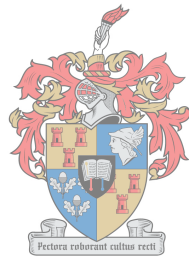# UTILISATION OF PERFORMANCE ANALYSIS AMONGST WESTERN PROVINCE CLUB RUGBY COACHES

Heinrich Painczyk

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Thesis presented in partial fulfilment of the requirements for the degree
Master of Science in Sport Science
in the Department of Sport Science, Faculty of Education
at
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Supervisor: Dr Wilbur Kraak
Co-supervisor: Dr Sharief Hendricks

March 2018

DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own original work, that I have read and understand the Stellenbosch University Policy on Plagiarism and the definitions of plagiarism and self-plagiarism contained in the Policy. I also understand that direct translations are plagiarism. Accordingly, all quotations and contributions from any source whatsoever (including the internet) have been cited fully. I understand that the reproduction of text without quotation marks (even when the source is cited) is plagiarism. I declare that the work contained in this thesis is my own work and that I have not previously (in its entirety or in part) submitted it for grading in this module or another module. Opinions expressed and conclusions arrived at, are those of the researcher and are not necessarily to be attributed to the National Research Foundation (NRF).

The co-authors of the two articles that form part of this thesis, Dr Wilbur Kraak (supervisor) and Dr Sharief Hendricks (co-supervisor), hereby give permission for the candidate, Mr Heinrich Painczyk, to include the two articles as part of a Master's thesis. The contribution (advice and support) of the co-authors was kept within reasonable limits, thereby enabling the candidate to submit this thesis for examination purposes. This thesis, therefore, serves as partial fulfilment of the requirements for the degree Master of Science in Sport Science at Stellenbosch University.

March 2018

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Mr Heinrich Painczyk

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Dr Wilbur Kraak   Dr Sharief Hendricks

Supervisor and co-author   Co-supervisor and co-author

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DEDICATION

I would like to dedicate this thesis to those who are not here. My biological mother, the 5 years we spent together leaves few memories, but the few I have are filled with love: I wish you had been here to experience this journey with me. My best friend, Jared, your journey ended at the hands of someone who had no right to end it, and there is not a day that goes by where I am not reminded of you. Your memory lives on strongly in your friends and family. My uncles, Sigi and Fred, I view you as fathers to me; thank you for everything you taught me about love, family, honour and strength.

"Grief is a most peculiar thing; we're so helpless in the face of it. It's like a window that will simply open of its own accord. The room grows cold, and we can do nothing but shiver. But it opens a little less each time, and a little less; and one day we wonder what has become of it"

Arthur Golden

SUMMARY

The use of performance analysis (PA) by coaches has significantly increased across many sporting codes around the world. The demand for effective feedback due to memory retention limitations in the coaching process is a main contributing factor. Researchers have investigated the utilisation of performance analysis within certain coaching populations and found that it is used extensively in the coaching and feedback process. Its popularity and importance in drawing accurate conclusions regarding athletic performance has led to the investigation of the inter- and intra-coder reliability of the computerised notational systems used to produce this data. However, there are many systems that are available to coaches that have not yet been tested.

The first objective of this study was to determine and compare the utilisation of performance analysis by Western Province Rugby Union club rugby coaches. This was carried out with the aim of providing insight into the extent to which PA is currently being used in a practical setting. The second objective of this study was twofold: firstly, to determine the inter- and intra-coder reliability of the EncodeProRX performance analysis software and secondly to compare coding done by novice coders and an experienced coder.

This thesis is structured as a series of research articles. Article 1: '*Utilisation of Performance Analysis among Western Province Rugby Union Club Coaches'* addresses the first objective: it highlighted that only 16% of coaches in the Super League have access to video footage after every game, with 39% of coaches never having access to video footage. It also highlighted that 80% of coaches value performance analysis strongly, yet 82% do not have access to a computerised notational system. The number of coaches that do not have access to video and computerised notational systems can be attributed to the fact that 80% of coaches do not receive a budget for performance analysis resources from their clubs. Despite this, 76% of coaches perform their own analysis, to some extent, indicating that they are aware of their memory retention issues but lack the resources to do this effectively.

Article 2: '*Reliability of EncodeProRX performance analysis software to assess rugby performance'* addresses the second objective. The EncodeProRX system showed very good inter-coder reliability agreement among most of the performance indicators measured, namely scrums (K=.93), lineouts (K=.93), handling errors (K=.90), tackles

(Қ=.83), mauls (Қ=.92) and rucks (Қ=.92). There was an average agreement of Қ=.79 across all the performance indicators. Furthermore, the intra-coder reliability showed an average agreement of Қ=.82 which shows that coders can use this system consistently. When comparing an experienced coder to the novice coders, there was some variability with two coders yielding very good agreement (Қ=.81 and Қ=.84) and three coders with good agreement (Қ=.69, Қ=.72 and Қ=.79).

This study concluded that there is an unfavourable situation in Western Province club rugby where many coaches do not have access to performance analysis resources. The primary contributing factor of this was budget related issues. The EncodeProRX performance analysis system was proven to have good inter- and intra-coder reliability meaning that it is an affordable computerised notational system available to coaches that can be used to determine effective training protocols and provide precise operational definitions.

Key words: club rugby coaches, coaching process, coder reliability, computerised notational systems, performance analysis, video analysis

OPSOMMING

Wêreldwyd het die gebruik van prestasie analise (PA) betekenisvol oor baie sport kodes heen toegeneem. Die hoof bydraende faktor is die behoefte aan effektiewe terugvoer as gevolg van geheue beperkings in die afrigtingsproses. Navorsers het die gebruik van PA binne sekere afrigtingspopulasies ondersoek en tot die gevolgtrekking gekom dat dit omvattend in die afrigting en terugvoer prosesse gebruik word. Die popolariteit en belangrikheid van PA om tot akkurate gevolgtrekkings aangaande sport prestasie te kom, het aanleiding gegee tot die ondersoek na die eksterne- en interne- kodeerder betroubaarheid van die gerekenariseerde notering sisteme wat gebruik word om hierdie data te produseer. Daar is egter baie sisteme tot die beskikking van afrigters wat nog nie getoets is nie.

Die eerste doelwit van die studie was om die gebruik van PA deur Westelike Provinsie Rugby Unie afrigters te bepaal en te vergelyk. Dit is uitgevoer met die doel om insig te bekom in die mate waartoe PA huidig in praktiese situasie gebruik word. Die tweede doelwit van die studie was tweeledig van aard: eerstens om die eksterne- en interne-kodeerder betroubaarheid van die "*EncodeProRX*" PA sagteware te bepaal en tweedens om die kodering wat deur beginner kodeerders en 'n ervare kodeerder uitgevoer word, te vergelyk.

Die struktuur van hierdie tesis bestaan uit 'n reeks artikels. Artikel 1: '*Utilisation of Performance Analysis among Western Province Rugby Union Club Coaches'*, spreek die eerste doelwit aan. Die bevindinge toon dat slegs 16% van die afrigters in die Super Liga toegang tot video opnames na afloop van elke wedstryd het, terwyl 39% van die afrigters geen toegang tot video opnames het nie. 80% van die afrigters heg baie waarde aan PA, maar 82% het nie toegang tot 'n gerekenariseerde notering sisteem nie. Die aantal afrigters wat nie toegang het tot video en gerekenariseerde notering sisteme kan toegeskryf word aan die feit dat 80% van die afrigters nie 'n begroting vir PA hulpbronne van hulle klubs ontvang nie. Afgesien hiervan voer 76% van die afrigters, tot 'n sekere mate, hulle eie analise uit. Hulle is terdeë bewus van hulle geheue beperkings kwessies, maar het nie die hulpbronne om dit effektief uit te voer nie.

Artikel 2: '*Reliability of EncodeProRX Performance Analysis System to Assess Rugby Performance'* addresses the second objective. Die "EncodeProRX" sisteem het baie goeie interne-kodeerder betroubaarheid ooreenkomste tussen meeste van die gemete

prestasie indikators getoon, naamlik: skrums (K=.93), lynstane (K=.93), hanteringsfoute (K=.90), duikslae (K=.83), losgemale (K=.92) en losskrums (K=.92). Daar was 'n gemiddelde ooreenkoms van K=.79 oor al die prestasie indikators heen. Aan die ander kant het die interne-kodeerder betroubaarheid 'n gemiddelde ooreenkoms van K=.82 getoon, wat daarop dui dat kodeerders die sisteem konsekwent kan gebruik. Die vergelyking van 'n ervare kodeerder met beginner kodeerders, het 'n mate van inkonsekwentheid getoon met twee kodeerders wat baie goeie ooreenkomste getoon het (K=.81 en K=.84) en drie kodeerders met goeie ooreenkomste (K=.69, K=.72 en K=.79).

Die studie het tot die gevolgtrekking gekom dat daar 'n ongunstige situasie in Westelike Provinsie klub rugby heers, aangesien baie afrigters nie toegang tot PA hulpbronne het nie. Die primêre bydraende faktor hiertoe is begrotingskwessies. Daar is bevind dat die "EncodeProRX" PA sisteem goeie eksterne- en interne-kodeerder betroubaarheid toon. Dit impliseer dat die "EncodeProRX" 'n bekostigbare gerekenariseerde noteringsisteem is wat deur afrigters gebruik kan word om effektiewe inoefening protokolle te bepaal en om presiese operasionele definisies te voorsien.

Sleutel woorde: klub rugby afrigters, afrigtings proses, kodeerder betroubaarheid, gerekenariseerde notering sisteme, prestasie analise, video analise

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LIST OF ABBREVIATIONS

C	Coder
CI	Confidence Intervals
CNS	Computerised notational system
GPS	Global positioning systems
IRB	International Rugby Board
MATS	Movement awareness and technical skill
NRF	National Research Foundation
PA	Performance analysis
PIs	Performance indicators
SANZAR	South Africa, New Zealand and Australia Rugby
SLA	Super League A
SLB	Super League B
SLC	Super League C
UK	United Kingdom
UKCC	United Kingdom Coaching Qualification

APPENDICES

CHAPTER 1

INTRODUCTION AND PROBLEM STATEMENT

This chapter is included herewith in accordance with the referencing style of the Department of Sport Science, Stellenbosch University.

1.1   Introduction

Rugby union (hereafter referred to as rugby), which gained its professional status in 1995, has been exposed to a rapid growth in the science of examining players' characteristics and game tactics through the use of technology (Prim & Van Rooyen, 2013). This performance analysis (PA) technology allows coaches to analyse performances and assists coaches in making informed decisions; ultimately allowing them to provide players with accurate feedback necessary for skill development and performance enhancement (Lemmink & Frencken, 2013; O'Donoghue & Mayes, 2013; Wright, Atkins & Jones, 2012). PA has become increasingly accessible across all levels of rugby (Wright *et al*., 2012) allowing a more comprehensive analysis of individual and team performances (Fernandez-Echeverria, Mesquita, González–Silva, Claver & Moreno, 2017). The wide use of PA across many sporting codes has made it a very popular topic in sport science research (Fernandez-Echeverria *et al*., 2017). Most of the research on PA in rugby, however, has explored aspects of the game, such as patterns of play, performance indicators associated with winning, breakdowns, technical skills and physiological estimates of players' work rates (Austin, Gabbett & Jenkins, 2011; Bishop & Barnes 2013; Hendricks, Roode, Matthews & Lambert, 2013; Quarrie, Hopkins, Anthony & Gill, 2013; Van den Berg & Malan, 2012; Van Rooyen, Diedrick & Noakes, 2010).

The popularity and advancement of PA is evident in the growth and development of modern computerised notational systems (CNS) (Wright *et al*., 2012). Growth is also evident in the number of employed, full-time performance analysts at professional level and the increase in PA companies that provide match-coding services (Wright *et al*., 2012). There has been a substantial increase in the use of PA amongst sub-elite and elite coaches, and today it is one of the most important techniques used by coaches (Bampouras Cronin & Miller, 2012; Fernandez-Echeverria *et al*., 2017; Magwa, 2015; O'Donoghue, 2010; Wright *et al*., 2012). In the past, the coaching process was reliant on the ability of coaches to accurately remember events (memory retention); however, this not always accurate or reliable (Franks, 1993; Franks & Miller, 1986; Laird & Waters, 2008; Wright *et al*., 2012). This ineffective coaching process is due to coaches identifying, diagnosing and correcting technical and tactical flaws (Wright *et al*., 2012) based on subjective opinions formulated from their memory of the game, which equates to approximately less than 60% of key events in a match (Franks, 1993; Franks &

Miller, 1986; Laird & Waters, 2008). PA functions as a tool to reduce these memory retention issues by providing coaches with objective information to allow formulation of more accurate opinions of matches (Groom *et al*., 2012; Lemmink & Frencken, 2013; O'Donoghue & Mayes, 2013); however, not all coaches make use of PA (Magwa, 2015; Wright *et al*., 2012).

Wright *et al*. (2012) investigated the use of PA by coaches in the United Kingdom. It was found that PA is commonly used by coaches from various sporting codes. The findings by Wright *et al*. (2012) are supported by findings by Magwa (2015) who investigated the use of PA amongst sub-elite coaches in South Africa across three levels. These two studies show that PA is used by many sub-elite coaches but there is still a large number of sub-elite coaches who do not have access to any form of PA (Magwa, 2015; Wright *et al.,* 2012).

A common tool used by coaches for PA is CNS which are computer-based programs which allow coaches or analysts to log match events to receive quantitative data. Furthermore, CNS have improved the PA process and made performance data more reliable (O'Donoghue & Mayes, 2013). Through their use, coaches are able to categorise the actions that have occurred in a match which allows them to create an objective statistical analysis of the game for use in the feedback process to players (O'Donoghue & Mayes, 2013). However, CNS are not automated, thus leading to potential human error during data capture (O'Donoghue, 2007). To confidently make decisions based on this data, the reliability needs to be evaluated so that it can be interpreted with an understanding of measurement error (O'Donoghue, 2007).

There are many CNS on the market, some of which have been tested for reliability (Bradley, O'Donoghue, Wooster & Tordoff, 2007; Liu, Hopkins, Gomez & Molinuevo, 2013), while others have not (O'Donoghue, 2007). To prove the reliability of a system, these tests need to yield high levels of agreement (Bradley *et al.,* 2007; O'Donoghue, 2010). There are two types of reliability: intra-coder reliability and inter-coder reliability. Intra-coder reliability indicates the coders' ability to use the system consistently whereas inter-coder reliability determines the objectivity of the CNS, as well as the understanding of operational definitions by the coders (O'Donoghue, 2010). If coaches are going to use PA to make informed objective decisions about their team's performance and to correct and alter any tactical or technical issues for their future

performances (O'Donoghue, 2010; Wright *et al.,* 2012), then it is vital that there are numerous reliable CNS available for them to choose from.

1.2   Problem statement

There is a lack of published research investigating the use of PA at club rugby level in South Africa. A further void in the field of PA is reliability of the CNS currently being used by coaches and teams. If coaches are not using PA at club level, then this raises concerns as to the effectiveness of their coaching (Franks, 1993; Franks & Miller, 1986; Laird & Waters, 2008; Wright *et al*., 2012). The current World Rugby education process for coaches does not expose coaches sufficiently to the use PA (Magwa, 2015). Furthermore, if coaches are trained to use PA, an affordable CNS that has undergone reliability testing needs to be available for them to use.

1.3   Aim of the study

The aims of this study are twofold, firstly to investigate the utilisation of PA amongst Western Province Rugby Union club coaches and secondly to determine the reliability of the EncodeProRX PA software.

The specific objectives are as follows:

Research article 1 (Chapter 3): to determine and compare the utilisation of PA among Western Province Rugby Union Super League club rugby coaches.

Research article 2 (Chapter 4): to determine the inter- and intra-coder reliability of the EncodeProRX™ PA software as well as to compare the coding proficiency of novice coders and an experienced coder.

1.4   Motivation for the study

The investigation into the utilization of PA by club rugby coaches in the Western Cape, South Africa, will help us understand the current usage thereof at this level. The investigation will also assess the opinion of coaches on the importance of PA in the coaching process. This study will ultimately provide insight into how many coaches are using PA to assist the development of amateur rugby players. A study by Magwa (2015) revealed that 72% of sub-elite coaches in the Western Cape, South Africa, have access to video footage; and that 67% of these coaches perform analysis using this footage. Magwa (2015) also highlighted that coaches are only exposed to PA in the World Rugby Level 3 course. If the current coaching levels and use of PA by club coaches can

be identified then the appropriate unions and bodies can be made aware of it and hopefully intervene to aid player and coach development. In addition to this understanding, a reliable and affordable CNS needs to be available to coaches in order for them to gain access to analysis. The CNS that coaches use needs to be easy to operate by inexperienced coders and should not require extensive training. User-friendly CNS could possibly increase the utilisation of PA in schools and clubs; and possibly benchmark the future of PA in South African rugby.

1.5   Structure of the thesis

This thesis is presented in a research article format. The two research articles (Chapters three and four) were prepared according to the guidelines of different journals. Consequently, the referencing style used in the different chapters of this thesis will differ.

Chapter 1:   Introduction and problem statement: This chapter is included herewith in accordance with the referencing style of the Department of Sport Science, Stellenbosch University.

Chapter 2:   Literature review: In order to establish theoretical background, the purpose of this chapter is to summarise the performance analysis literature, specifically on the utilisation of CNS and reliability of CNS applicable to rugby. This chapter is included herewith in accordance with the referencing style of the Department of Sport Science, Stellenbosch University.

Chapter 3:   Research article 1: '*Utilisation of performance analysis amongst Western Province Rugby Union club coaches'*. This chapter is included herewith in accordance with the referencing style of the International Journal of Performance Analysis in Sport.

Chapter 4:   Research article 2: '*Reliability of EncodeProRX performance analysis software to assess rugby performance'*. This chapter is included herewith in accordance with the referencing style of the International Journal of Computer Science in Sport.

Chapter 5: <u>Summary limitations and future research</u>: This chapter is included herewith in accordance with the referencing style of the Department of Sport Science, Stellenbosch University.

1.6 References

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CHAPTER 2

LITERATURE REVIEW

This chapter is included herewith in accordance with the referencing style of the Department of Sport Science, Stellenbosch University.

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2.1   Introduction

Rugby union (hereafter referred to as rugby) is a dynamic and complex team sport which involves multiple players and various points of contest to win possession of the ball (World Rugby, 2017). Due to the dynamic nature of rugby, recalling key events in matches is a problem and hinders the coaching process (Franks, 1993; Franks & Miller, 1986; Laird & Waters, 2008). This has led to performance analysis (PA) becoming an integral part of the coaching process. The use of PA has grown substantially over the past decade (O'Donoghue, 2010; Bampouras *et al*., 2012; Wright *et al*., 2012; Fernandez-Echeverria *et al.*, 2017) and there has been a noticeable growth in the number of PA systems available for coaches and analysts (Wright *et al*., 2012). This has resulted in PA becoming a popular discipline in sport science (Fernandez-Echeverria *et al.*, 2017).

