	No	One	One
8	Unsuccessful	Two	Q1	Winning	2 Point - Centre - Near	12 - 7 seconds	Mid-Pointer	Right Hand	Two Handed	Lay-Up	Catch & Shoot	10-90 Left	Rotating Left	No	No	No	No	No	No	Zero	Zero
9	Unsuccessful	Two	Q1	Winning	2 Point - Centre - Near	24 - 18 seconds	Mid-Pointer	Right Hand	Two Handed	Post-Up	Dribble & Shoot	Square to Basket	Towards Basket	No	Yes	No	No	No	Yes	One	One
10	Successful	Two	Q1	Winning	2 Point - Centre - Near	12 - 7 seconds	Mid-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	Square to Basket	Stationary	Yes	No	No	Yes	Yes	No	Two	Two

Appendix 15: Data sample of Great Britain’s team performances during the 2015 European Wheelchair Basketball Championships and the 2016 Rio de Janeiro Paralympic Games.

Tournament	Offensive Team	Defensive Team	Game Outcome	Stage	Possession Number	Time	Off Unit - 3-3.5	Off Unit - 4-4.5	Def Unit - 3-3.5	Def Unit - 4-4.5	Match Status	Start of Possession	Man Out Offence	Shot Taken	Shot Point	Shot Outcome	Shot Location	Shot Clock Remaining	End of Possession	Defensive System	Defensive Outcome	Possession
Euro	First	Third	Win	SF	69	Q3	One	Two	One	Two	Winning	Free Throw	Equal Numbers	Shot	One	Successful	No Shot Loc	12 - 7 seconds	Basket Scored	No Def Sys	Unsuccessful	Basket Scored
Euro	First	Other	Loss	Pool	54	Q3	One	Two	One	Two	Losing	Sideline - Front	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Centre - Near	12 - 7 seconds	Defensive Rebound	Zone	Successful	Lost
Euro	First	Third	Win	SF	95	Q4 & OT	Two	Zero or One	One	Two	Winning	Free Throw	Equal Numbers	Shot	One	Successful	No Shot Loc	No Shot or Dead	Basket Scored	No Def Sys	Unsuccessful	Basket Scored
Euro	First	Other	Win	Pool	100	Q4 & OT	Two	Zero or One	One	Two	Winning	Offensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Loc	No Shot or Dead	Foul For	Zone	Unsuccessful	Maintained
Euro	First	Third	Win	SF	96	Q4 & OT	Two	Zero or One	One	Two	Winning	Free Throw	Equal Numbers	Shot	One	Successful	No Shot Loc	12 - 7 seconds	Basket Scored	No Def Sys	Unsuccessful	Basket Scored
Para	First	Third	Loss	Pool	1	Q1	Two	Zero or One	Two	Zero or One	Drawing	Other Start	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Left - 45	12 - 7 seconds	Defensive Rebound	Zone	Successful	Lost
Para	First	Other	Loss	Pool	2	Q1	Two	Zero or One	Two	Zero or One	Losing	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Near	6 - 0 seconds	Basket Scored	Highline	Unsuccessful	Basket Scored
Para	First	Third	Loss	Pool	3	Q1	Two	Zero or One	Two	Zero or One	Drawing	Defensive Rebound	Equal Numbers	No Shot	No Shot	No Shot	No Shot Location	No Shot	Foul For	Zone	Unsuccessful	Maintained
Para	First	Other	Loss	Pool	4	Q1	Two	Zero or One	Two	Zero or One	Drawing	Inbound - Baseline	Equal Numbers	Shot	Two	Successful	2 Point - Centre - Mid	12 - 7 seconds	Basket Scored	Zone	Unsuccessful	Basket Scored
Para	First	Third	Loss	Pool	5	Q1	Two	Zero or One	Two	Zero or One	Winning	Defensive Rebound	Equal Numbers	Shot	Two	Unsuccessful	2 Point - Right - 45	6 - 0 seconds	Defensive Rebound	Zone	Successful	Lost

Appendix 16: Data sample of Great Britain’s shooting performances during the 2015 European Wheelchair Basketball Championships and the 2016 Rio de Janeiro Paralympic Games.