The number of research articles on PA has also increased over the years; however, it has been stressed in the literature that there is a concerning lack of evidence for the reliability of computerised notational systems (CNS) used in PA research (Hughes, Cooper & Nevill, 2004; O'Donoghue, 2007). These systems are used by coaches to make informed decisions about their team's performance and to use these decisions to create appropriate interventions to alter future performances (O'Donoghue, 2006; O'Donoghue, 2007; Laird & Waters, 2008; Carling, Reilly & Williams, 2009; Wright *et al*., 2012). In research, investigators use this coded data from various CNS to investigate their hypotheses' and draw conclusions for their research (Bishop & Barnes, 2013; Villarejo, Palao, Ortega, Gomez-Ruano & Kraak, 2015; Vahed, Kraak & Venter, 2016; Kraak, Coetzee & Venter, 2017). It is for these reasons that the reliability of the CNS used in both practical and research context needs to be tested (O'Donoghue, 2007).

Despite reliability issues, PA has become increasingly popular and accessible across all levels of rugby (Wright *et al*., 2012). A study by Wright *et al*. (2012) on coaches involved in various sporting codes in the United Kingdom revealed that 68% of coaches have access to video footage, and 50% use PA systems. Magwa (2015) found similar results in a South African population study; 72% of coaches had access to match footage and 67% of the coaches performed their own match analysis. Both studies revealed that over 80% of coaches feel PA is vital in decision making and planning (Wright *et al*., 2012; Magwa, 2015). However, there is currently limited literature

investigating the access to and the use of PA and video footage at different levels of play in rugby within South Africa.

This chapter is aimed at summarising the current literature and is presented in three sections: firstly, a background on rugby and an overview of the club rugby structure in the Western Province Rugby Union; secondly, insight into the use of PA in rugby and in the coaching process, CNS currently being used as well as the determination and usage of performance indicators; and lastly, the role of feedback to players and the analysis of opposition.

2.2   Rugby union background

The most common held belief is that the game of rugby originated in 1832 when a school pupil by the name of William Webb Ellis, a pupil at the school "Rugby", picked up a football with his hands and began to run with it; this was the origin of rugby's distinctive feature of running with the ball rather than kicking it (Bolligelo, 2006; Richards, 2007). Some of the earliest accounts of similarly styled games date back to the Romans in 1603 (Bolligelo, 2006; Richards, 2007); however, historians have concluded that there is no specific date or time that one can define as the birth of rugby (Bolligelo, 2006). There were many forms of the game with no real rules in place; rules were passed around by word of mouth (Richards, 2007). The first laws written for rugby occurred in 1845 when the school "Rugby" felt word of mouth was not sufficient. These drafted "rules" were actually more on the lines of decisions based on disputed points (Richards, 2007). Rugby continued to develop into an amateur sport where players were not paid; it finally became a professional sport in South Africa in 1995 with the formation of SANZAR (South Africa, New Zealand and Australia Rugby) (Bolligelo, 2006). The formation of SANZAR led to the formation of the Super 12™ and Tri-Nations™ competitions (Higham & Hinch, 2003). These competitions were inaugurated in 1996 (Higham & Hinch, 2003) and today have grown into the Super Rugby™ and Rugby Championships™.

Rugby is played by two teams of 15 players plus authorised replacements (usually 7); with no more than 15 players from each team on the field at one particular time (World Rugby, 2017). There are various positions that players play in: the two groups that these positions are divided into are forward players (forwards) and backline players (backs) (Biscombe & Drewett, 2010). These two teams contest for possession of the ball and

attempt to continue play while in possession (World Rugby, 2017). The forwards, due to their positional requirements, need to be strong and powerful because they compete in more total impact tackles, tackle assists and rucks in offense and defence than backline players (Duthie, Pyne & Hooper, 2003; International Rugby Board, 2007; Lindsay, Draper, Lewis, Gieseg & Gill, 2015). The physical demands of forwards means that forward players are typically larger in size compared to the backs (Deutsch, Kearney & Rehrer, 2007; Cunniffe, Proctor, Baker & Jacobs, 2009; Jarvis, Sullivan, Davies, Wiltshire & Baker, 2009; Lindsay et al., 2015). Backline players cover more distance, travel at higher speeds, and are more agile and evasive than the forwards; they are also smaller in stature (Deustch et al., 2007; Cunniffe et al., 2009; Jarvis et al., 2009; Lindsay et al., 2015). These physical demands on backs means that they are more involved in carrying the ball in more open space and advancing their team with speed, skill and evasive running (Lindsay et al., 2015). Table 2.1 presents the different positions in rugby along with the different classification groups.

Table 2.1: Positions and positional groups of rugby union.

Jersey number	Position	Positional group	Positional sub-group
1	Loose-head prop	Forward players	Tight five/tight forwards
2	Hooker		
3	Tight-head prop		
4	Lock		
5	Lock		
6	Blind-side flanker		Loose forwards
7	Open-side flanker		
8	Eighth man		
9	Scrum half	Backline players	Inside backs
10	Fly half		
12	Inside Centre		
13	Outside Centre		
11	Left wing		Outside backs
14	Right wing		
15	Fullback		

Source: (Vahed, 2014a)

Rugby competition structures around the world follow various formats. Western Province Rugby Football Union is a club league grouped into nine league divisions. These leagues are structured as follows, Super League A (SLA) (15 Clubs), Super League B (SLB) (15 Clubs), Super League C (SLC) (15 Clubs), City League (12

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Clubs), Northern League (12 Clubs), Southern League (11 Clubs), Paarl Region (11 Clubs), Simonsberg Region (10 Clubs) and Sunday League (10 Clubs). In addition to these leagues, there are also league competitions in the U/20, Reserve, Women and Golden Oldies divisions. Every Super League (A, B and C) team must enter an U/20 team in their respective division (Western Province Rugby Football Union, 2016). The Super League follows a single round format where each team plays every team within their league once in a season. Team placements at the end of the league determine promotion and relegation as well as playoffs for promotion and relegation.

The following section covers the literature on PA in rugby. More specifically this section covers PA in the coaching process, reliability of PA as well as the selection of performance indicators (PIs) for rugby.

2.3   Performance analysis in rugby

2.3.1   Background

Match analysis, or PA, is currently a very popular discipline in sport science due to its wide use across many sporting codes (Fernandez-Echeverria *et al.*, 2017). Over the past decade, there has been a substantial increase in the use of PA amongst sub-elite and elite coaches and today it is one of the most important tools used by coaches (Bampouras *et al.*, 2012; Fernandez-Echeverria *et al.*, 2017; Magwa, 2015; O'Donoghue, 2010; Wright *et al.*, 2012). Many definitions of PA exist. One such definition is that PA is an objective way of recording performance so that key elements of that performance can be quantified in a valid and consistent manner (Hughes & Bartlett, 2002). O'Donoghue (2006) describes the primary purpose of PA as providing information about performance that will assist coaches and players in the decision-making process. Carling *et al.* (2009) similarly suggest that the most important aspect of analysis is to analyse performance and provide the team and/or players with feedback that is necessary for skill development and performance enhancement. All the definitions of PA have one central theme which is that PA is aimed at providing the team and/or individual players with information on their performance in an attempt to improve performance (James, 2006).

The PA process after a match has two main purposes that are both aimed at improving the performance of players in the following match (O'Donoghue, 2006) (Figure 2.1).
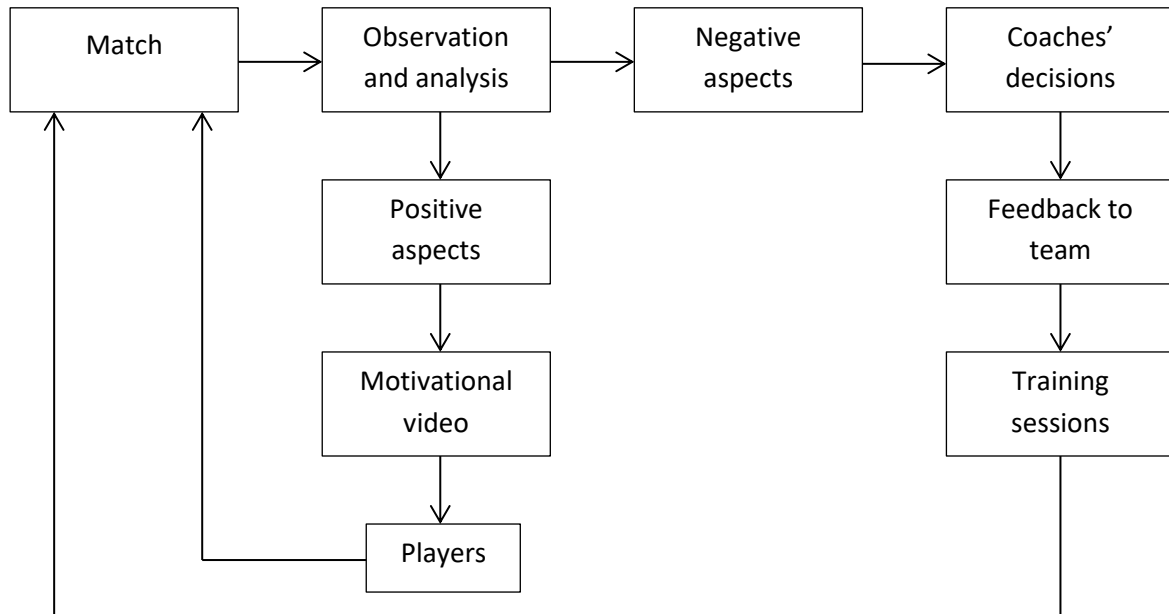
Figure 2.1: A dynamic model of PA process (O'Donoghue, 2006).

Following a match, coaches and analysts use video footage to observe the team's performance with additional statistical data generated from the notational analysis. This allows coaches to identify key aspects that contribute positively to the performance as well as key aspects that negatively influence the performance. Coaches are then able to make informed decisions based on this information to appropriately alter and adapt training sessions to yield the desired outcomes based on the PA done (Wright *et al.*, 2012; O'Donoghue & Mayes, 2013). Positive aspects that were identified by coaches can be used to create motivational videos for players and to highlight what the team did well. This process also aids in improving the performance of players and the team (O'Donoghue, 2010).

The discipline of PA involves many techniques that are associated with improving sports performance and can be described as being on a continuum ranging from notational analysis to biomechanical analysis (O'Donoghue, 2006). Video analysis is a technique also used in PA, which involves the analysis of digital video footage using biomechanical techniques, notational analysis techniques or technical analysis.

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Notational analysis is the process of generating and analysing data relating to mostly field sports which involve dynamic and complex situations (O'Donoghue, 2010). The PA process in team sports involves mostly notational analysis (data input) where the object is the athlete, analysis of the data and video, and then finally the feedback output where the receiver is the athlete (Bampouras, 2012). It is important to note that the athlete is not usually involved in the data gathering process; this is typically done by the coach and sport scientist (Bampouras, 2012).

Notational analysis forms an integral part of the PA process and has a long history in sport. It has been highlighted by Eaves (2015) that many academic papers mention that sports notation was started in the twentieth century with Hugh S. Fullerton being instrumental in its invention; it was, in fact, developed as early as the mid-nineteenth century. Eaves (2015) investigated evidence of the first use of sports notation; he found that the pioneers were newspaper reporters who not only acted as unofficial 'scorers' but also collected game event data, simply to record the game and to report on it. Today match analysis is completed using CNS based on match video footage.

Video analysis allows coaches and performance analysts to analyse the technical and tactical ability of players and to monitor players' contributions in games through match coding using CNS (O'Donoghue, 2006; Wright *et al*., 2012). CNS are computer-based programs which allow coaches and analysts to log and record data and events for a particular match (notational analysis), thus integrating quantitative data with video footage (O'Donoghue, 2006; Bradley *et al*., 2007). There are many CNS on the market which vary in terms of cost and ability; these systems are discussed later on. There is also little research on the CNS used within professional rugby which will be explored in terms of club rugby within the current study.

There is a large amount of literature focused on PA in sport, with an international journal devoted purely to the subject, namely the International Journal of Performance Analysis in Sport. Many of these studies identify that CNS are an important tool used for PA to provide objective data (Carling *et al*., 2009; Fernandez-Echeverria *et al.*, 2017; Laird & Waters, 2008; Wright *et al*., 2012) and a tool to assist coaches in identifying strengths and weaknesses in their teams and their opposition which are then used to set training targets (Groom, Cushion & Nelson, 2011; Sarmento, Bradley & Travassos, 2015; Wright *et al*., 2012; Wright, Atkins, Jones & Todd, 2013; Wright,

Carling, & Collins, 2014). There is, however, a dearth in the literature with regard to the investigation into the usefulness of PA, although it can be surmised that it is useful based on the large number of coaches who use it (Fernandez-Echeverria *et al*., 2017). It has been reported by players that they find PA extremely useful and that PA improves their performance significantly if used correctly by their coaches (Francis & Jones, 2014). There is also a lack of literature investigating the reliability of the CNS used for PA by the coaches (Hughes *et al*., 2004; O'Donoghue, 2007). The sections to follow investigate the literature focusing on these aspects.

2.3.2   *Analysis in the coaching process*

The coaching process in sport is a repetitive cycle involving practice and performance (Figure 2.2). The coach's role is to enhance the performance of players through observing the performance, evaluating the performance, providing feedback on the performance and then implementing appropriate interventions to improve the performance (O'Donoghue & Mayes, 2013). Without PA, this process is somewhat flawed due to memory retention issues which limits the accuracy of performance assessment and feedback (Franks & Miller, 1986; Laird & Waters, 2008). In this current model, without performance analysis, coaches draw conclusions based on subjective opinions formulated from what they remember of the match. Also, these opinions are influenced by "stand out events", tacit knowledge, bias, fans and spectators, as well as emotions (Hughes & Bartlett, 2002).
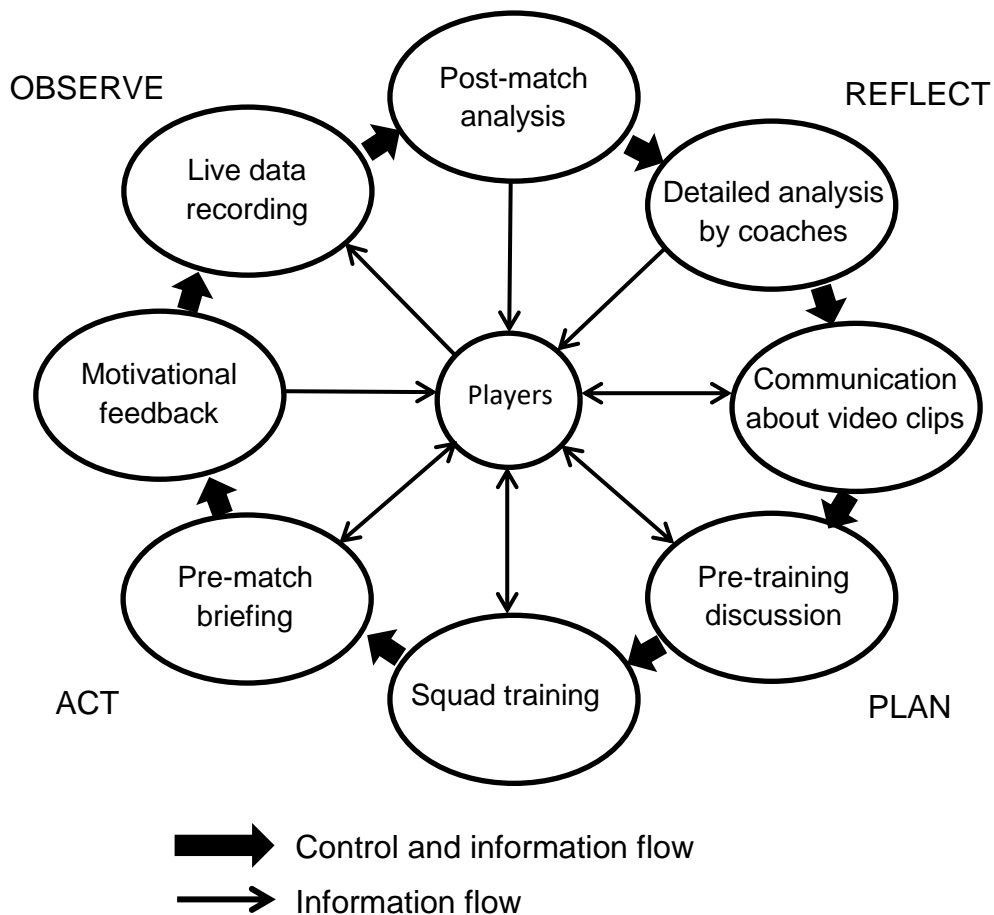
Figure 2.2: Performance analysis in the coaching process (Mayes *et al*., 2009:37)

The lack of reliability in the subjective observation process was highlighted in a benchmark study by Franks and Miller (1986). The authors concluded that coaches are only able to remember 30-50% of key events in a competitive fixture. The limitations in the observational ability of coaches found by Franks and Miller were further supported by Franks (1993). More specifically, the average recall ability of novice football coaches in the Franks and Miller (1986) study was 42%. Laird and Waters (2008) attempted to replicate the study by Franks and Miller (1986) to investigate the recall ability amongst more experienced and more qualified football coaches. This study found that qualified football coaches with a minimum professional level 1 qualification (Scottish Football Association) and a minimum of 6 months' experience had an average recall ability for critical events of 59%. These qualified coaches had a 17% average higher recall ability when compared to the novice coaches in the Franks and Miller (1986) study. Qualified coaches thus have a better understanding of the game and show greater familiarity with the game (Laird & Waters, 2008). The authors from both these studies concluded that there was a higher recall ability at the set-piece which was due to the game stopping, thus increasing the attention of the subjects (Franks & Miller, 1986;

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Laird & Waters, 2008). The limitations in the coaching process due to memory retention issues directly affect decision-making and feedback by coaches thus creating a need for coaches to become better at assessing their players (Groom & Cushion, 2011).

PA is critical within the coaching process as it allows coaches to quantitatively and qualitatively assess performances. This allows accurate and timely feedback to be given to teams so that their performance can be improved through accurate training interventions (Groom & Cushion, 2011; O'Donoghue & Mayes, 2013). Quantitative information is provided in the form of match statistics, tables, graphs, charts and field diagrams representing event locations (O'Donoghue & Mayes, 2013). This quantitative data assists coaches by highlighting areas of concern. Coaches are able to analyse technical and tactical aspects of the performance by watching video segments of the team's performance (O'Donoghue & Mayes, 2013). Including the PA process within the coaching process allows coaches to generate accurate objective conclusions that assist them in the feedback process and help to identify, diagnose and correct tactical and technical flaws or problem areas in training interventions (Wright *et al*., 2012; O'Donoghue & Mayes, 2013).

The importance of PA, as previously mentioned, is well-documented and strongly understood in the coaching and scientific communities (Wright *et al*., 2012; Fernandez-Echeverria *et al.*, 2017). This has ultimately led to a significant growth in its use and accessibility to coaches (Wright *et al*., 2012). The growth of modern CNS and PA companies which provide the service of coding and analysing games has contributed to this growth and accessibility (Carling *et al*., 2009; Wright *et al*., 2012); furthermore, the user-friendliness, availability of quality video equipment and reduction in costs has led to match analysis playing a bigger role in the coaching process (Carling *et al*., 2009). The growth of PA is also evident in the increase of employed, full-time performance analysts in professional sport (Wright *et al*., 2012). In addition to its growth, there is also a need to understand the extent to which PA is used and how it is integrated into the coaching process.

The extent to which PA is used was investigated by Wright *et al*., (2012), who attempted to determine the use of performance analysis by coaches in the UK. The participants in this study were experienced coaches and their qualifications ranged from level 2 to level 5. There were 46 respondents in this study: 46% of these coaches were

involved in rugby league, 21% in hockey, 18% in football, 9% in basketball, and 7% in rugby. Wright *et al*. (2012) showed that most of the coaches (68%) had access to DVD/edited clips after every game; 68% of coaches were supplied with video of the opposition; and 50% of coaches used performance analysis tools. Quantitative game data was collected by 64% of coaches and 43% of coaches used some form of live coding analysis during games. The evidence provided by Wright *et al*. (2012) suggests that PA is being widely used by elite level coaches. Coaches indicated that the PA information they gathered strongly affects their short-term planning (93%), medium-term planning (80%) and long-term planning (70%). This study provided significant insight into the engagement with PA by United Kingdom Coaching Course (UKCC) qualified coaches.

A similar study by Magwa (2015), which used a questionnaire adapted from Wright *et al*. (2012) showed similar results. The author investigated the engagement with PA by South African rugby coaches at a sub-elite level. The sub-elite coaches included rugby coaches at school (top 30 ranked schools), university and provincial levels. The questionnaire investigated six key themes: demographic information, analysis process, feedback process, implications for coaching practice, factors affecting performance indicator selection and finally the value of PA (Magwa, 2015). The study found that 53% of university coaches were not provided with video footage which may be due to the fact that 73% of the University coaches do not have access to a performance analyst. At school level, 75% of coaches received video footage after every match and 80% of coaches received it within 2 days after the match. Predictably 93% of provincial coaches that responded consistently received video footage after a game; these provincial coaches had the fastest delivery time with 87% of them receiving their footage within one day (Magwa, 2015). It was found that most of the coaches at sub-elite level performed their own PA (67%), and at provincial level, 73% of coaches had access to a performance analyst. For most coaches (85%), it was essential that PA should affect decisions made on team tactics and 48% of coaches felt that the person providing PA was essential (Magwa, 2015).

The use and perception of PA within the coaching process, more specifically the use by South African rugby coaches is limited. Most South African rugby coaches participating in high-level coaching value the use of PA and constantly use the information from PA to inform their coaching practice (Magwa, 2015). Coaches at provincial level have more

access to PA and use it more regularly in the coaching process than university and school coaches; this is possibly due to available finances and manpower (Magwa, 2015). The study by Magwa (2015) did not look at the engagement at club rugby level. There is, therefore, no information as to how many clubs are using PA and to what extent it is being used in South Africa.

2.3.3 Reliability

2.3.3.1 Sport and research

Coaches rely on PA data to make informed objective decisions about their team's performance and to correct and alter any tactical or technical issues for their future performances (O'Donoghue, 2006; O'Donoghue, 2007; Laird & Waters, 2008; Carling *et al.,* 2009; Wright *et al.,* 2012). Similarly, as previously mentioned, researchers use data from CNS for their investigations and it is thus vital that this data is reliable (Bishop & Barnes, 2013; Higham, Hopkins, Pyne & Anson, 2014; Hughes, Hughes, Williams, James, Vuckovic & Locke, 2012; Vahed, Kraak & Venter, 2014; Vaz, Mouchet, Carreras & Morente, 2011; Villarejo *et al*., 2015). The reliability of data became a concern when Hughes *et al*. (2004) found that 70% of published papers had failed to make reference to the reliability procedures followed. O'Donoghue (2007) strengthened this statement when he concluded that there is limited evidence of reliability for the various PA systems in research papers investigating PA. More recently, studies investigating aspects in PA such as performance indicators associated with success have used reliability tests to check their data (Bishop & Barnes., 2013; Higham *et al*., 2014; Hughes *et al*., 2012; Vahed *et al*., 2014b; Vaz *et al*., 2011; Villarejo *et al*., 2015). CNS are not automated which leads to concern about the human error involved when capturing this data during match coding (O'Donoghue, 2010). In practical and research settings, confidence in the data is substantially increased when the data (or the instrument) is shown to be reliable. There are various reliability procedures which will be investigated further in this section.

There are two types of reliability: intra-coder and inter-coder reliability. Intra-coder reliability involves the re-analysis of two or more of the same games by a single coder. O'Donoghue (2007) defines this reliability as an indication of the coder's ability to use the system consistently. Inter-coder reliability involves the analysis of the same games by different coders (James, Mackenzie & Capra*,* 2013). Inter-coder reliability is more

successful in determining the objectivity of a PA system as well as indicating the understanding of operational definitions by coders (O'Donoghue, 2007). When testing the reliability of a CNS and performance data, it is vital that the level of inter- and intra-operator agreement on results is understood. It is also important that, for reliability to be strengthened, the four sources of error need to be minimised as highlighted by Thomas and Nelson (1996). The four sources of error include participants, testing, scoring (notation) and instrumentation. Subject error is dependent on the operator's mood, state of mind, motivation and memory. Errors arising from testing are particularly associated with a lack of clarity or adherence to instructions by the operator (Williams *et al*., 2006). Notation is affected by system operators and their level of dedication and motivation during the analysis. The last source of error is the instrumentation which can be faulty and produce inaccurate data. Successful reduction in these four sources of error will assist in producing reliable data.

Once reliability procedures have been put into place, the results need to be tested for the level of agreement. It has been highlighted that the Kappa (K) thresholds values for fair, moderate, good and very good levels of agreement provided by Altman (1991) may not be suitable for performance analysis of sport (Choi *et al*., 2007; O'Donoghue, 2007). Choi *et al*. (2007) therefore investigated inter-coder reliability tests for real time analysis using CyberSports software. The study involved the comparison of observed basketball events by four participants and the reliability tests used were K, chi square, Pearson's r and % error. In addition to performing the various reliability tests, the researchers introduced a peer-review process of generating errors to deliberately create observations that they considered to have good, acceptable and poor agreement. The peer-reviewed error levels were then compared to the various reliability tests to assess which reliability test had construct validity for reliability analysis of PA. Despite the concerns highlighted, Choi *et al.* (2007), eventually concluded that K is acceptable for testing performance analysis reliability in basketball with nominal scale variables (event types, players and event outcomes).

Kappa has been used by many studies in rugby to determine the level of agreement between coders (Higham *et al*., 2014; Vaz *et al*., 2011; Villarejo *et al*., 2015). Furthermore, these reliability methods have also been used to test the reliability of various systems. Liu *et al*. (2017) used weighted K statistics to compare nominal variables between two coders in order to test the inter-coder reliability of live football

match statistics from OPTA Sportsdata[1]. Similarly, Larkin, O'Connor, and Williams (2016) used K-values to determine the inter- and intra-coder reliability of movement awareness and technical skill (MATS) analysis instrument in soccer. Bradley *et al*. (2007) also used K as a nominal variable to determine the reliability of results from two experienced coders. These studies have shown that K statistics used for nominal variables are successful in determining inter- and intra-coder reliability of CNS.

2.3.3.2 Computerised notational systems

CNS are computer-based programs which allow coaches or analysts to log match events to receive quantitative data. CNS have improved the match analysis process and made performance data more reliable (Carling *et al*., 2009). By using CNS, coaches are able to categorise the actions that have occurred in a game which allows them to create an objective statistical analysis of the game to use in the feedback process to players. The introduction of these CNS has allowed coaches to avoid drawing conclusions based on incomplete or inaccurate recollection of events in a game and also helps to avoid personal bias and emotions in the assessment of the performance of players.

CNS integrates the video footage with the quantitative data (O'Donoghue, 2006) which allows coaches and analysts to review the events and video in unison, post-match. CNS systems have been made easy to use through interactive interfaces and simplicity in terms of data capture. The automation of these systems in terms of data representation and time stamps has reduced the workload in PA and has made live analysis possible (Carling *et al*., 2009). The video sequences that are interactively provided through the CNS allow flexibility and immediate access as soon as the data is analysed on the system (O'Donoghue, 2006). The integration of data allows coaches to identify areas of concern through the statistical information, and with the benefits of video, coaches are able to identify the exact cause of the weakness (O'Donoghue, 2006; Carling *et al*., 2009).

CNS can significantly speed up the analysis process and also allow information to be stored on databases which allows coaches to track performances over a period of time (Carling *et al*., 2009). The continued development of different CNS and the growing competitive market has led to the development of new software systems which are affordable for lower division schools and clubs. CNS play a significant role in the

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[1] OPTA is the world's leading live, detailed sports data provider.

analysis process through their user-friendliness and availability, but the lack of academic literature comparing these systems or investigating the reliability of these tools is a matter of concern (Hughes *et al.,* 2004). Although many CNS have still not yet been tested for reliability, published research does test the inter and intra reliability of the coding used to generate data for the study (Vaz *et al*., 2011; Hughes *et al*., 2012; Bishop & Barnes., 2013; Higham *et al*., 2014; Vahed *et al*., 2014; Villarejo *et al*., 2015).

Bradley *et al.* (2007) investigated the inter-operator reliability of a CNS, ProZone Match Viewer. The coders used for this study underwent end-user training. The training included testing and familiarisation with various important aspects such as player identification, team strips, operational definitions and data input. Operational definitions are vital in improving the agreement between coders, as highlighted by O'Donoghue (2007). There were 14 participants involved in this study, split into two teams of 7; however, of the 14 participants, only 8 (4 per team) were coders (observers). The other participants were setup operators and team leaders, who were responsible for setting up fixtures on the system and performing quality control checks, respectively. The match footage was split into four equal segments which were distributed among the four coders. The automated event orders and sequential coding allowed this study to drastically reduce procedural and input errors. Interestingly, this study compared two observers; each "observer" was one team. The study found a high level of inter-observer reliability and a very good level of agreement. The high levels of agreement were achieved due to the use of precise, operational-event definitions and the amount of end-user training. Bradley *et al.* (2007) concluded that the ProZone Match Viewer™ has sufficient reliability for the use in coaching and academic environments. This conclusion, however, is for one product on the market; there are many more CNS which have not been tested.

There is a range of CNS on the market at the moment which are available for teams, although such systems are expensive and can often only be afforded by elite clubs (Carling *et al*., 2009). Some of the CNS available include Dartfish™, Sportscode™, Hudl™, Nacsport™, ProZone™, Verusco™, Fairplay™, Stratus™, Statspro™, EncodeProRX™, LongoMatch™, Kinovea™ and Focus X2™. The prices of these systems vary widely as do the countries of origin for the different systems. Furthermore,

there is a concerning lack of investigation into the different CNS on the market and which systems are favoured by different sports, clubs and unions.

2.3.3.3 Coding

Match coding is the process whereby coaches and/or analysts log various PIs on a CNS, either during a live match (live coding) or post-match with video reference (post-match coding). The PIs coded are dependent on what the coach and/or analyst has selected to measure and monitor (Wright *et al*., 2012, Bremner, Robinson & Williams, 2013). As previously mentioned, there are various CNS that are available to coaches and/or analysts. These systems are not automated and all involve the manual input of data into the CNS, which raises some concerns (O'Donoghue, 2007; Liu *et al*., 2013;). Human error in the coding process can greatly affect the reliability of data, and it is, therefore, important to put procedures in place to test the reliability of the collected data (Bradley *et al*., 2007; O'Donoghue, 2007; Liu *et al*., 2013; O'Donoghue & Mayes, 2013).

The success and reliability of coding is largely dependent on validity and working definitions for various events (O'Donoghue, 2007). This encourages consistency, especially when there are multiple coders. Prior to reliability testing, consistency and reduction in errors can be achieved through extensive training, the setting of clear operational definitions and supplementing operational definitions with example footage (O'Donoghue, 2010; Hughes *et al*., 2012; Liu *et al*., 2013). Operational definitions are clear and precise descriptions of events that occur in a sporting match (O'Donoghue, 2010; Hughes *et al*., 2012). For example, in rugby, events may include 'gain line success', and the definition could be, 'when the ball carrier carries the ball over the opposition's defensive line'. Supplementing these operational definitions with video footage during the training of coders will strengthen their understanding of the event and improve their accuracy (O'Donoghue, 2010).

Operational definitions and video footage do not guarantee accuracy by the coder. Williams and O'Donoghue (2006) investigated different defensive styles used by international netball teams and found that it was difficult to accurately describe particular events or defensive shapes using operational definitions. The operational definitions used were extremely brief and vague: an example is, 'Zone defence – Where all players concerned in the area of play analysed are marking the space' (Williams &

O'Donoghue, 2006:157). The study found 100% agreement between the two coders who were experienced netball players and coaches and coded a single quarter of netball. This agreement, despite the vagueness and briefness of the operational definitions, indicates that worded operational definitions are not sufficient for reliable observations and that experience and a good knowledge of the game and actions within that game are vital for reliable data capture (O'Donoghue, 2007).

There are various ways that researchers, coaches and analysts can check the accuracy of coded data. One such method, which is a good field method, involves consistency checking where logical sequences of events or logical tallies are checked for any input errors. This can be done manually or a system can automatically scan the data for any logical errors (O'Donoghue & Mayes, 2013). An example of logical consistency checking (error checking) in rugby would be a tackle made or missed by a player while his team was in possession of the ball. Another example is to use inter-coder and intra-coder (re-analysis) reliability tests to test the ability of the coder. Inter-coder tests are usually compared with results from an experienced coder (Bishop & Barnes, 2013). However, these methods are not practical in the field due to time constraints. Finally, another good field method is peer review, where a more experienced analyst or team leader assesses the coding by spot-checking the coded data for any errors and assessing the statistics for any irregularities (Wright *et al*., 2012). These methods will help ensure that the selected PIs are being logged accurately.

2.3.4 *Selection of performance indicators*

PIs are defined as a selection or a combination of action variables that are aimed at defining some or all aspects of performance (Hughes *et al.,* 2012) and form an integral part of PA. PIs are constructed by the coaching staff and performance analysts in order to measure the most important elements of the match that ultimately may determine its outcome; furthermore, these PIs are used to provide routine feedback to the team and coaching staff on their performance (Bremner *et al.,* 2013; Sampaio & Leite, 2013). It is therefore important to select PIs that are related to success throughout the tournament or league that one is competing in, thus helping coaches to formulate informed tactical approaches (Bishop & Barnes, 2013).

There is a large amount of academic literature investigating PIs that predict success (Bishop & Barnes, 2013; Bremner *et al.,* 2013; Vaz *et al*., 2010; Villarejo *et al.,* 2015);

however, this information is not being translated into field-based practice (Bishop, 2008; Wright *et al*., 2012). Wright *et al*. (2012) found that coaches are selecting PIs based on their coaching philosophy and gut instinct (91% and 43% of coaches respectively). Furthermore, they found that a mere 2% of coaches are selecting PIs based on scientific research. It should be made clear that a PI is not just another term for a variable that is measured in sport (Sampaio & Leite, 2013). A PI by definition is a valid measure of performance of important aspects in a sports performance, and has a known scale of measurement and a valid means of interpretation (O'Donoghue, 2010). When considering this and reviewing the findings of Wright *et al*. (2012), it raises concerns that coaches are not actually using PIs but merely using variables that they feel are important.

Academic literature in sport in general is rich in the amount of research focused on identifying PIs that can successfully measure performance. In rugby, there have been several attempts to identify different PIs that can discriminate between winning and losing teams (Bishop & Barnes, 2013; Bremner *et al*., 2013; Higham *et al*., 2014; Vaz *et al*., 2010; Vaz *et al*., 2011). These traits that are identified between winning and losing teams are PIs that coaches should consider measuring to monitor their team (Sampaio & Leite, 2013). These types of studies, however, simply compare PIs against a single outcome of winning or losing which has some limitations when trying to determine differences between teams (Hughes *et al.*, 2012). These studies tend to compare grouped data into randomly-sampled winning and losing sides which will obscure individual team differences and therefore will not be an appropriate method when attempting to compare strengths and weakness of a team (Hughes *et al.*, 2012; Vaz *et al*., 2010). When investigating PIs, it is important to consider the confounding variables that may affect the outcome of the match, such as match venue, weather conditions and strength of the opposition (James *et al.,* 2002; Hughes *et al.,* 2012, Bremner *et al*., 2013). It is therefore even more important to consider these aspects when coaches select the PIs with which to measure their team's performance.

As previously mentioned, measuring the PIs associated with winning or losing will simply provide the measure of a team's success at a given instant (Sampaio & Leite, 2013). This has led to authors attempting to monitor certain PIs in the form of performance profiles across an entire season (Oberstone, 2009; Rampinini, Impellizzeri, Castagna, Coutts & Wisloff, 2009). These measures take into account all the variability

in performance that occurs due to situational variables such as location, weather, officiating style and the opposition team (Higham *et al*., 2014; Hughes *et al.*, 2012; Sampaio & Leite, 2013;). Analysing data from a large data set creates a clearer indication of the impact of various PIs on match outcome (Higham *et al*., 2014; Hughes *et al.*, 2012). Nevertheless, when considering the selection of PIs, coaches and researchers need to consider the pool of data from which the PIs came (Higham *et al*., 2014).

Rugby is a complex and dynamic team sport which means the outcome of a match is affected by many variables (Hughes *et al.*, 2012). Simple frequency data is not an efficient method in profiling rugby performance due to the complexity of the game: qualitative analysis of outcomes and relationships between different events needs to be investigated (Hughes *et al.*, 2012). The data sets used for this need to be large enough because performance profiles which have been developed from too few data sets become inferences that are purely based on subjective opinion (Hughes *et al.*, 2012; Sampaio & Leite, 2013; Higham *et al*., 2014). There are many PIs that have been proven to predict success from many different tournaments, and when coaches select the PIs to be measured through a rugby season it is important that research and coaching philosophy (playing style) are considered. There is concerning lack of research that investigates what coaches and teams actually measure and how they use their data which is possibly due to the competitiveness of the game, causing coaches to hold onto sensitive information in order to remain competitive.

The following section looks at how this PA information is communicated to the players in the form of feedback. More specifically this section covers the background of the feedback process, post-match and training feedback, and finally pre-match and within-match feedback.

2.4   Feedback

2.4.1   *Background*

The feedback process is a vital component of the coaching process which makes this the main application area for PA (O'Donoghue & Mayes, 2013). PA is simply a tool that is ultimately targeted at providing meaningful and accurate feedback to players (Sarmento, *et al.,* 2015). There have been many proposed feedback models in the coaching process over the years. Some of the stand-out models, as proposed by O'Donoghue and Mayes

(2013), are the feedback models of Winkler (1988), Franks (1997), Irwin *et al*. (2005), O'Donoghue (2006), Lees (2008) and Carling *et al*. (2009). All the models depict that, in general, a coach's most important role is to aid the development of players and motivate them to perform to the best of their ability (Maslovat & Franks, 2008; Cushion *et al*., 2012; Horne, 2014). In this process of developing players, coaches are required to monitor, measure and evaluate their performance and skill execution (Horne, 2014). However, this process is seriously hampered due to recall limitations as previously mentioned (Franks & Miller, 1986; Franks, 1993; Laird & Waters, 2008).