Tournament	Possession Number	Outcome	Point	Quarter	Game Status	Shot Location	Shot Clock Remaining	Classification	Shot Hand	Number of Hands on the Ball	Shot Type	Pre-Shot	Shot Positioning	Shot Movement	SH	NSH	Space	DIF	DB	DOS	Number of Defenders	Pressure
Para	521	Unsuccessful	Two	Q4 & OT	Winning	2 Point - Centre - Near	17 - 13 seconds	Mid-Pointer	Right Hand	Two Handed	Lay-Up	Catch & Shoot	0-90 Left	Towards Basket	Yes	No	No	No	Yes	No	One	One
Para	522	Unsuccessful	Two	Q4 & OT	Winning	2 Point - Centre - Long	6 - 0.1 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	0-90 Left	Rotating Right	Yes	No	No	Yes	No	No	One	One
Para	523	Successful	Two	Q4 & OT	Winning	2 Point - Left - Base	6 - 0.1 seconds	Mid-Pointer	Right Hand	Two Handed	Post-Up	Catch & Shoot	Square to Basket	Away From Basket	Yes	No	No	Yes	No	No	One	One
Para	524	Successful	Two	Q4 & OT	Winning	2 Point - Centre - Near	17 - 13 seconds	Mid-Pointer	Right Hand	Two Handed	Lay-Up	Catch & Shoot	Square to Basket	Towards Basket	No	No	No	No	No	No	Zero	Zero
Para	525	Successful	Two	Q4 & OT	Winning	2 Point - Centre - Near	12 - 7 seconds	Mid-Pointer	Right Hand	Two Handed	Post-Up	Pick n Roll	0-90 Left	Rotating Left	No	No	Yes	Yes	Yes	No	Two	One
Euro	526	Successful	Three	Q1	Losing	3 Point	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Square to Basket	Towards Basket	No	No	No	No	No	No	Zero	Zero
Euro	527	Successful	Three	Q1	Losing	3 Point	17 - 13 seconds	High-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Square to Basket	Towards Basket	No	No	Yes	No	No	No	One	One
Euro	528	Successful	Two	Q1	Losing	2 Point - Centre - Long	24 - 18 seconds	Mid-Pointer	Right Hand	Two Handed	Set-Shot	Dribble & Shoot	Square to Basket	Towards Basket	No	No	Yes	Yes	No	No	One	Three
Euro	529	Successful	Two	Q1	Losing	2 Point - Right - 45	17 - 13 seconds	Low-Pointer	Right Hand	Two Handed	Set-Shot	Catch & Shoot	Square to Basket	Towards Basket	No	No	Yes	Yes	No	No	One	One
Euro	530	Successful	Two	Q1	Losing	2 Point - Centre - Near	24 - 18 seconds	Mid-Pointer	Right Hand	One Handed	Lay-Up	Dribble & Shoot	0-90 Right	Towards Basket	No	No	No	No	No	No	Zero	Zero

Appendix 17: Participant Information Sheet and Informed Consent Form

University of Worcester
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Participant Information Sheet

Thank you for showing an interest in this project. Please read all the information in this leaflet carefully. Then please consider whether you wish to take part in this project. Participation in this study is completely voluntary. If you decide to take part, you will be asked to sign this form. If you decide that you do not wish to participate, then please appropriately discard this leaflet or hand it back to the researcher. Regardless of your decision, I thank you for your time.

What are the aims of the project?
To analyse, explore and reflect on my role as the performance analyst with an elite wheelchair basketball organisation.

What will you be asked to do?
Procedures
The project involves the researcher creating field notes and reflective diaries regarding the use of performance analysis within wheelchair basketball. Players and staff maybe interviewed and discussions recorded on a portable recording device with the information being transcribed and utilised to support the research. All individuals discussed within the research will be provided with false names to protect your identify. However, your false identity maybe unintentionally compromised to maintain the true story, as a particular configuration of attributes can frequently identify an individual.

Risks and discomfort
There are no risks associated within the ethnography. Although your false identity will be maintained throughout the study, this maybe unintentionally compromised in order to maintain the true story, as a particular configuration of attributes can frequently identify an individual.

Safety
There are no health and safety issues that participants need bringing to their attention.

Injury
The project involves holding discussions and observing the participants in their working environments and therefore no additional risk of injuries other than their day-to-day work roles will occur.

Benefits
The benefits that you will gain by taking part in this study are:
- An in-depth understanding of the role of performance analysis in wheelchair basketball.
- The documented process for developing a performance analysis culture within wheelchair basketball.
- An increased involvement of performance analysis within wheelchair basketball.
- A potential improvement in the delivery of performance analysis within British Wheelchair Basketball.
- Increase knowledge of the use of critical reflection to enhance performance.