PA within the coaching process is aimed at improving feedback to players by providing coaches with objective information from video and statistics to assist them in evaluating performance (Carling *et al*., 2009, Horne, 2014). The inclusion of PA allows coaches to eliminate inaccurate recollections and subjective opinions based on highlighted significant events thus increasing objective feedback (Maslovat & Franks, 2008; Carling *et al*., 2009). This ultimately leads to adequate and accurate interactive feedback being provided to players (Carling *et al*., 2009). Furthermore, it allows for a more accurate identification of strengths and weaknesses so that proper interventions can be put into place at training (O'Donoghue & Mayes, 2013; Horne, 2014). The feedback that is developed from PA is achieved through identification of problem areas by the performance analyst (O'Donoghue & Mayes, 2013). The performance analyst, through match-video tagging, is able to provide coaches and players with video sequences so that the problem areas can be qualitatively analysed for their causes and corrective measures can be put in place (O'Donoghue & Mayes, 2013; Horne, 2014).

The feedback that players receive occurs in mainly two forms as described by Magill (2001): sensory feedback and augmented feedback. Sensory feedback is the feedback that a player receives from all his senses when competing in his sport. These include visual (sight), auditory (sound), proprioceptive (feel) and tactile (touch) feedback which all occur intrinsically (O'Donoghue & Mayes, 2013). Intrinsic feedback comes from "within" and can also be in the form of self-reflection after a performance or training or in the form of self-motivation prior to a game or training (Wright *et al*., 2012; Cerasoli *et al*., 2014; Wright *et al*., 2016). Augmented feedback is additional feedback that comes from the coaches, analysts and managers in the form of qualitative feedback, video clips, images and quantitative feedback of statistical information in the form of graphs, charts and tables (O'Donoghue and Mayes, 2013). This type of feedback can

also be described as extrinsic feedback (Cerasoli *et al*., 2014). Extrinsic feedback is strongly dependent on the accuracy of PA as well as the expertise and experience of the coaching staff to evaluate and correct effectively (Hughes & Franks, 2008; Wright *et al*., 2013). It is important that players are involved in this feedback so that it becomes interactive (Francis & Jones, 2014; Wright, Carling, Lawlor & Collins, 2016). Players feel that being more involved in the analysis and feedback process has a greater impact in their learning and subsequently has a greater impact on their performance (Francis & Jones, 2014; Wright *et al*., 2016).
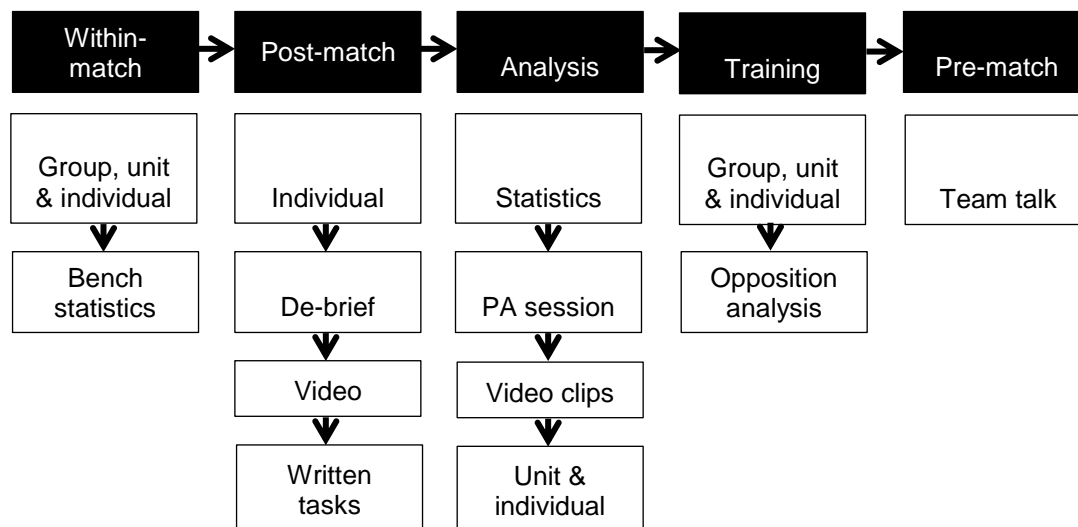
Figure 2.3: Model of the interactive feedback process (Horne, 2014:5)

The different types of feedback are used during different stages of the feedback process (Figure 2.3), as particular situations demand the different types. The different areas (within-match, post-match, analysis, training and pre-match) where feedback is required and the level of feedback associated with these areas were highlighted by Horne (2014) in an interactive feedback model (Figure 2.3). The model was created to provide structure to the feedback process for the Scottish netball squads (Horne, 2014). The structure this model shows, is the structure of PA feedback used in most team sports, rugby being one of them.

In the following sections, the feedback process during each of these areas will be discussed in more detail.

2.4.2   *Post-match and training feedback*

In team sports, more particularly rugby, there is limited time between matches, usually 1 week or even as little as 3 days, and in some tournament formats such as the Rugby Sevens games, even an hour or less. This means that analysis needs to be completed as soon as possible after a match to provide sufficient time for feedback and interventions in training. Directly after a match there is a debrief where coaches and players reflect on the performance via interactive feedback to assess the achievement of goals and targets that were set out during preparation (Horne, 2014; Sarmento *et al*., 2015). Post-match analysis using a CNS is then carried out by the analyst or service provider (Fernandez-Echeverria *et al*., 2017; Sarmento *et al*., 2015). The role of the analyst or service provider is to generate quantitative match data and identify strengths and weaknesses of the team and provide supporting footage for qualitative analysis by the coaches (Fernandez-Echeverria *et al*., 2017; O'Donoghue & Mayes, 2013; Sarmento *et al*., 2015). In the feedback to players, interactive feedback should be encouraged (Francis & Jones, 2014; Horne, 2014). Players want to be involved in the analysis process and learn more through an interactive approach (Francis & Jones, 2014). Sub-groups (units) and individual player feedback are successful as they allow for a more direct relay of information that is specific to those players involved (Francis & Jones, 2014; Horne, 2014). This process makes the feedback more targeted and ultimately allows it to be translated into the training, making it more focused, efficient and effective (Carling *et al*., 2009; Francis & Jones, 2014; O'Donoghue, 2006).

The use of PA during the coaching process allows for a more focused approach in training and preparation for upcoming matches (Fernandez-Echeverria *et al*., 2017; Sarmento *et al*., 2015). The feedback developed from the post-match analysis makes training interventions more accurate due to the PA process accurately highlighting problem areas (Horne, 2014; Sarmento *et al*., 2015). Further interactive feedback can take place between players and coaches as small units and individuals while they strengthen weaknesses in their technical and tactical skills (Horne, 2014). The use of video during training is advantageous, especially when one considers the coaching process; a skill is performed and observed by the coach; the coach then evaluates and provides feedback through interventions to correct errors or better current strengths (Sarmento *et al*., 2015). Video footage allows replays, thus allowing coaches to repeatedly view skills resulting in more accurate qualitative feedback to players

(Sarmento *et al*., 2015). In addition, CNS can be used to generate quantitative training data by measuring and monitoring skill execution and tactical ability. This data can then be used to provide feedback on the success of training interventions in achieving the set objectives based on post-match analysis and pre-match analysis.

2.4.3   *Pre-match and within-match feedback*

Pre-match feedback is given to players by coaches who have qualitatively analysed opposition games in order to identify strengths and weaknesses of their upcoming opposition (Carling *et al*., 2009; Francis & Jones, 2014; Sarmento *et al*., 2015). It has been stressed that for accurate pre-match feedback to be given, coaches need to analyse a minimum of three games, otherwise they are merely drawing inferences (O'Donoghue, 2005; Sarmento *et al*., 2015). It is also important that the quality of the opposition that the team played against is considered when selecting matches to analyse (Sarmento *et al*., 2015). Furthermore, coaches have highlighted that they prefer to do this analysis themselves (Fernandez-Echeverria *et al*., 2017) as the analyst may not look at the game in the same way as they do, thus drawing different conclusions (Wright *et al*., 2013). These aspects have to be considered in the opposition analysis process to provide meaningful pre-match feedback to players.

The pre-match feedback sessions can be presented to players as a team and also as sub-units (Francis & Jones, 2014; Horne *et al*., 2014). These sessions can make use of video clips to highlight the target areas and specific objectives for the upcoming fixture (Sarmento *et al*., 2015; Fernandez-Echeverria *et al*., 2017). It is important that these sessions are not filled with too much information as this can result in an overload of information and may overwhelm players having a negative effect on their performance (Francis & Jones, 2014; Horne, 2014; Sarmento *et al*., 2015). Pre-match feedback also involves the motivation of players by using highlight videos to depict their strengths and motivational videos to motivate them (O'Donoghue, 2010). Motivational pre-match feedback is typically given closer to the match so that it can have a meaningful impact on their performance (O'Donoghue, 2010).

Within-match feedback has not been investigated in much depth. Horne (2014) described the process used by the Scottish netball squads. It was explained that within-match feedback is used to assist athletes in achieving the goals and targets set out in the pre-match feedback. Further feedback that is given to the players are subjective

opinions of the coaches, which are supplemented with "bench statistics" (hand notation statistics). Sarmento *et al*. (2015) investigated within-match feedback used by futsal coaches. These coaches indicated that they regularly communicate to players during the game, especially when there are stoppages, mostly in the form of gestures. Furthermore, they stated that time-outs are used strategically to provide their team with instructions and correct tactical or technical issues. All the feedback provided by these coaches are subjective views based on experience.

2.5   Summary

The literature shows us that PA plays a very important role within the coaching and feedback process. At professional and semi-professional level, PA is being used well in the coaching and feedback process (Magwa, 2015; Wright *et al*., 2012). Its use in sport has grown significantly and it has become one of the most important tools used by coaches (Bampouras *et al*., 2012; Fernandez-Echeverria *et al.*, 2017; Magwa, 2015; O'Donoghue, 2010; Wright *et al*., 2012). Furthermore, there is a large demand for its use by players as well as the inclusion of players in the PA and feedback process (Francis & Jones, 2014; Wright *et al*., 2016). There is, however, no literature investigating the use of PA at club level in South Africa, more specifically the Western Province Rugby Football Union. The importance of PA use at amateur level is vital to ensure the growth and development of players. There is a need to understand how amateur level coaches view PA, whether or not they use it and to what extent they use it.

It is vital that the PA used by coaches and researchers which informs their decisions is reliable. Reliability testing in PA research has increased (Bishop & Barnes, 2013; Higham *et al*., 2014; Hughes *et al*., 2012; Vahed *et al*., 2014; Vaz *et al*., 2011; Villarejo *et al*., 2015) since the concerns were first raised by Hughes *et al*. (2004) and O'Donoghue (2007). However, these reliability tests have merely tested the data that they have been provided by companies providing coding services. The reliability testing of CNS available to coaches is still limited and only a handful of systems have been tested (Bradley *et al*., 2007; Larkin *et al*., 2016; Liu *et al*., 2017). A reliable CNS needs to be available to coaches for PA that can be used reliably by inexperienced coaches.

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CHAPTER 3

RESEARCH ARTICLE 1:

UTILISATION OF PERFORMANCE ANALYSIS AMONG WESTERN PROVINCE RUGBY UNION CLUB COACHES

This article will be submitted for publication in the International Journal of Performance Analysis in Sport. The article is included herewith in accordance with the guidelines for authors of this esteemed journal. However, to provide a neat and well-rounded final product for this thesis, the article has been edited to represent an actual published article as it would appear in this particular journal. This does not imply that the article has been accepted or will be accepted for publication. Consequently, the referencing style used in this chapter may differ from that used in the other chapters of this thesis.

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Utilisation of performance analysis among Western Province Rugby Union club coaches

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Abstract

The growth and accessibility of performance analysis (PA) is attributed to the growth of modern PA systems and PA companies that provide the services of match coding. The purpose of this study was to determine and compare the utilisation of PA among Western Province Super League club rugby coaches. Fifty-one coaches involved at senior and under 20 level teams participated in this study. The study had a response rate of 88%. The study revealed that only 16% of coaches have access to video footage after every game and 82% of coaches do not have access to and do not use computerised notational systems (CNS). Despite the fact that 80% of coaches value PA extremely, the study concluded that PA is not being used by a large majority of coaches in Western Province Rugby Union clubs. It was further concluded that this is due to the availability of PA resources (video equipment and CNS) due to budget restraints.

Key words: performance analysis, club rugby coaches, qualitative study approach, coaching process

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3.1   Introduction

Rugby union (hereafter referred to as rugby) as like any other sport has been constantly evolving over the years through law amendments and advancements in science and technology (Vahed *et al.*, 2016). The growth and development of the sport has led to advancements in the form of performance analysis (PA). This evolution of PA is ultimately aimed at improving the quality of players and team tactics in order for teams to be better than their opposition (Vahed *et al.*, 2016). There has been a noticeable growth in the use of PA in rugby and in the amount of research focused on PA (Bampouras *et al*., 2012; Fernandez-Echeverria *et al.*, 2017; O'Donoghue, 2010; Vahed *et al.,* 2016; Wright *et al.,* 2012). PA is defined as an objective way of recording performance so that key elements of that performance can be quantified in a valid and consistent manner (Hughes & Bartlett, 2008). The use of PA allows coaches to make informed decisions based on objective data; these decisions and recall of events allow coaches to identify, diagnose and correct technical and tactical flaws or problem areas (Laird & Waters, 2008; O'Donoghue, 2006; Sarmento *et al.,* 2015; Wright *et al.,* 2012). The increase in the game's competitiveness has brought about the use of objective data as well as video footage of oppositions' performances, which allows coaches to accurately and effectively prepare for upcoming fixtures (Francis & Jones, 2014; Laird & Waters, 2008; Wright *et al.,* 2012;).

Since the first evidence of PA, there has been a noticeable growth in its use which is evident in the number of employed full time analyst positions in professional teams (Bampouras *et al*., 2012; O'Donoghue, 2010; Wright *et al.,* 2012). The growth and accessibility of PA is attributed to the growth of modern PA systems and PA companies that provide the services of match coding and analysis, as well as the availability of affordable quality video equipment and the user friendliness of PA software (Carling *et al*., 2009; Wright *et al*., 2012). In a qualitative study, Francis and Jones (2014), were able to successfully confirm that players have a strong appreciation and desire for PA and the viewing of post-match footage, as well as opposition footage. The feedback process is vital in the learning and development of players as expressed by players in the study. Players reported that the following had significant effects on their learning: having an active role in PA; greater, detailed, position-specific feedback; improving performance through the viewing of footage to "see what they do right"; and actively taking notes during the feedback process (Francis & Jones, 2014). PA and the viewing

and analysing of video footage should not only be used by coaches, as players have shown improvements in performance when they are included in the PA process by improving their learning, understanding and decision-making (Bampouras *et al*., 2012; Francis & Jones, 2014). There is currently limited literature available on the access to and the use of PA and video footage at different levels of play in rugby, specifically in South Africa.

The use of PA by United Kingdom (UK) coaches was investigated by Wright *et al.* (2012). This study covered various sport codes: of the 46 responders, 46% were rugby league, 21% hockey, 18% football, 9% basketball and 7% rugby union. It was found that 68% of coaches had access to DVDs/video edited clips after every game, 68% of them had access to opposition footage, 64% collected quantitative game data and 50% used PA tools. In addition to the popular use of PA in the UK, it was further noted that 93% of coaches indicated that this PA affected their short-term planning. This study shows that PA is widely used by sub-elite UK football coaches who have access to it. A similar study by Magwa (2015) on South African sub-elite coaches across three levels (top 30 schools, Varsity Cup, Shield and provincial) of coaching, using an adapted version of the survey used by Wright *et al.* (2012) found similar results with regard to the use of PA. This study had a response rate of 57%. It was noted that 72% of coaches had access to match videos and 67% of coaches performed their own PA. There was a good agreement amongst coaches (85%) that PA should affect decisions made on team tactics. The results from these two studies show similarities at a sub-elite level in terms of PA use as well as the perception of PA by coaches (Magwa, 2015).

The introduction of PA at club level allows coaches to eliminate and overcome the limitations associated with using subject observations and to provide players and coaches with objective information in order to improve performance or to gain a competitive edge over the opposition. The introduction of this information can ultimately lead to improved understanding of performance to assist coaches in their decision-making (O'Donoghue, 2010). At club level, it can be surmised that funding is significantly less and therefore the use of PA may be restricted due to these budget restraints as well as the availability of analysts and time constraints. The aim of this study is to determine and compare the utilisation of PA among Western Province Rugby Union Super League club rugby coaches.

3.2   Research methodology

3.2.1   Study design

A qualitative approach was adopted by Thomas *et al.* (2011), allowing for the thoughts and opinions of Western Province Rugby Union Super League club senior and under 20 coaches of PA to be investigated. The survey was completed through the use of an online questionnaire. Ethical approval (REC-050411-032) was obtained from the Research Ethics Committee: Human Research of the Stellenbosch University.

3.2.2   Participants

Sixty-eight coaches involved with Western Province Rugby Union Super League clubs' senior and under 20 teams were identified and contacted of which (n=51) responded and took part in the study. The study revealed a response rate of 75% (Table 3.1). All participants in this study were male; the average age for senior coaches was 42 ± 11 and 38 ± 10 for under 20 coaches respectively. Furthermore, the average years that coaches had been working with their current team was 3.43 ± 2.89.

Table 3.1: The response rates of the different levels of coaches who took part in the study.

Responses	Senior	Under 20	Total
Potential number of coaches	40	28	68
Respondents	32	19	51
Response rate (%)	**80**	**68**	**75**

3.2.3   Data collection procedure

3.2.3.1 Questionnaire

The questionnaire used in this study was adapted from the original questionnaire by Wright *et al.* (2012). The questionnaire was uploaded online using Checkbox™, and was tested through a pilot study prior to the commencement of the main study. The questionnaire consisted of six themes as highlighted by Wright *et al*, (2012). The six themes were demographic information, analysis process, feedback process, implications for coaching practice, PI parameters, and the value of PA.

3.2.3.2 Pilot study

Prior to the commencement of the main study, a pilot study was performed. The aim of the pilot study was to determine if there were any questions that were misleading or incorrectly understood by participants. This was used to assess for any technical issues with the online questionnaire and to assess if there were any questions that may need to be added to the questionnaire. The pilot study questionnaire was completed by 10 coaches who did not take part in the main study. The coaches were contacted telephonically to request their participation in the pilot study and were then emailed with the online questionnaire link. Post-questionnaire completion, each coach completed a telephonic interview and answered pre-set questions about the questionnaire, aimed at investigating the above-mentioned pilot study aims. Findings from the pilot study were presented to the Stellenbosch University Sport Science Department Masters and Doctoral Committee.

3.2.3.3 Main study

Questionnaire. The findings and suggestions from the pilot study were considered, after which, a number of changes were made to the questionnaire before commencing with the main study.

Data collection procedure. Contact details of all the relevant participants were obtained from the Western Province Rugby Union amateur department. Initial contact with participants was made telephonically. During this interaction, the primary researcher requested their participation and provided them with background to the study. Participants who confirmed their willingness to partake were emailed the online questionnaire link. Online questionnaires were then completed at the participants' earliest convenience. The primary researcher sent the participants two emails to remind and encourage them to complete the online questionnaire.

3.2.4   Statistical analysis

The Statistica 13 package was used to process the data. Descriptive statistics for the questions were reported as frequencies and expressed as percentages. The relationships between the different levels of coaches and certain outcome variables were calculated using Chi-squared tests for independent groups. Results were considered statistically significant if $p < 0.05$.

3.3 Results

The results are presented under the following headings: demographic information, analysis process, feedback process, implications for coaching practice, PI parameters, and the value of PA.

3.3.1 Demographic information

Table 3.2 shows that the majority of the coaches (55%) held a World Rugby level 2 qualification and were subsequently working towards their level 3 (51%). The average years of coaching experience was 9.8±4.5 with 13 coaches (25%) having coached for more than 16 years. A high percentage (89%) of U20 coaches only coached as high has Super League, which was similar for the senior coaches (63%). However, there were a few coaches who had coached at provincial and international level (26%). Majority of these coaches were part time coaches (55%) and 20% full time coaches.

Table 3.2: Demographic information of the participating coaches.

Question	Response	S%(n)	U20%(n)	C%(n)
What is your highest coaching qualification?	WR level 1	22(7)	42(8)	29(15)
	WR level 2	59(19)	47(9)	55(28)
	WR level 3	13(4)	0	8(4)
	SARU level 1	3(1)	0	2(1)
	SARU level 2	3(1)	5(1)	4(2)
	Other	0	5(1)	2(1)
	None	0	0	0
What coaching qualification (if any) are you working towards?	WR level 1	0	0	0
	WR level 2	25(8)	32(6)	27(14)
	WR level 3	53(17)	47(9)	51(26)
	SARU level 1	0	0	0
	SARU level 2	0	0	0
	Other	0	0	0
	None	22(7)	21(4)	22(11)
How many years, of rugby coaching experience, do you have?	<5	19(6)	26(5)	22(11)
	6-10	38(12)	37(7)	37(19)
	11-15	16(5)	16(3)	16(8)
	>16	28(9)	21(4)	25(13)
What is the highest level you have coached at?	International	9(3)	5(1)	8(4)
	Provincial	25(8)	5(1)	18(9)
	University	3(1)	0	2(1)
	Super League	63(20)	89(17)	73(37)
Which of the following best describes your current coaching position?	Full Time	19(6)	21(4)	20(10)
	Part Time	53(17)	58(11)	55(28)
	Part Time + other	19(6)	5(1)	14(7)
	Volunteer	9(3)	16(3)	12(6)

Note: Senior coaches (S), Under 20 coaches (U20) and levels combined (C)

3.3.2 Analysis process

Table 3.3 shows that 39% of coaches do not receive video footage and 16% receive video after every game. Results showed that 86% of coaches do not use a PA company to provide them with coded games; furthermore, 82% of coaches do not have a CNS available to them. There were 10 coaches (20%) who indicated that they had access to a performance analyst, yet 80% (n=41) of coaches said that a good working relationship with a performance analyst was extremely important. Responses show that 20% of coaches received budget for PA, 30% (n=3) of these coaches said that the budget was not sufficient, 60% (n=6) reported that it was just enough to acquire the basics although 10% (n=1) said that it was sufficient. One coach (2%, n=1) indicated that video recording of training sessions is carried out all the time where as 49% never or 24% rarely recorded training sessions.

Table 3.3: Analysis process across the two coaching levels.

Question	Response	S%(n)	U20%(n)	C%(n)
Do you have access to, or are you provided with a video/ DVD/edited clips, following each match?	All the time	25(8)	0	16(8)
	Not at all	31(10)	53(10)	39(20)
	Occasionally	22(7)	37(7)	27(14)
	Often	13(4)	5(1)	10(5)
	Rarely	9(3)	5(1)	8(4)
On average, how long does it take before you receive the above video/DVD after a match?	Same day	16(5)	29(2)	18(7)
	Following day	16(5)	0	13(5)
	2 days later	19(6)	71(5)	28(11)
	3 days later	9(3)	0	8(3)
	5+days later	3(1)	0	3(1)
	NA	38(12)	0	31(12)
Do you use a PA agency/service provider for PA services?	Yes	16(5)	11(2)	14(7)
	No	84(27)	89(17)	86(44)
If yes you answered 'Yes' to the previous question, what services do they provide?	Video of own performance	19(5)	33(2)	21(7)
	Videos of the opposition	19(5)	17(1)	18(6)
	Recruitment videos	4(1)	0	3(1)
	Scouting reports	4(1)	0	3(1)
	Match statistics of own game	19(5)	17(1)	18(6)
	Match statistics of the opposition's game	11(3)	17(1)	12(4)
	Player statistics/work rate of own game	15(4)	17(1)	15(5)
	Player statistics/work rate of the opposition's game	11(3)	0	9(3)
Do you or your club have a computerised notational system, which is used for analysis?	Yes	25(8)	5(1)	18(9)
	No	75(24)	95(18)	82(42)

Question	Response	S%(n)	U20%(n)	C%(n)
Do you have access to a performance analyst?	Yes	25(8)	11(2)	20(10)
	No	75(24)	89(17)	80(41)
If you answered 'Yes' to the above question, with what does your performance analyst provide you?	Match/notational analysis	25(2)	50(1)	30(3)
	Individual technique analysis	0	0	0
	Both	75(6)	50(1)	70(7)
How important would you consider a good working relationship with your performance analyst to be?	Extremely	84(27)	74(14)	80(41)
	Somewhat	6(2)	11(2)	8(4)
	Not at all	6(2)	11(2)	8(4)
	Undecided	3(1)	5(1)	4(2)
If match analysis is provided by a performance analyst; how much time is spent reviewing this information per week?	0 – 0.5 hours	0	0	0
	0.5 – 1 hours	10(1)	0	8(1)
	1 – 1.5 hours	0	0	0
	1.5 – 2 hours	30(3)	100(2)	42(5)
	2 – 2.5 hours	0	0	0
	2.5 – 3 hours	30(3)	0	25(3)
	3 – 3.5 hours	0	0	0
	3.5 – 4 hours	0	0	0
	4 – 4.5 hours	10(1)	0	8(1)
	4.5 – 5 hours	0	0	0
	>5 hours	20(2)	0	17(2)
Does your club set aside money for PA services or systems in the budget?	Yes	25(8)	11(2)	20(10)
	No	75(24)	89(17)	80(41)
Please select the statement that best describes the budget amount supplied by your club for PA.	Not at all sufficient	25(2)	50(1)	30(3)
	Not very sufficient	0	0	0
	Just enough to get the basics	63(5)	50(1)	60(6)
	Extremely sufficient	13(1)	0	10(1)
Do you complete your own analysis of matches?	Yes	72(23)	84(16)	76(39)
	No	28(9)	16(3)	24(12)
If you answered 'Yes' to the previous question, how much time on average do you spend on PA following a match?	Does not apply	0	6(1)	3(1)
	<1 hour	22(5)	19(3)	21(8)
	1 – 1.5 hours	13(3)	44(7)	26(10)
	1.5 – 2 hours	35(8)	25(4)	31(12)
	2 – 2.5 hours	4(1)	0	3(1)
	2.5 – 3 hours	17(4)	6(1)	13(5)
	3 – 3.5 hours	0	0	0
	3.5 – 4 hours	0	0	0
	4 – 4.5 hours	4(1)	0	3(1)
	4.5 – 5 hours	4(1)	0	3(1)
	>5 hours	0	0	0
How often do you video training sessions?	Never	47(15)	53(10)	49(25)
	Rarely	19(6)	31(6)	24(12)
	Occasionally	25(8)	11(2)	20(10)
	Often	6(2)	5(1)	6(3)
	All the time	3(1)	0	2(1)
What are the benefits of videoing training sessions?	No benefit at all	0	0	0
	Assess effort	44(14)	68(13)	53(27)
	Assess tactical/spatial	66(21)	58(11)	63(32)

Question	Response	S%(n)	U20%(n)	C%(n)
	awareness			
	Assess technical capability	78(25)	58(11)	71(36)
	Assess movement related activity	53(17)	58(11)	55(28)
	Assess current form	44(14)	26(5)	37(19)
	Use as a visual coaching tool for players	56(18)	84(16)	67(34)

Note: Senior coaches (S), Under 20 coaches (U20) and levels combined (C)

3.3.3 Feedback process

Table 3.4 highlights several factors that affect coaches' ability to provide their players with feedback, namely: PA resources due to budget restraints (69%, n=35); general lack of available time (59%, n=30); availability of laptops, projector, etc. (49%, n=25); time taken to complete analysis (45%, n=23); and the time lost from training (45%, n=23). Coaches indicated that feedback sessions last between 11-20 minutes (33%, n=17), 21-30 minutes (16%, n=8) and 31-40 minutes (20%, n=10). During this time coaches spend somewhere between 0-20 minutes on each of the following feedback systems: match and player statistics, video feedback, feedback to individual players, feedback to small groups and time given to performance analysts to present findings.

Table 3.4: The coaches' perceptions of feedback.

Question	Response	S%(n)	U20%(n)	C%(n)
What factors affect your ability to provide feedback to your players and coaching staff?	Time taken to complete analysis	47(15)	42(8)	45(23)
	Time lost from training/practice due to feedback	47(15)	42(8)	45(23)
	General lack of time available	56(18)	63(12)	59(30)
	Availability of appropriate room or space for feedback sessions to whole group	22(7)	37(7)	28(14)
	Availability of laptops, PCs, data projector, projector screen, etc.	53(17)	42(8)	49(25)
	PA resources due to budget restraints	63(20)	79(15)	69(35)
	Players receptiveness to feedback	9(3)	21(4)	14(7)
	Other coaches/support staff receptiveness to feedback	0	0	0
	Usability of the information obtained	9(3)	21(4)	14(7)
	Reliability of the information obtained	0	0	0
	None of the above	0	0	0
	Other	0	0	0

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Question	Response	S%(n)	U20%(n)	C%(n)
Do you make use of any systems to remotely interact/share information with players on a feedback basis? If	Does not apply	69(22)	74(14)	71(36)
	Hudle	0	0	0
	Dartfish TV	0	0	0
	Dropbox	6(2)	5(1)	6(3)
	Google Drive	0	0	0
	Social media platforms	19(6)	21(4)	20(10)
	Other	6(2)	0	4(2)
How much time do you spend every week on the following feedback systems?				
Length of entire feedback session?	NA	13(4)	21(4)	16(8)
	0-10	13(4)	4(1)	10(5)
	11-20	38(12)	26(5)	33(17)
	21-30	6(2)	32(6)	16(8)
	31-40	22(7)	16(3)	20(10)
	41-50	3(1)	0	2(1)
	51-60	3(1)	0	2(1)
	61-90	3(1)	0	0
	91+		0	2(1)
Presenting match and player statistics?	NA	28(9)	47(9)	35(18)
	0-10	25(8)	16(3)	22(11)
	11-20	25(8)	0	16(8)
	21-30	3(1)	16(3)	8(4)
	31-40	16(5)	5(1)	12(6)
	41-50	0	5(1)	2(1)
	51-60	3(1)	5(1)	4(2)
	61-90	0	5(1)	2(1)
	91+	0	0	0
Presenting video feedback?	NA	31(10)	26(5)	29(15)
	0-10	13(4)	32(6)	20(10)
	11-20	13(4)	32(6)	20(10)
	21-30	16(5)	5(1)	12(6)
	31-40	16(5)	5(1)	12(6)
	41-50	10(3)	0	6(3)
	51-60	3(1)	0	2(1)
	61-90	0	0	0
	91+	0	0	0
Presenting feedback (stats & video) individual/players	NA	41(13)	42(8)	41(21)
	0-10	22(7)	37(7)	27(14)
	11-20	9(3)	11(2)	10(5)
	21-30	6(2)	11(2)	8(4)
	31-40	13(4)	0	8(4)
	41-50	3(1)	0	2(1)
	51-60	3(1)	0	2(1)
	61-90	3(1)	0	2(1)
	91+	0	0	0
Presenting feedback (stats & video) to small groups (e.g. forwards & backs)	NA	38(12)	42(8)	39(20)
	0-10	22(7)	26(5)	24(12)
	11-20	9(3)	26(5)	16(8)
	21-30	9(3)	5(1)	8(4)
	31-40	16(5)	0	10(5)
	41-50	0	0	0
	51-60	3(1)	0	2(1)
	61-90	3(1)	0	2(1)
	91+	0	0	0

Question	Response	S%(n)	U20%(n)	C%(n)
Time given to performance analyst to present match findings or statistics	NA	41(13)	42(8)	41(21)
	0-10	22(7)	26(5)	24(12)
	11-20	6(2)	11(2)	8(4)
	21-30	6(2)	21(4)	12(6)
	31-40	16(5)	0	10(5)
	41-50	0	0	0
	51-60	3(1)	0	2(1)
	61-90	0	0	0
	91+	6(2)	0	4(2)

Note: Senior coaches (S), Under 20 coaches (U20) and levels combined (C)

3.3.4 Implications for coaching process

Most coaches agreed that PA affects their player selection for the next match (61%, n=23), change of strategy for next match (58%, n=22) and short-term planning (58%, n=22) as can be seen in Table 3.5. Furthermore, 42% (n=16) and 39% (n=15) of coaches respectively, indicated that PA affects their medium- and long-term planning. Interestingly, 53% (n=20) of coaches said that PA information rarely or never influences their coaching sessions.

Table 3.5: Implications for coaching practice.

Question	Response	S%(n)	U20%(n)	C%(n)
Does any of the information that you receive, relating to PA, determine?	Short term planning	60(15)	54(7)	58(22)
	Medium term planning	52(13)	23(3)	42(16)
	Long term planning	48(12)	23(3)	39(15)
	Players you recruit	24(6)	8(1)	18(7)
	Players selection for the next match	68(17)	46(6)	61(23)
	Change of strategy for the following match	68(17)	38(5)	58(22)
	None of the above	4(1)	8(1)	5(2)
To what extent does the above information collected through PA influence your coaching session?	All the time	20(5)	23(3)	21(8)
	Often	8(2)	0	5(2)
	Occasionally	24(6)	15(2)	21(8)
	Rarely	48(12)	54(7)	50(19)
	Not at all	0	8(1)	3(1)

Note: Senior coaches (S), Under 20 coaches (U20) and levels combined (C)

3.3.5 Performance indicator parameters

Table 3.6 presents the coaches' responses regarding PIs. The study revealed that 25% (n=13) of coaches use PIs, and of these coaches, 54% (n=7) said there PIs varied from match to match while 31% (n=4) said they remained the same from match to match. Coaches indicated that they selected their PIs based on their opposition (69%, n=9),

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coaching philosophy (69%, n=9) and gut instinct (46%, n=6). Furthermore, they indicated that they were fairly (38%, n=5) and very (46%, n=6) confident in the ability of the PIs to predict success.

Table 3.6: Coaches' perceptions on the use of performance indicator parameters.

Question	Response	S%(n)	U20%(n)	C%(n)
Do you use performance indicators to code events from a match?	Yes	34(11)	11(2)	25(13)
	No	66(21)	89(17)	75(38)
If you answered 'Yes' to the previous question, do your performance indicators:	Remain consistent from match to match	36(4)	0	31(4)
	Change from match to match	9(1)	50(1)	15(2)
	Vary – some remain consistent while some are more flexible and will change	55(6)	50(1)	54(7)
What factors influence your selection of performance indicators?	Other coaches	18(2)	50(1)	23(3)
	Your opposition	73(8)	50(1)	69(9)
	Your coaching philosophy	64(7)	100(2)	69(9)
	Coaching literature	27(3)	0	23(3)
	Academic literature (PIs proven to predict success)	18(2)	0	15(2)
	Gut instinct	55(6)	0	46(6)
	Performance analyst	45(5)	0	38(5)
	Other	9(1)	0	8(1)
How confident are you that the performance indicators you measure are able to determine/predict the success of your team?	Not at all	0	0	0
	Not very	0	0	0
	Fairly	36(4)	50(1)	38(5)
	Very	45(5)	50(1)	46(6)
	Extremely	18(2)	0	15(2)

Note: Senior coaches (S), Under 20 coaches (U20) and levels combined (C)

3.3.6   *Value of performance analysis*

In Table 3.7, 40% (n=17) of coaches indicated that their team values PA extremely, 33% (n=14) of coaches indicated very while 12% (n=5) of coaches said their players do not value PA at all. In terms of the coaches' own value of PA, 80% (33) said they value it extremely, 17% (n=7) said very and one coach (2%, n=1) said not at all.

Table 3.7: The value of performance analysis according to the coaches.

Question	Response	S%(n)	U20%(n)	C%(n)
To what extent, in your opinion, does your team value the role of performance or match analysis?	Not at all	11(3)	14(2)	12(5)
	Not very	7(2)	7(1)	7(3)
	Fairly	4(1)	14(2)	7(3)
	Very	25(7)	50(7)	33(14)
	Extremely	54(15)	14(2)	40(17)
To what extent, in your opinion, does your team value the role of individual technique analysis?	Not at all	7(2)	0	5(2)
	Not very	11(3)	8(1)	10(4)
	Fairly	18(5)	15(2)	17(7)
	Very	14(4)	69(9)	31(13)
	Extremely	50(14)	8(1)	37(15)
How much do you as a coach value the use of PA?	Not at all	3(1)	0	2(1)
	Not very	0	0	0
	Fairly	0	0	0
	Very	14(4)	25(3)	17(7)
	Extremely	83(24)	75(9)	80(33)
How much do you as a coach value access to a performance analyst?	Not at all	3(1)	0	3(1)
	Not very	0	0	0
	Fairly	7(2)	0	5(2)
	Very	3(1)	30(3)	10(4)
	Extremely	87(26)	70(7)	83(33)
Please score the following statements about the usefulness of PA on a scale of 1 to 5. (1 representing unhelpful; 5 representing very useful).				
Evaluation of player performance	1	0	0	0
	2	0	0	0
	3	9(3)	16(3)	12(6)
	4	25(8)	37(7)	29(15)
	5	66(21)	47(9)	18(9)
Evaluating the effectiveness of your tactics, or game plan	1	0	0	0
	2	0	0	0
	3	16(5)	11(2)	14(7)
	4	22(7)	32(6)	25(13)
	5	63(20)	58(11)	61(31)
Evaluate players you are considering recruiting	1	6(2)	5(1)	6(3)
	2	9(3)	0	6(3)
	3	16(5)	37(7)	24(12)
	4	28(9)	32(6)	29(15)
	5	41(13)	26(5)	35(18)
Evaluate technical weaknesses of players	1	0	0	0
	2	0	0	0
	3	22(7)	11(2)	18(9)
	4	13(4)	37(7)	22(11)
	5	66(21)	53(10)	61(31)
Evaluate player fitness	1	0	0	0
	2	3(1)	0	2(1)
	3	19(6)	32(6)	24(12)
	4	22(7)	32(6)	25(13)
	5	56(18)	37(7)	49(25)

Question	Response	S%(n)	U20%(n)	C%(n)
Evaluate the effectiveness of the opposition	1	0	5(1)	2(1)
	2	0	11(2)	4(2)
	3	19(6)	21(4)	20(10)
	4	31(10)	37(7)	33(17)
	5	50(16)	26(5)	41(21)
Develop/introduce changes in your style/tactics/game plan	1	0	0	0
	2	6(2)	0	4(2)
	3	16(5)	11(2)	14(7)
	4	22(7)	32(6)	25(13)
	5	56(18)	58(11)	57(29)

Note: Senior coaches (S), Under 20 coaches (U20) and levels combined (C)

3.4 Discussion

The purpose of this study was to determine and compare the utilization of PA among Western Province Rugby Union Super League club rugby coaches. This discussion is organised under the following headings to maintain flow: response rate, demographic information, analysis process, feedback process, implications for coaching practice, performance indicator parameters, and the value of PA will be used.