Can I withdraw from this study?
You can change your mind and decide not to take part any time. If you decide to withdraw from the study, you do not have to give any reason for your decision, and you will not be disadvantaged in any way. If the participant requests to stop or reduce their participation within the study, a discussion between the participant and the researcher will commence regarding the utilisation of the collected data, up until point of withdrawal.

University of Worcester

Institute of Sport and Exercise Science

What information will be collected, and how will it be used?
The data collected from the field notes, reflective diaries, interviews and discussions will comprise of the researchers and your personal thoughts and feelings. This data will then be analysed, interpreted and be written up as part of a thesis.

The findings of this project may be published, but the information will not be linked to any specific person. Your false identity will be carefully presented within the research, however this maybe unintentionally compromised to maintain the true story, as a particular configuration of attributes can frequently identify an individual. A copy of the results and/or the field notes may be given to you upon request. All data from the research will be stored on an external encrypted hard drive and stored for a period of ten years following completion of the PhD Studentship.

Should you require further information please do not hesitate to contact the Chief Investigator, John Francis, at the focus group or via e-mail (j.francis@worc.ac.uk), or Professor Derek M Peters, my Director of Studies via d.peters@worc.ac.uk.

University of Worcester
Institute of Sport and Exercise Science

Informed Consent Form

I have read the information enclosed within the participant information sheet, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. Through consenting to participation within this research, I understand the following:

I have volunteered to take part in this project	Initial:
I know I can withdraw at any time without being disadvantaged	Initial:
I am satisfied that the transcribed information will be stored securely	Initial:
I know that the results may be published, but they will not be linked to me	Initial:
I am aware of any possible risks and discomfort	Initial:
I agree to inform the researcher immediately if I feel uncomfortable	Initial:
I have had the chance to ask questions regarding the study	Initial:
I know that I will not receive any money for taking part	Initial:

If you have concerns about any aspect of this study you should ask to speak to the researcher(s) who will do their best to answer your questions. However, if you have further concerns and wish to complain formally about any aspect of or about the way you have been treated during the study, you may contact Dr John-Paul Wilson on (01905) 54 2196.

I have read and understood this form it. I agree to take part in the project entitled "An ethnographic study exploring a performance analyst within elite disability sport".

Participant
Name: **Signature:** **Date:**

Witness
Name: **Signature:** **Date:**

University of Worcester, Henwick Grove, Worcester, WR2 6AJ
Main Switchboard: 01905 855000 Fax: 01905 855132 www.worcester.ac.uk

Appendix 18: Interview schedule

Opening Questions
- Could you describe what performance analysis is?
- During your entire coaching/playing/support experience how has performance analysis influenced your practice?

Person Specific Questions:
- Thinking specifically regarding the last Paralympic cycle….

<table>
<tr><th colspan="2">Players</th></tr>
<tr><td colspan="2">- How has PA influenced your development as a player?
- How has PA influenced your pre-match preparations and understanding of opponents?
- How has the information from the research studies influenced your training and match preparations?</td></tr>
<tr><th>Coaches</th><th>Support staff</th></tr>
<tr><td>- How has PA influenced your coaching?
- To what extent has PA influenced your practice?
- How has the information from the research studies been affected your practice?</td><td>- How has PA influenced your delivery/role in making a decision?
- What multi-disciplinary projects has the support of PA been used? And what was the impact of having this?</td></tr>
<tr><td colspan="2">- Can you provide an example were PA has assisted you?
- Can you provide an example were PA has hindered you?
- What impact has PA had in your Paralympic preparations?</td></tr>
</table>

Softer-Skills
- Since I began in this role, how do you think I have developed as a practitioner?
- What do you think has been the key to this development?
- My ability to create data are an essential component of my role, however, without the development of softer skills, I would not be able to share this information with you. What do you think is the key skill? How do you think I have performed in this skill?
- The establishment of rapport is an essential skill for a member of the support staff, how do you think I built rapport during the time we have been together?
- Educating individuals on how to use PA has been an important component in the last year, how do you think I have performed in this area?

Final Questions
- What future adjustments to the PA provision are required in the next four years?
- How would you like your suggestions to be incorporated in the next cycle?
- What could I have done to help you use PA more?

Appendix 19: Additional interview questions

Additional questions posed to the second coach

Having an analyst who understands the sport, does that help you as a coach?