3.4.1 Response rate

This study had an overall response rate of 75% in which the senior league coaches (80%, n=32) contributed to the highest participation rate. This was higher than previous studies which focused on similar populations; a study by Magwa (2015) had a response rate of 57% and another by Thomas *et al.* (2011) had a response rate of only 28%. In comparison to previous studies, this study had a very good response rate. This high response rate is possibly due to the primary researcher's persistence in follow up telephonic communications with coaches.

3.4.2 Demographic information

The participants used in this study differed from previous studies as it focused on coaches involved with amateur clubs in the Western Province Rugby Union Super League competition. Most coaches in this study were part-time coaches, although there were a few full-time coaches. Over half the coaches held World Rugby level 2 coaching qualifications with most of the other coaches holding only World Rugby level 1, and senior coaches held statistically significant (p=0.04) higher qualifications than under 20 coaches. These findings differ from those of Magwa (2015), who indicated that there was not one coach who held a World Rugby level 1 qualification, most coaches had

level 2 while the rest of the coaches held higher qualifications (World Rugby level 3 & South African Rugby Union levels 1, 2 & 3). In addition, most of these coaches, due to the higher level, were full-time coaches. Most of the target population for this study had only ever coached at Super League level with a handful having had experience coaching at university, provincial and international level. Senior coaches in this study had coached at higher levels than under 20 coaches, this finding was statistically significant (p=0.04). Nonetheless, the coaches in this study can be described as experienced as many of them had over 6 years' coaching experience, with some exceeding 16 years' experience.

3.4.3 Analysis process

The investigation into the use of PA by the coaches in this study revealed some concerning points. In contrast to the findings by Wright *et al*. (2012) and Magwa (2015), very few of coaches in this study had access to video footage after every game. Most of the coaches (16%, n=8) who did receive footage were senior coaches while there were significantly fewer under-20 coaches who had access to video. The coaches who received match footage tended to receive this footage up to 2 days after the match, further contrasting the study by Wright *et al*. (2012). In addition to poor access to video footage, most of the coaches did not use CNS or even PA companies to provide them with coded data. These findings suggest that 82% of coaches at club level are providing feedback to players based on recalled events and are not using a systematic approach to enhance their observations (Wright *et al*., 2012). Recall ability has been identified as being 59% accurate without reviewing the video of the performance (Laird and Waters, 2008). This suggests that coaches are not appropriately identifying areas of concern with the team and the players and, therefore, cannot provide their players with accurate feedback.

Most coaches (80%, n=41) do not receive any PA budget from their organisations which could be the possible contributing factor in their lack of access to video and CNS. The study further highlighted that coaches predominantly did not have access to a performance analyst, despite the belief by coaches that a strong working relationship with a performance analyst was extremely important. This finding highlights the fact that coaches were aware that having a performance analyst would be very beneficial. Most coaches (20%, n=10) who had the help of a performance analyst were provided

with match/notational analysis and technique analysis. These coaches spent approximately 1.5 to 3 hours a week reviewing the information with some spending over 5 hours reviewing this information. Despite not having PA resources, most coaches spend 1.5 to 2 hours a week performing their own PA, with or without PA tools. A high number of coaches performing their own analysis was also identified in previous studies (Wright *et al*., 2012; Magwa, 2015). PA use within training was also highlighted by coaches as being effective in measuring various aspects of their players but half the coaches did not have access to video footage during their training sessions. This emphasises the lack in PA resources available to coaches.

3.4.4 Feedback process

The lack of PA structures results in feedback being based on recalled events and subjective interpretation of this poor recall (Middlemas *et al*., 2017). Additionally, a previous study by Butterworth *et al*. (2012) indicated that coaches feel that PA reduces bias, therefore giving them a more objective opinion, therefore reducing subjective feedback. Subjective feedback is severely flawed and it is important that one keeps this in mind when reviewing the length of feedback from the coaches.

Based on the responses by coaches, feedback sessions last between 11-40 minutes. Previous research by Wright *et al*. (2016) suggests that players feel that feedback should not exceed 30 minutes. The current study highlighted that some coaches had feedback sessions of longer than 30 minutes (26%, n=13). Players feel that feedback sessions longer than 30 minutes are too long (Francis & Jones, 2014; Wright *et al*., 2016) and furthermore research has shown that individuals can only maintain focus for a maximum of 20 minutes (Bunce *et al*., 2010). Some coaches presented PA feedback to individuals (27%, n=14) and small groups (24%, n=12) in 0-10 minute sessions, but this feedback is largely subjective and based on recalled events. Key findings in this theme, the feedback process, highlighted several factors affecting the ability of coaches to provide feedback to players. These factors are the time taken to complete analysis; time lost from training due to feedback; availability of laptops and projectors; general lack of available time; and lack of PA resources due to budget constraints.

The use of video to provide feedback is popular amongst many coaches as it improves decision-making ability of players by improving their cognitive understanding of events that occur during matches (Wright *et al*., 2012). Most of the coaches from this study

indicated that they used video to provide feedback to their players. However, taking into consideration the responses by coaches on the availability of video, this most likely only occurs on an ad hoc basis. This suggests that coaches incorporate PA in preparation for games of significant importance (Wright *et al*., 2012). Players therefore mostly rely on the subjective feedback of the coaches and their own recollection of the game to evaluate their previous performance and prepare for upcoming matches.

3.4.5 Implications for coaching practice

One of the main purposes of PA is to help coaches make informed decisions, allowing them to appropriately alter and adapt training sessions thereby yielding the desired outcomes (O'Donoghue & Mayes, 2013; Wright *et al*., 2012). The most popular use for PA by the coaches in this study was to use it for player selection (61%, n=23) and change of strategy for the next match (58%, n=22); this would explain why coaches said that PA affects their short-term and medium-term planning. The results of this study for short- and medium-term planning, however, were not close to a unanimous agreement as found by Wright *et al*. (2012) and Magwa (2015). These findings suggest that coaches at amateur level are not using PA information sufficiently to inform their coaching process. This is possibly related to the quality of information provided, as many coaches do not have any form of CNS to record data and potentially align this information with video segments. This suggests that the PA performed by many coaches in this study is in the form of hand-written notes and manually-recorded statistics. This hand written statistics will not be as accurate as data generated from CNS, purely because the hand written statistics are being done live without the use of video footage and replays, as only 16% of coaches receive footage after every game. Further evidence of poor use of PA information is that 53% (n=20) of coaches indicated that PA rarely influenced their coaching sessions, which may also indicate a lack in the coaches confidence in the quality and accuracy of their PA information. This finding is completely contradictory to other findings where most coaches indicated that PA influenced their coaching practice all the time (Magwa, 2015; Wright *et al*., 2012).

3.4.6 Performance indicator parameters

It has been highlighted that PIs are used to provide routine feedback to the team and coaching staff on their performance (Bremner *et al.,* 2013; Sampaio & Leite, 2013). This study revealed that most coaches (60%, n=21) do not make use of PIs to highlight

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key events in a match. This can possibly be associated with the fact that most coaches (82%, n=42) do not have a CNS present at their club. The findings in this study did not yield similar results to previous studies by Wright *et al*. (2012) and Magwa (2015), who found that almost all the coaches used PIs to measure key behaviours of a match. In this study, coaches who used PIs indicated that their opposition, coaching philosophy and gut instinct influenced their selection of PIs which is in line with other studies (Magwa, 2015; Wright *et al*., 2012). Furthermore, more than half of the coaches (54%, n=7) indicated that their PIs vary from game to game, with some remaining the same. This supports previous findings (Wright *et al*., 2012), but also contrasts previous findings of coaches from the same location (Magwa, 2015). The varying PIs highlight that coaches use their coaching philosophy to adapt and change their strategies during live performances; the dynamic nature of the sport requires this skill and supports the statement that coaching is an art (Wright *et al*., 2012). The ability of the selected PIs to predict success was agreed by most coaches (61%, n=8).

3.4.7 Value of performance analysis

Despite the lack in use of PA tools by coaches in this study, most of the coaches indicated that they value PA as a coaching a tool, similar to previous studies (Butterworth *et al*., 2012; Wright *et al*., 2012, Magwa 2015). Furthermore, 83% (n=33) of coaches indicated that access to a performance analyst was extremely valued, there was a statically significant difference (p=0.01) between responses by senior and under 20 coaches. This indicates that coaches were aware of the work load and did not necessarily want an analyst for their input in selecting PIs as only a few coaches (38%, n=5) indicated that the performance analyst influenced their selection of PIs. Coaches felt that PA was valued by a player which is in accordance with other studies that have evaluated the opinion of PA by players (Francis & Jones, 2014; Wright *et al*., 2016). When asked to indicate what aspects of the coaching process PA were the most helpful, coaches indicated the evaluation of player performance, effectiveness of tactics/game plan, technical weaknesses of players, player fitness, opposition effectiveness and the introduction of new tactics/game plans. These indications by coaches further reiterate the fact that coaches value the use of PA and would use it should they have it available to them.

3.5 Conclusion

The findings of this study provide insight into the current utilization of PA by Western Province Rugby Union Super League club coaches and the specific aspects that contribute to their coaching practice. This study was novel to rugby, as well as the coaching levels involved. A major finding of this study was that most of the coaches do not have access to PA resources despite a general agreement among coaches that PA is extremely important and useful in improving team performance. Another major finding was that almost all coaches have no budget set aside by their club for PA systems. This has highlighted a need for investigation into the perception of PA by club committees. PA structures can be set up for a reasonable price and many clubs receive money from organisations; therefore, an analysis of the funds available to a club and how these funds are distributed could be beneficial. This type of study would also give an indication as to the financial situations of rugby clubs in the Western Cape and what their funds are spent on.

Future studies should investigate the use of PA by coaches of a similar level across different countries. This type of study will provide insight and a comparison into the global use of PA at an amateur/club level and possibly at academies. Understanding these trends would help provide insight into the development and utilisation of PA across competitive-rugby countries. This type of study could also be used to help understand the growth in competitiveness of the smaller international rugby unions.

3.6 Acknowledgements

3.7 References

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CHAPTER 4

RESEARCH ARTICLE 2:

RELIABILITY OF ENCODEPRORX PERFORMANCE ANALYSIS SYSTEM TO ASSESS RUGBY PERFORMANCE

This article will be submitted for publication in the International Journal of Computer Science in Sport. The article is included herewith in accordance with the guidelines for authors of this esteemed journal. However, to provide a neat and well-rounded final product for this thesis, the article has been edited to represent an actual published article as it would appear in this particular journal. This does not imply that the article has been accepted or will be accepted for publication. Consequently, the referencing style used in this chapter may differ from that used in the other chapters of this thesis.

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Reliability of EncodeProRX performance analysis system to assess rugby performance

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Field of study: Sport Science (Performance analysis)

Running title: Reliability of performance analysis system

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Reliability of EncodeProRX Performance Analysis System to Assess Rugby Performance

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ABSTRACT

In applied and research environments, there can only be confidence in the data generated from computerised notational systems, if it has undergone appropriate reliability testing. There are many of these systems on the market yet only a few have been tested for reliability. The aim of the study was, firstly, to determine the inter- and intra-coder reliability of the EncodeProRX™ PA software and secondly, to compare the coding proficiency of novice coders and an experienced coder. Five novice and one experienced coder each coded five international rugby matches and re-coded two of these matches for intra-coder reliability. The agreement in these reliability tests were measured using Cohen's kappa statistic (K). There was a good inter-coder agreement across all performance indicators (K=.79) with the strongest agreement for the set-piece (scrums and lineouts) (K=.93). Very good intra-coder reliability was also recorded for the coders; there was a mean of K=.82. Comparing the novice coders to the experienced coder showed a good mean agreement of K=.77. The study concluded that the EncodeProRX™ is a reliable computerised notational system that can be accurately and consistently used by novice coders with good understanding of operational definitions in a practical environment.

KEY WORDS: PERFORMANCE ANALYSIS, CODER RELIABILITY, COMPUTERISED NOTATIONAL SYSTEMS, VIDEO ANALYSIS, CODING.

4.1 Introduction

Performance analysis (PA) has grown significantly over the past decade, and is currently being used as a coaching and research tool to assess performance (Bampouras *et al*., 2012; O'Donoghue, 2010; Vahed *et al.,* 2016). PA is used by coaches to make

informed objective decisions about their team's performance; similarly, researchers use PA data to draw conclusions in their investigations. Therefore, for both coaching and research purposes, it is vital that the data generated are reliable (Bishop & Barnes., 2013; Higham *et al*., 2014; Hughes *et al*., 2012; Vahed *et al*., 2014; Vaz *et al*., 2011; Villarejo *et al*., 2015). The PA tool which is used by coaches and researchers to generate match data is called 'computerised notational systems' (CNS). CNS are computer-based programs, which allow coaches or analysts to log match events to produce quantitative data (O'Donoghue, 2010). Through the use of CNS coaches are able to categorise the actions that have occurred in a match to create an objective statistical analysis of the game. The statistical analysis can then be used in the feedback process to players (Carling *et al*., 2009).

CNS are not automated and are open to human error during data capturing (O'Donoghue, 2010). Accordingly, recent studies investigating aspects of PA, such as performance indicators associated with success in rugby, have started to use reliability tests to check their data (Bishop & Barnes., 2013; Higham *et al*., 2014; Hughes *et al*., 2012; Vaz *et al*., 2011; Villarejo *et al*., 2015). These studies generally use data captured by external match coding companies who use trained coders. In the practical environment, coaches typically capture their own data. For example, in a recent survey, 67% of semi-professional rugby coaches in South Africa indicated that they conduct their own PA (Magwa, 2015). It is essential that these systems used are tested for reliability (O'Donoghue, 2010), additionally the reliability amongst different coders is also required to determine the objectivity of the system (O'Donoghue 2007). This highlights the need for reliability testing when data is captured by coaches.

The reliability of a CNS can be determined by using inter- and intra-coder reliability tests (Bradley *et al.,* 2007; Larkin *et al*., 2016; Liu *et al*., 2017; O'Donoghue, 2007). K statistics, as highlighted by Choi *et al*. (2007), are then used to determine the level agreement (Higham *et al*., 2014; Larkin *et al*., 2016; Liu *et al*., 2017; Vaz *et al*., 2011; Villarejo *et al*., 2015). Prior to reliability testing, consistency and reduction in errors can be achieved through extensive training, the setting of clear operational definitions and supplementing operational definitions with example footage (O'Donoghue, 2010; Hughes *et al*., 2012; Liu *et al*., 2013).

There is a range of CNS on the market; however, there is only a few that have undergone reliability testing. Recently Liu *et al*. (2017) used four well-trained coders to code a single match (two coders coding each match). Using K and inter-class correlation, the authors concluded that the data-gathering methods used by OPTA Sportsdata™ had high levels of inter-coder reliability. Similarly, Bradley *et al*. (2007) used 14 participants (two teams of seven) to code one match. The teams consisted of a setup operator, four trained coders and two team leaders for control checking. Based on the K results, the authors concluded that ProZone MatchViewer™ had high levels of inter-coder reliability. These studies have all shown the reliability of systems from external match coding companies using experienced coders. To date, there is no system that has been tested for reliability in a practical context when used by coaches.

EncodePro™ is a South African-based company which has developed a CNS that is intended to be used by a coach or performance analyst. This software was designed for use by clubs and schools who do not have a lot of funding, and it is therefore priced well below many competitors. The CNS system does not require top of the range computers, it can operate smoothly and effectively on entry level i3 computers and is purely a windows based program. Additionally due to the current size of their operation and their client to staff ratio there is a good level of technical support and after sale service. The template design of the software has automated logical steps and automated event insertions built into it. For example, if a ruck has been logged, the coder cannot log another event such as a kick until the outcome of the ruck has been completed; also, should the outcome of the ruck be that it was won by the opposition then the software automatically logs in a turnover. Furthermore, performance indicators (PIs) such as possession and field of play percentages are automatically calculated by the software based on the team involved in the events being logged and the location of the event that is logged on the pitch layout. These automated processes and logical steps improve the coding time and reduce errors (Bradley *et al.*, 2007).

Based on this introduction, there is a clear need for CNS to be accessible to coaches and performance analysts who have undergone appropriate reliability testing. This study will attempt to firstly, determine the inter- and intra-coder reliability of the EncodeProRX™ PA software and secondly to compare the coding proficiency of novice coders and an experienced coder.

4.2 Research methodology

4.2.1 Study design

A quantitative study was performed. Figure 4.1 presents the data collection procedure. The participants in this study were required to undergo training on the software prior to commencement of the study. Once the training was completed, the coders were required to code five matches according to the set PIs in Table 4.2. After completion of this coding process they were required to re-code two randomly selected matches to test for intra-coding reliability. The primary researcher followed up with participants on a regular basis and collected all the data upon the completion of the coding.

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        │ and copying of video footage │
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        │      Reliability coding     │
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        │  Data collection and analysis │
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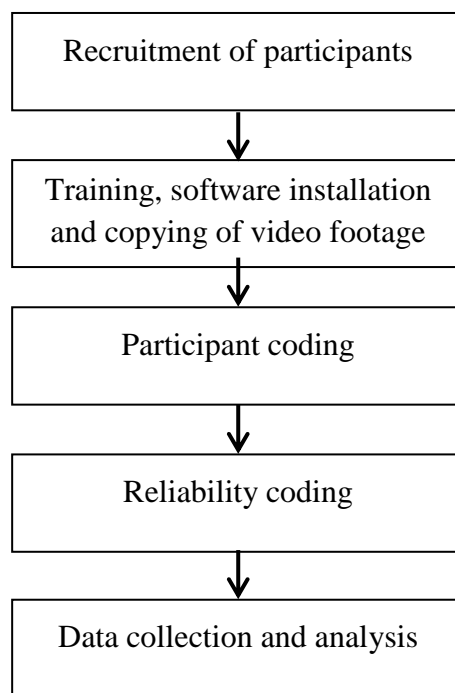
Figure 4.1. Illustration of the study design.

4.2.2 Participants

The participants for this study consisted of five (n=5) novice coders with no experience with computerised notational analysis. They were all Western Province Rugby Union club coaches participating in the Super League. One (n=1) experienced coder in the use of EncodeProRX™ also participated.

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4.2.3 Data collection procedure

4.2.3.1 Recruitment

Coaches were identified based on inclusion and exclusion criteria. Coaches were included if they had no current access to or experience using a CNS. Coaches were excluded from this study if they failed to complete the coding of all the matches. The coaches were telephonically contacted to ask if they were willing to participate. During the telephonic communication, the primary researcher described the objectives of the study, what would be required of the participant and how long the study would take. Coaches were then requested to indicate if they would be available to participate in the study. Six participants agreed to participate in the study.

4.2.3.2 Training

Training was conducted by the primary researcher who followed the training protocol as presented in Table 4.1. The training programme consisted of training on how to use the software, followed by operational definition explanation for the various PIs and a coding walk through. Before training commenced, the primary researcher loaded the software as well as the five televised matches onto the participants' laptops.

Table 4.1: Training protocol used for the study participants.

Detail	Description
Software navigation and match set up	The participant was guided through the general layout of the software and the process of inserting team names for the games that will be coded. The participant was also shown how to set up a new game to commence with coding (selecting teams, period, date, venue, pitch conditions, tag mode and kick off direction). All matches were logged as home games, the home team was coded as "Us", the blue team, and the away team was coded as "Them", the red team.
Navigating coding panel	The event log was shown and explained, as well as the location of all the relevant PIs on the coding layout screen.
Saving and editing	The process to save and exit and then edit existing games was shown.
Correcting errors	Re-coding events using the event log, in the case of an error during event logging, was explained and presented.

Detail	Description
Back-up	Participants were shown the back-up process, both local and remote, in order to avoid accidental loss of data.
Explanation of PIs and operational definitions	The study investigator and the participants worked through the PIs together to make sure the participant fully understood the PIs and operational definitions.
Coding walk through	The participant coded the first 20 minutes of match footage and logged the relevant PIs. The primary researcher oversaw this process to confirm their understanding of operational definitions and to assist the participant with any problems that arose. The match was specifically selected so that the 20 minutes of coding training exposed the participants to all the relevant PIs.

4.2.3.3 Coding

Participants in this study were required to code five international televised matches that were randomly selected by the primary researcher from an International Rugby Union tournament. After completion, they had to-recode two of these games randomly selected by the primary researcher. Participants had 10 weeks to complete the seven matches.

4.2.3.4 Performance Indicators

The PIs with operational definitions are presented in Table 4.2.

Table 4.2. PIs with operational definitions used in this study.

Performance indicators	Operational definitions
Possession	When a player is carrying the ball or a team has the ball in its control.
Scrum	Players from each team come together in scrum formation and play is restarted by throwing the ball into the tunnel of the scrum. Won A scrum is won when the team that put the ball in retains possession afterwards. Lost A scrum is lost when the team that put the ball in does not retain possession afterwards.
Lineout	A lineout is formed when at least two players from each team come together and form two lines; play is restarted by throwing the ball between the two lines of players.

Performance indicators	Operational definitions
	<u>Won</u> A lineout is won when the first person who gains possession of the ball is a team mate of the person who threw the ball in. <u>Lost</u> A lineout is lost when the first person who gains possession of the ball is an opposition player of the person who threw the ball in.
Handling error	<u>Knock on</u> When ball possession is lost in a forward direction or hits the player's arm or hand and goes forward and hits the ground or another player before the original player can catch it. <u>Forward pass</u> Occurs when the player throws or passes the ball in a forward direction to a team player.
Penalty kick	<u>Penalty kick</u> A kick awarded to the non-offending team after an infringement by its opponents. The referee indicates what the infringement was.
Free kick	<u>Free kick</u> A kick awarded to the non-offending team after an infringement by its opponents. The referee indicates what the infringement was.
Turnover	<u>Turnover</u> Turnovers occur when a team who did not have possession of the ball gains possession of the ball. This can be at a ruck, maul, scrum, lineout, at tackle (when a turnover occurs during the tackle), general play.
Tackle	<u>Tackle made</u> A tackle is successfully made if a player is brought to ground by one or more defenders. <u>Tackle missed</u> A tackle is missed when: - A defender reaches for an attacking player in attempt to tackle him but does not make contact; or - A defender makes contact but is then pushed off by the attacker.
Maul	A maul is formed when the ball carrier and at least one player from each team are bound and on their feet contesting for the ball. <u>Won</u> A maul is won when the team who entered the maul with possession of the ball retains possession. <u>Lost</u> A maul is lost when the team who entered the maul with possession of the ball does not retain possession.
Ruck	A ruck is formed when at least one player from each team makes contact over the ball on the ground in competition to win the ball. <u>Won</u>

Performance indicators	Operational definitions
	A ruck is won when the team who entered the ruck with possession of the ball retains possession. Lost A ruck is lost when the team who entered the ruck with possession of the ball does not retain possession.
Kick attack	An attacking player kicks the ball tactically or territorially. Drop kick – when the ball is kicked over the poles by dropping it and kicking it after it has touched the ground. - Complete – ball is successfully kicked over the posts - Incomplete – ball is not successfully kicked over the post Chip ahead – when the ball is kicked a short distance in attempt to regain possession by any attacking player. - Complete – possession is retained after the kick - Incomplete – possession is lost after the kick Up and under – ball is kicked high and chased down by attacking players. - Complete – possession is retained after the kick - Incomplete – possession is lost after the kick Grubber – when the ball is hacked forward on the ground in attempt to regain possession by any attacking player. - Complete – possession is retained after the kick - Incomplete – possession is lost after the kick Field position – a long kick for territory which may or may not find touch - Complete – the kick finds touch resulting in a gain in ground - Incomplete – the kick does not go into touch Box kick – when the ball is kicked from the base behind a ruck, maul, scrum or lineout (usually by halfback). - Complete – the kick finds touch resulting in a gain in ground or possession is retained after the kick - Incomplete – possession is lost after the kick

4.2.4 Statistical analysis

The data were exported from the EncodeProRX software into Excel by the primary researcher and corresponding events based on time and outcome were identified. If coders missed an event identified by other coders, an empty row was inserted, indicating that a particular event was missed. The inter- and intra-coder reliability were tested using Cohen's K to measure the agreement of the nominal variables between coders as well as between each coder's re-coding (intra-reliability). The interpretations

of agreement of the K-values are indicated in Table 4.3. 95% Confident Intervals (CI) and a significant level of 5% were applied.

Table 4.3: Agreement interpretation for K-values

K-Value	Interpretation of agreement
<0	Less than chance agreement
.01 –.20	Poor agreement
.21 –.40	Fair agreement
.41 –.60	Moderate agreement
.61 –.80	Good Agreement
.81 –.99	Very good agreement

Source: (Altman, 1991)

4.3 Results

The coders (C) used in this study are referred to as C1, C2, C3, C4, C5 (novice) and C6 (experienced) in this results section. The results are discussed under the following headings: inter-coder reliability, intra-coder reliability and comparison between novice and experienced coders.

4.3.1 Inter-coder reliability

Table 4.4 below shows the K values, level of agreement and confidence intervals for the PIs coded. These K values show the agreement between the coders in identifying the same outcome for PIs that were logged by every coder; for example, scrum won. Six of the PIs had very good agreement, namely, scrum, lineout, handling error, tackle, maul and ruck. The PI that had the least agreement, with a K=.55 was free kicks.

Table 4.4: Inter-coder reliability presented as K -values and confidence intervals, PI – performance indicator, CI – Confidence Interval.

PI	K-value	Agreement interpretation	CI
Scrum	.93	Very good	0.88-0.97
Lineout	.93	Very good	0.89-0.96
Handling error	.90	Very good	0.77-1.00
Penalty kick	.55	Moderate	0.48-0.61
Free kick	.66	Moderate	0.17-1.00
Turnover	.70	Good	0.61-0.77
Tackle	.83	Very good	0.72-0.90
Maul	.92	Very good	0.82-1.00
Ruck	.92	Very good	0.90-0.95
Kick attack	.60	Moderate	0.56-0.64

4.3.2 Intra-coder reliability

The intra-coder reliability K-scores are depicted in Table 4.5. The experienced coder (C6) had the strongest agreement K=.94, between his two re-coded games. All the coders had good or very good levels of intra-coder reliability.

Table 4.5: Intra-coder reliability presented as K-values and confidence limits, CI – confidence interval.

Coder	K value	Agreement interpretation	CI
1	.73	Good	0.70-0.77
2	.80	Good	0.78-0.83
3	.78	Good	0.75-0.81
4	.85	Very good	0.83-0.87
5	.82	Very good	0.80-0.85
6	.94	Very good	0.92-0.96

4.3.3 Comparison between novice and an experienced coder

Table 4.6 below indicates the K-values for each novice coders' agreement with the experienced coder. C2 and C4 K=.81 and K=.84 respectively means that they were very similar to the experienced coder.

Table 4.6. Comparison between novice and to experienced coders.

Coder	K-value	Agreement interpretation
1 vs 6	.69	Good
2 vs 6	.81	Very good
3 vs 6	.72	Good
4 vs 6	.84	Very good
5 vs 6	.79	Good

4.4 Discussion

This study determined the inter- and intra-coder reliability of the EncodeProRX™ PA software and compared the coding proficiency of novice coders to an experienced coder. The findings of the study are discussed under the following headings: inter-coder reliability, intra-coder reliability and comparison between novice and an experienced coder.

4.4.1 Inter-coder reliability

There was a good agreement across the various PIs measured (mean of Ҡ=.79). Compared to studies with data generated from external companies, the agreement is not as strong (generally Ҡ≥.90) (Bradley, 2007; Larkin *et al*., 2016; Liu *et al*., 2017). The set-piece, namely scrum and lineout PIs, had the strongest agreement across all coders. The nature of the set-piece allows for strong agreement due to the stoppage in play which can draw the attention of the coder and therefore increase their focus (Franks & Miller, 1986). The other PIs that had high levels of agreement were handling error, ruck, tackle and maul with the tackle having the lowest agreement, although it was still very good. The PIs: scrum, lineout, ruck and maul all have basic outcomes that are easily identifiable, these being won, lost, penalty and free kick. Similarly, handling errors also had easily identifiable outcomes of knock-on and forward pass, which is further indicated with appropriate signals by the referee. The easily-identified outcomes ensured strong agreement among coders. The PIs: tackle, had the lowest Ҡ-value among the PIs with strong agreements. Although the outcomes for tackles were only made, missed and penalty, there was still some disagreement among coders. Tackle missed was given clear operational definitions; however, the subjectivity in determining if the tackle was indeed missed is made clear by the weaker agreement between coders.

Penalty and free kicks, although all the coders correctly identified them, had moderate agreements for the outcomes. A possible reason for this could be that referee signals at times were not clear and precise; therefore, these events require good rugby law knowledge to identify accurately what the referee has penalised the infringer for. Kick attack and turnover did not have good agreement; this could be due to poor understanding of operational definitions. The primary researcher noticed that one particular coder only logged one type of kick. Although the kicks logged matched the times with the other coders, C1 only logged field position kicks, thus not distinguishing between the different kick types. Turnover locations were not well agreed upon; this is due to "grey" areas on which coders had different opinions. For example, in many cases the ball is turned over in a contact situation, and coders disagreed whether the turnover occurred in the tackle or once the ruck had already formed.

To summarise, there were PIs that had very good agreement; this occurred with PIs that were "black and white". Many of the inconsistencies were due to poor understanding of

operational definitions. Although there were differences across the different coders, the intra-coder reliability results (discussed in the next session) shows that the coders were consistent in "their" understanding of the operational definition.

4.4.2 Intra-coder reliability

Intra-coder reliability showed strong and very strong agreement with an average K=.82 (very strong). This confidently shows that the coders could operate the system consistently. The findings show that the experienced coder (C6) had the strongest consistency (K=.94) which is to be expected. An experienced coder has years of experience, and as highlighted by Liu *et al*. (2017) and O'Donoghue (2007), a strong familiarity with the software use and a strong understanding of operational definitions will strengthen intra-coder reliability.

4.4.3 Comparison between novice and an experienced coder

The objective of this comparison was to determine if the EncodeProRX software can be operated by coders and coaches without extensive training. This comparison showed good and very good agreements between the novice coders and the experienced coder. These findings indicate that a PA system is objective and can be effectively used by coders (O'Donoghue, 2007). The EncodeProRX system which the coders used has automated logical steps and automated event insertions built into it. For example, if a ruck has been logged, the coder cannot log another event such as a kick until the outcome of the ruck has been completed; also, should the outcome of the ruck be that it was won by the opposition then the software automatically logs in a turnover. These automated processes and logical steps improve the coding time and reduce errors (Bradley *et al.,* 2007). This is evident in the strong agreements found.

4.5 Conclusion

The present study has determined the inter- and intra-coder reliability of the EncodeProRX match analysis system and found it to be reliable. The strong agreements for the PIs such as scrums, lineouts, free kicks, tackles, mauls and rucks has deemed this system reliable in measuring these PIs in practical and research environments. The good agreements in the intra-coder study shows that the system can be used consistently with a good understanding of operational definitions by coders. The inter-operator agreement in this study (K=.79; good agreement) is similar, although not as strong, to those found

by Bradley *et al.* (2009) and Liu *et al.* (2017). These two studies tested inter-operator agreement using different CNS and found mean inter-operator agreements for the respective systems to be K=.93 (Liu *et al.*, 2017) and K=.99 (Bradley *et al.*, 2009). This study has proven the EncodeProRX system to be an acceptable tool to be used in a practical environment by coaches and performance analysts who do not have experience with CNS. This is achieved through the software's logical steps that need to be completed by the coder during the coding process.

The comparison between novice coders and an experienced coder yielded some varying results, with some coders agreeing strongly with the experienced coder, and others only having good agreement. Further research is required to investigate these differences; these studies could possibly investigate the effect of age, computer literacy and coaching experience on coding ability. Future studies could also possibly investigate the systems inter-reliability agreement among only the experienced coder and further investigation into the inter-coder reliability of PIs for individual players rather than only team PIs. Using experienced coders or even just younger coders may yield better inter-coder agreement as this study included two noticeably weaker coders.

4.6 Acknowledgements

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CHAPTER 5

SUMMARY, CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

This chapter is included herewith in accordance with the referencing style of the Department of Sport Science, Stellenbosch University.

5.1   Summary

Performance analysis (PA) is a very popular topic in sport science due to its wide use across many different sporting codes. There is literature that has investigated the use of PA among coaches; however, there is no research that has done this with club coaches in the Western Province Rugby Union. The same can be said for literature investigating the reliability of computerised notational systems (CNS). There are systems that have been tested for reliability but many systems have not. The CNS that are currently being used most commonly among club coaches in the Western Province are EncodeProRX™, Stratus™, Longo Match™ and Sportscode™ specifically the coding function namely Gamebreaker™.

The first objective of this study was to determine and compare the use of PA among Western Province Rugby Union Super League club rugby coaches. This was carried out with the aim of providing insight into how widely PA is currently being used in the practical environment. The second objective of this study was twofold: firstly, to determine the inter- and intra-coder reliability of the EncodeProRX™ PA software and secondly to compare the coding of novice versus an experienced coder. This was carried out with the aim of checking the reliability of an affordable CNS that can be used by coaches in South Africa. EncodeProRX™ is an affordable South African CNS that can be used by coaches at school and club level.

This study was presented in four main parts, which consisted of an introduction and problem statement (Chapter 1), a literature review (Chapter 2), research article one (Chapter 3) and research article two (Chapter 4). The article format of the thesis was approved by the Senate of Stellenbosch University and the two research articles were presented in accordance with the guidelines of the specific journals.

Chapter 1 of this thesis introduced the problem and stated the objectives, it also further motivated the study. The literature review (Chapter 2) focused on the importance of PA and how it is integrated into the coaching and feedback process. There was also a focus on how CNS are used in PA and reliability issues surrounding these systems. The chapter emphasised that PA is a valuable tool in the coaching and feedback process and is currently being used widely by semi-professional and professional coaches. It was highlighted that the use of PA has grown and there is a large demand for it by players.

The use of PA by many coaches and researchers who draw conclusions from the data produced, has raised concerns about the reliability of the systems being used. The literature showed that reliability testing of the data used in research has increased, but it was also highlighted that many of the systems available to coaches in the practical environment still lack reliability testing.

Chapter 3 was written as a research article: 'Utilisation of PA among Western Province Rugby Union club coaches'. The results in this study indicated that only 16% of coaches have access to video footage after every game; furthermore 80% of coaches do not use a PA company; 82% do not have access to a CNS; and 80% do not have access to a performance analyst. These values make sense due to the fact that 80% of coaches do not receive a budget for PA resources. Despite this 76% of coaches still perform their own analysis, many of these without the use of video and CNS. Coaches revealed that despite not having PA tools, 80% of coaches value PA strongly and 83% value access to a performance analyst. These findings highlight an unfavourable situation where players are being coached ineffectively based on the subjective opinions of their coaches. These players could possibly feed into provincial and national teams which affects our selection pool at higher levels.

Chapter 4 was written as a research article: 'Reliability of EncodeProRX PA system to assess rugby performance'. The results in this study showed very good inter-coder reliability agreement on most of the performance indicators measured, namely scrums (K=.93), lineouts (K=.93), handling errors (K=.90), tackles (K=.83), mauls (K=.92) and rucks (K=.92). There was an average agreement of K=.79 across all the performance indicators. The intra-coder reliability showed an agreement rating of K=.82 (very strong). In the comparison of novice coders to an experienced coder, there were two coders with very good agreement (K=.81 and K=.84) and three coders with good agreement (K=.69, K=.72 and K=.79). From these results, it can be concluded that EncodeProRX has good inter- and intra-coder reliability as well as a good agreement between novice coders and an experienced coder.

To summarise, the majority of coaches in the Western Province, South Africa, value PA but are unable to utilise it due to financial restraints and poor education in the use of free PA systems. This leads to player feedback in the coaching process being inadequate and subjective based on recalled events. It has been highlighted in the literature that this

is a very ineffective coaching method. The study further proved the reliability of an affordable South African developed CNS which, with a short basic training programme could lead to accurate use by inexperienced coders.

5.2   Conclusions

The conclusions drawn from this research study were presented in accordance to the set objectives in Chapter 1.

5.2.1   Research Article 1: Utilisation of performance analysis among Western Province Rugby Union club coaches.

This study identified that PA is not used by many Super League club rugby coaches in the Western Province Rugby Union. Budget constraints seem to be the main contributing factor to this issue, which was evident in the available PA budgets and availability of PA tools that coaches reported. Coaches indicated that they value PA and agree that it has a significant impact on the coaching and feedback process. The fact that coaches are not using CNS, even though there are free systems available, suggests that they have not been educated about them. Current coaching courses do not expose coaches to these systems that are available to them and to PA in general. Intervention from the Western Province Rugby Union is needed to uplift and empower these coaches with the tools they need to successfully carry out PA. Achieving this may increase the quality of the players available for selection at higher levels.

5.2.2   Research Article 2: Reliability of EncodeProRX performance analysis system to assess rugby performance.

This study determined the inter- and intra-coder reliability of the EncodeProRX™ PA system and found it to be reliable. The inter-coder reliability proved that performance indicators such as scrums, lineouts, free kicks, tackles, mauls and rucks have very strong agreement across different coders. The intra-coder reliability indicated that this system can be used consistently by the same coder with precise operational definitions and a sufficient training protocol. The comparison between novice and an experienced coder showed good agreement overall; however, there was some variation between coders and further research is required to investigate factors causing this variation. Ultimately this study concluded that coders who follow clear and precise operational definitions and undergo a training protocol similar to the one used in this study will be

able to operate this system accurately and effectively. This study proved EncodeProRX™ to be an acceptable field based tool that can be used by coders/coaches who do not have experience working with CNS.