Do you think getting the athletes involved in the process is beneficial to their learning?

Additional questions posed to the players

What barriers potentially prevented you from utilising performance analysis for the national squad during the cycle?

Out in Lanzarote 2016, I showed you some of the work that I was doing, why do you think this was not followed through?

In Colorado 2016 I introduced some further bits and pieces, why do you think this was not followed through?

During Rio, on a number of occasions, you asked for my opinion on what I was seeing. Why did you value my opinion?

Appendix 20: Interview transcript: Bob

In your experience what is performance analysis?
I think it is the feedback through video and stats. (Drawing on his past playing and coaching experience)

In your playing career was performance analysis used in your training and pre-match?
It varied at the different levels I competed at. During World Championships and Paralympics, it was a daily routine during competition. We used it for scouting the opposition during competitions and pre-competitions we used it for evaluating and learning. (Drawing on his past playing experiences which finished during the previous cycle)

Since your time with GB, what have we used performance analysis for?
A little of both, but primarily we have used it for scouting opposition. (Reflecting on how SPA was used when preparing for competitions in 2016)

What have we focused on and has that been driven by the coaches or the analyst?
I would say that it has been primarily driven by the head coach. (Reflecting on how SPA was used when preparing for competitions in 2016)

Are there specific things that he has focused on?
We watch the videos together, as coaches, to see tenancies on the other team. (Reflecting on how SPA was used when preparing for competitions in 2016)

You say he drives the process, what has been your role?
I would like it to evolve a little bit now that I am going to be around a bit more. Before and during the Paralympics I was just providing advice to the head coach, confirmation if he saw something and also he was asking me for confirmation if I was seeing the same thing. I felt I was more of a sounding board. (Reflecting on how SPA was used when preparing for competitions in 2016 and how he wants to progress this in the future)

You mentioned that you would like to see it progress, where would you like to see it moving towards?
I would like to do more one on one video sessions with athletes and more line-up sessions. (Reflecting on how he wants to progress SPA in the future)

Why do you think these types of sessions would be important for the learning of the athletes?
I think people become timid in group sessions. They can sometimes be scared to speak up and ask questions. One on one video sessions it's easier to have those conversations and individualise things for them and break things down. It is the same principles when in line-up sessions, the five people that would be watching the video are obviously working together on-court and they need to understand what each other is thinking and doing at all times. (Reflecting on how SPA was used when preparing for competitions in 2016)

In those big group sessions, why do you think people are timid?

It just comes down to personalities. It is going to happen in any group setting where you will have your alpha males rise to the top and some people are content in riding coat tails so to speak. I think in individual settings that can help bring out more aggressive or more confidence in people. (Reflecting on how SPA was used when preparing for competitions in 2016 as well as drawing on his previous experience as a player)

During the previous 6 months the prevision has started to improve, can you think of any reasons behind this?
Part of that could be your understanding of the game has increased and you are willing and able to offer more to the coaches. Your confidence in breaking down the video itself has also improved. I think you are getting more on the same page regarding the language that people use in this sport. That helps you out more. Personally, I feel that I can use you a lot more in my new role. I feel that I can ask you to break down a player's defensive clips over the last two games for example. This would allow me as a coach to go into the extra detail, such as looking at no chair contact or where he has got beaten to provide more objective feedback to help that player learn. (Reflecting on how SPA was used and how I have developed as the analyst in terms of assisting the coaches over the last six months)

What has made you feel that you are able to come to me and ask for things or just listen to what I am saying?
I think, just me personally, it is who I am as an individual. I will always listen to anyone as I think you can always learn something from everyone. I can then absorb what you have said and filter out dependent on whether I agree with you, great if I learn something from you, great, or if I disagree with you we can have a discussion around that issue or I can move on. (Reflecting on the relationship with me as the analyst since working together for the past year)

Having an analyst who understands the sport, does that help you as a coach?
I would say that it would help, but our sport is very unique and it takes a long time to learn the nuances and specific details of the game. For being in this game for a long time, my knowledge of the game is going to be different from someone who is just learning the game. Not saying that they can't get up to that level but even different programmes have different languages so it takes a while to feel comfortable and be on the same page as the coaching staff. (Reflecting on my current knowledge of the sport and how I still need to learn the sport in more detail)

How effective do you think the performance analysis provision was used in the Paralympic Games?
I think we could have used it a little bit more. I think we underused performance analysis during that period. Obviously, it was a little disappointing that we couldn't have used everything that we had hoped. Not having the iPad on the bench due to technological issues was one of the things for example. I thought that would have added some value to our ability as coaches to make informed decisions during the games but that is something that we can look to develop as time goes on. I feel that we underused the performance analysis process but it is a fine balance between allowing the players to rest and getting training sessions in

during the tournament period. It just comes down to figuring out the timing of it all and something has to give. (Reflecting on the use of SPA during the Paralympics Games)

What element of the performance analysis process do you think was underused?
Scouting primarily. (Reflecting on how SPA could have been used further during the Paralympics Games)

What could you have done or would you have done in hindsight?
I would like to have gotten more specific clips on certain teams regarding their offensive and defensive tendencies. (Reflecting on how SPA could have been used further during the Paralympics Games)

What was the content and style of the video sessions during the games?
I thought they were done alright but I just find that people tend to tune out when they get too long. If a clip is too long it is almost information overload and they switch off. If you keep the clip to 10-15 seconds and be very specific, ‘this is their offensive set and this happens’, you allow yourself to replay it and explain it in detail. It allows you to talk about the team or the player's tendencies, for example, this player always cuts baseline. (Reflecting on the video sessions during the Paralympics Games)

The use of video and showing clips, was that a key component of match day preparation?
It is an integral part of match day or game day preparation. It has to be built in. I felt out in Rio it was beneficial showing the video session before a training session. It allowed us to go straight into a walk through. It highlighted to the players and provided them with a clear message of what they were required to do and what we as a coaching team want them to do in the upcoming game. It provided them with fresh feedback and was very valuable. I talked to the players about having the opposition team cards, which provided an overview of each player. Those can be very valuable for certain people, but the problem is athletes tend to be lazy. They do not necessarily want to do the homework behind creating them. If that comes down to the staff creating them then I think we should put the effort into trying to get these done but it takes a lot of time. (Reflecting on the video sessions during the Paralympics Games)

Do you think getting the athletes involved in the process is beneficial to their learning?
I think getting them involved would be the concept behind it but the reality behind it is I don’t think the athletes would want to put the effort in behind it. I think they feel as athletes they do enough work in terms of strength and conditioning and on-court work and all that kind of stuff. To give them homework, I don’t think they are fond of that thing. But if you can do that as a team building thing or exercise it might work. Being a former athlete, I took it upon myself to do it but I wouldn’t have done it in a concrete way. I would have watched the video and made mental notes. Like, this guy always does this or does that. I wouldn’t have written that all down and had a little booklet to look at later. (Reflecting on how I engaged the players during the SPA process during the build-up to the Paralympics Games)

For me building a rapport is important to ensure that I know what you guys as coaches want. Do you think that is important?
I 100% agree that building a rapport between staff to ensure that we are all on the same page is important. I am a firm believer that relationships are the foundation of everything that you do. If you don't have a relationship it is not going to go far. (Reflecting on the softer skills required of a coach)

Due to the time constraints that we had, did I do anything, in particular, to help build that relationship?
I don't think there was anything in particular you did but the situation we were in together was very unique. As in, not many people commute from Canada to do this job. It is a full-time job but I am not here full-time. I guess we could correspond a little bit more electronically to help build that relationship a bit more but it doesn't substitute having those face to face interactions. (Reflecting on the coach-analyst relationship during the year before the Paralympics)

Is that visibility key to building a strong relationship?
It plays a part in there. (Reflecting on the coach-analyst relationship during the year before the Paralympics)

What changes would you like to see going forward?
The big thing for me going forward is working more closely with you. If I can get that relationship with you then it is going to be a major benefit to the programme. I know the women's assistant has learnt the analysis software but I would trust you to get clips for me. I want to be in a position where I can say I want all of the defensive clips on player X, I think I would trust you to go and get that for me. Sure I can learn the system myself, but I could be focused on other things whilst you are collating those clips for me. (Reflecting on how SPA could have been used further during the Paralympics Games)

You mentioned about trust, if I am able to get those clips for you does that reinforce that element of trust?
For sure, it enhances our relationship. I feel we as support staff and the coaches are all one team. We are here to support those athletes in training and in competitions as they try to achieve their goals. It's not about us as staff. It is about the athletes being successful. The better, the tighter we can work together, the more successful we can be and will be at helping those athletes achieve their goal. (Reflecting on the coach-analyst relationship during the year before the Paralympics and the roles each person plays)