5.3   Limitations

The following limitations were made clear during this study:

- The questionnaire used in this study was too long. Many coaches started the questionnaire but failed to complete it due to time constraints, if it were not for the primary researcher's persistence there would have been fewer respondents. Many coaches have full time jobs, for most of them a 20-30 minute questionnaire is too long. Future questionnaires should probably take 5-10 minutes.

- The operational definitions used for some of the events such as kick attack lacked some clarity. This reiterates the importance of clear and precise operational definitions.

- A big challenge was to get coders to participate in this study. Each coder had to log approximately 4000 events. This required a lot of time for coaches who had a full-time job. Future studies should look to reduce the number of performance indicators being measured, to ultimately reduce the number of events, thus decreasing the coding time required.

- Due to time restrictions, the training sessions in this study were somewhat short. This involved rushing through the training protocol. As a result, there was insufficient time for coders to practise their coding under the guidance of the primary researcher. This led to issues surrounding identification of events according to the operational definitions.

- The use of one experienced coder in research article two limits the conclusions that one can draw from the results. If there was perhaps five experienced coders and 5 inexperienced coders then there could have been a better investigation into the comparison of inexperienced versus experienced coders.

5.4   Future Research

The results of this study highlighted some interesting points in the availability of PA resources that are in contrast with other research; however, the studies were done on different levels of coaches. Future studies should investigate the utilisation of PA at

club level across different international unions, perhaps those involved in the Rugby Championship. This will provide insight into the use of PA at an amateur level globally. An interesting comparison, for example, would be to investigate the PA structures of New Zealand clubs compared to South African clubs.

The inter- and intra-coder reliability investigation of the EncodeProRX™ PA software should be repeated to investigate the reliability of player performance indicators. These player-performance indicators are logged in order to measure player work rates and effectiveness in their specific roles. For this type of reliability test, due to the difficulty involved, it is recommended that experienced coders should be used in order to improve agreement through reduced coding errors. The comparison between novice coders and an experienced coder highlighted some differences between the coding ability of novice coders. Further research can possibly investigate these differences by exploring the effect of age, computer literacy and coaching experience on the coding ability of novice coders in a practical setting.

APPENDIX A: INSTRUCTIONS FOR AUTHORS

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Updated February 2017

APPENDIX B: INSTRUCTIONS FOR AUTHORS:

INTERNATIONAL JOURNAL OF COMPUTER SCIENCE IN SPORT

Guidelines for Authors

Bloggs, J.

University of Vienna, Department of Biomechanics, Kinesiology and Applied Computer Science, Country

Abstract

This document describes the formal guidelines for composing an article for the "International Journal of Computer Science in Sport" (IJCSS). In addition the most important rules of the "APA Style Sixth Edition" (short: "APA 6th ed."), the style of citing and quoting in this journal, are described.

KEYWORDS: IJCSS, TEMPLATE, GUIDELINES

Introduction

The "Guidelines for Authors" defines the formal rules such as font and styles for writing and gives further links to more detailed information. Given examples are highlighted in grey. At the end of this document the basic rules of the APA Style Sixth Edition (short: "APA 6th ed."), citation style are explained.

Rules for Content, Font and Styles

The article must be in American English using SI units. Use font Times New Roman size 12 throughout the text, fully justified, indented by 3cm from both sides. Number the pages consecutively, with no line numbering and no 'headers and footers' (other than page numbers), and without footnotes unless these are absolutely necessary. Arrange the article under headings (such as Introduction, Methods, Results, Discussion, Conclusion, and References) and subheadings.

Headlines

To structure your article use the style sheets, "Section_Headline_IJCSS" (Arial 12, bold),   "Subsection_Headline_IJCSS"   (Arial   12,   bold   and   italic)   and "Subsubsection_Headline_IJCSS" (Times New Roman 12, italic).

Title

The title is the first summary of the issue. It ***should*** shortly explain the outcome of the article. Title and subtitle are separated by a hyphen "-". Each word starts with a capital letter, except conjunction such as "and", "or", "a", "on" etc. Use font Times New Roman size 18 and bold style print (see Example 1).

Real-Time Training and Coaching Methods Based on Ubiquitous Technologies – An Illustration of a Mobile Coaching Framework

Example 1. Title and subtitle.

Institution

Authors and institution must be written in size 12 and in italics. Sur- and forename of multiple authors are separated by a comma. The first name(s) is/are abbreviated with the first letter of the name (see Example 2).

If the authors are from different institutions, they get assigned with suspended numbers to their affiliated institution (see Example 3).

Novatchkov, H., Bichler, S., Tampier, M., Kornfeind, P. Department of Biomechanics, Kinesiology and Computer Science, Faculty of Sport Science, University of Vienna, Auf der Schmelz 6A, 1150 Vienna, Austria

Example 2. Authors and institution.

Fischer, A.[1], Do, M.[2], Stein, T.[1], Asfour, T.[2], Dillmann, R.[2], Schwameder, H.[1]

[1]Instititute of Sports and Sport Science, Karlsruhe Institute of Technology

[2]Instititute for Anthropomatics, Karlsruhe Institute of Technology

Example 3. Multiple authors from different institutions.

Abstract

The abstract must not exceed 200 words and it should summarize the paper, giving a clear indication of the conclusions it contains. It must be inserted in the article after the authors' addresses, indented by 1 cm from both sides of the normal text. The abstract must not contain figures or tables (see Example 4).

Abstract

1 cm

There is common agreement that an appropriate framework for training and adaptation needs to consider the complexity and non-linearity of athletic performance and its response to training. General concepts …

1 cm

Example 4. Abstract.

Keywords

Keywords categorize your article and are placed after the abstract. You can use up to five keywords written in capital letters. Try to use keywords from the IEEE Approved Indexing

Keyword List for a standardized characterization of your article (see Example 5).

KEYWORDS: SPORTS EQUIPMENT, AD HOC NETWORKS, INTERNET TOPOLOGY

Example 5. Keywords.

Introduction

The introduction explains your motivation for your research described in the article. It contains background information, chains of thoughts, preliminary studies or other reasons that have led to the current issue.

Methods

The methods give an accurate explanation of your analyses. Examples are the kinds of equipment being used, the procedure of the research, the in- and exclusion criteria, characterization of the subject group etc.

Results

This section presents results from the research procedures described in the "Methods". For better understanding it is recommended to use tables and figures. The "Results" does not contain any discussion or conclusion.

Tables and Figures

Photographs and line drawings (referred to as 'Figure 1.', 'Figure 2.') should be placed below the figure and must be numbered in the same order as they occur in the text (see Example 7).
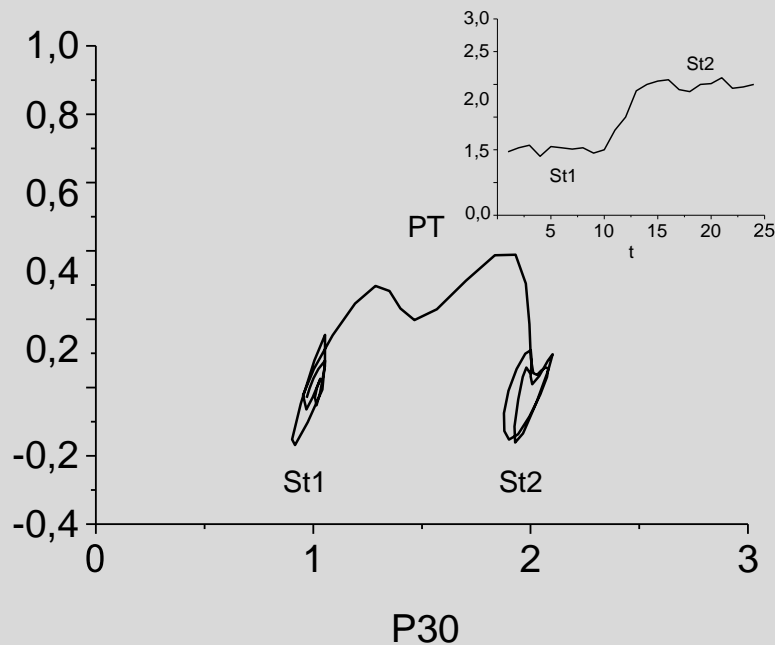
Figure 1. Phase plot of a fictitious time series P30(t) (chart in the upper right). From the phase plots the states

Example 7. Figure.

Illustrations, plates, tables and any other artwork should be included in the electronic submission. Tables must be clearly and simply laid out with clear row and column legends, units where appropriate, no vertical lines and horizontal lines only between the table title and column headings, between the column headings and the main body of the table, and after the main body of the table. Tables (referred to as 'Table 1.', 'Table 2.' etc.) should be placed over the table and must be numbered in the order in which they occur in the text. Make sure all shortcuts occurring in the table are explained in the table description (see Example 6).

Table 1. Mean comparison test between the assessments of the single tests for the male subjects, Wilcoxon

Technique	Practice-Test vs. PCR-Test	Practice-Test vs. PCSM-Test	PCR-Test vs. PCSM-Test
Gyaku-Zuki	0.94	0.262	0.012
Gyaku-Zuki over run	0.81	0.98	1.00
Gyaku-Zuki (left)	0.035	0.001	0.002
Ura-Mawashi (rear leg)	0.034	0.023	0.452
Kiza/Maw.(r.l.)	0.067	0.048	0.187
subj.1			
Mawashi (f.l.) subj.1	0.41	0.022	0.001
Kiza/Maw.(r.l.) subj.3	0.44	0.177	0.406
Mawashi (f.l.) subj.3	0.014	0.023	1.00

Example 6. Table.

Discussion

The results of the current research are discussed against the background of existing studies. Differences and similarities are interpreted, leading to the conclusion of the article. You can suggest further research possibilities.

Conclusion

The conclusion should sum up the main results of the research.

Citation and References

The IJCSS uses the "APA 6th ed." style for quoting literature. The following section describes the most important rules of this style. For further information about special shapes visit the homepage http://www.apastyle.org/. In order to follow all rules, the use of citation programs,
e.g. "Citavi" (http://www.citavi.com/), is highly recommended.

Quoting in Text

Books and articles need to have the same style of citation in text. Example 8 shows how to apply this rule for one author (1). If you refer to a work with two authors you need to cite both of the names in the text. Concerning articles written by three to five authors, cite all their names the first time you refer to their work in the text (3, 4). For further citations only mention the first author's name and add the abbreviation "et al." (2). For more than five authors you only need to cite the name of the first author and add "et al.". (see Example 8).

(1)	…results of matches of the Euro 2008 soccer tournament (O'Donoghue, 2009).
(2)	Bideau et al. (2010) and Vignais et al. (2009) use VR to analyze…
(3)	…in athletic training (Chang, Lin, & Chang, 2005; Leser, Uhlig, & Uhlig 2009) and…

Example 8. Citing a piece of literature in text.

Block Quotation

Longer quotes have to be presented as a separate paragraph with each line indented 1cm from both margins using font size 11 and written in italics. The quote must be followed by the name of the author, the year of publication and the page number (see Example 9).

1 cm *The essential part of his demonstration is the result not of mere observation but of the application of Galileo´s principle of measurement. He showed first that the blood can only leave the ventricle of the heart in one direction. (Fung, 1993,* **1 cm**

Example 9. Block quotation.

References

All sources have to be listed in alphabetical order at the end of the article. The title of this section is called "References". The APA Style demands hanging paragraphs and in general all single pieces of information (authors, publication date, title …) are separated by full stops. This section describes the quotation of articles in journals and books (monography) in detail. The style of other sources such as legislative texts, conference transcripts or articles in a collected edition differs slightly and is depicted on the APA homepage.

Articles in Journals

Example 10 shows how to list an article in a journal in your reference list. The name of the journal and the volume are written in italics.

Author   Publication   Title of the

Lees, A., Graham-Smith, P., & Fowler, N. (1994). A biomechanical analysis

of the last stride, touchdown, and takeoff characteristics of the mens long jump. *Journal of applied biomechanics, 10*(1), 61–78.

Page numbers

Name of the journal   *Volume*
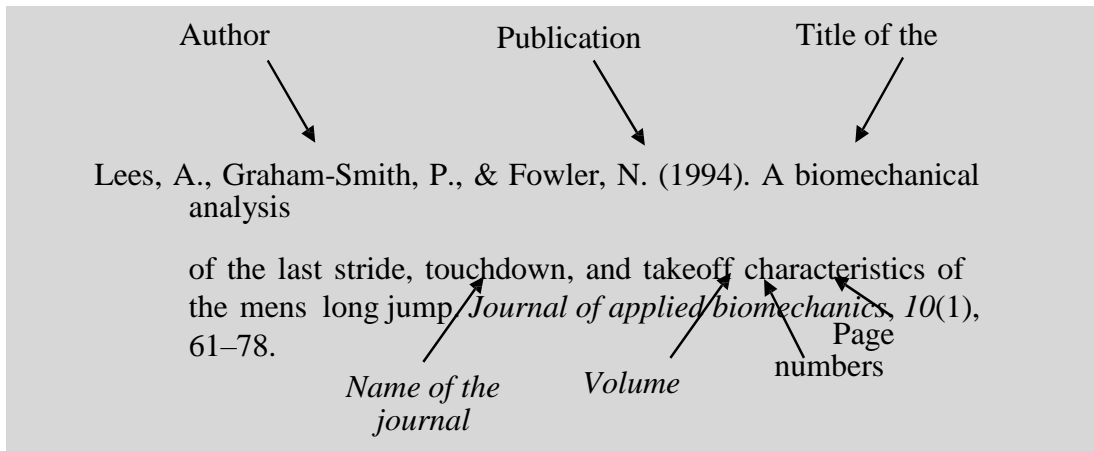
Example 10. Article listed in the reference list.

Sometimes you might have to quote an article in another language (see Example 11). In this case the title of the article has to be translated, put in square brackets "[ ]" and listed after the original title.

The sample in Example 11 also includes a DOI ("Digital Object Identifier") number, which is used the same way as ISBN numbers for books. If you search the number on http://www.doi.org/, this unique code leads you directly to the publisher homepage where you can find the article information and usually also a link to a digital version.

Original title of the

Herrmann, S., Lenz, R., Geier, A., Lehner, S., Souffrant, R., Woernle, (2012).   Modellierung   des Gelenks   Dynamisch   patellare   Führun g
Analyse   der
[Musculoskeletal modeling of the patellofemoral joint:

Dynami c 252–

analysis of patellar tracking]. *Der Orthopäde, 41*(4), doi:10.1007/s00132-011-1851-1

DOI
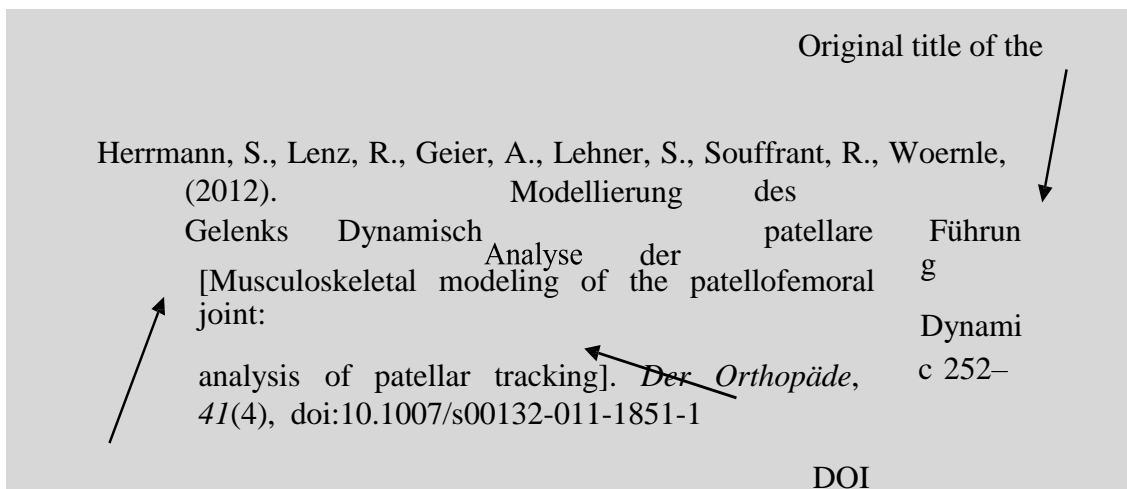
Example 11. Quotation of an article in another language.

Books (Monography)

Example 12 shows a quotation of a book. Title and subtitle (separated by a colon ":")

are written in italics.
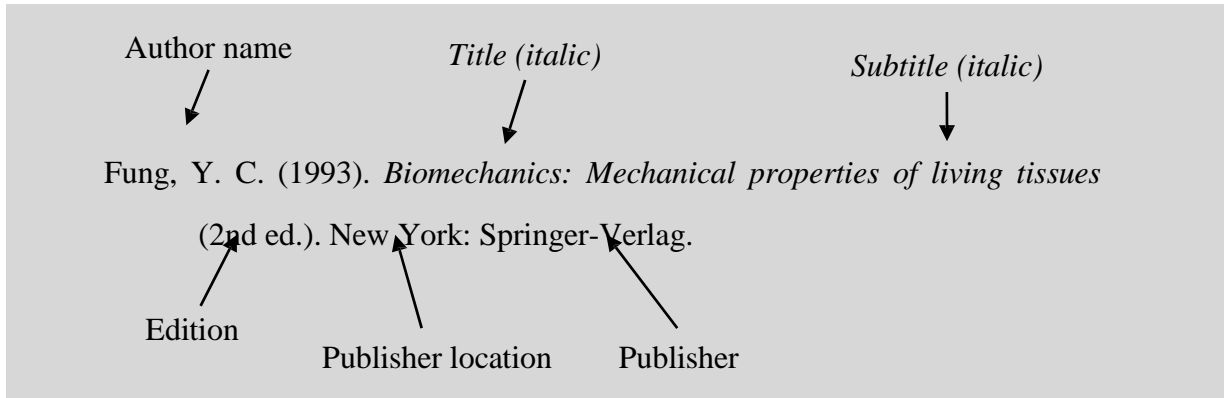
Example 12. Quotation of a book.

Other Examples

In the following other examples are listed.
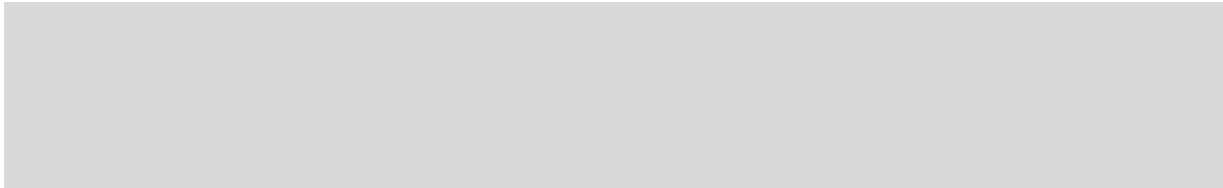
Example 13. Article in a published proceeding.

Csapo, R. (2010). *Acute changes in muscle architecture in response to resistance exercise* (Dissertation). University of Vienna, Vienna.

Example 14. University publications.

Biomechanics (2012). Retrieved October 11, 2012, from http://www.brianmac.co.uk/biomechanics.htm.

Example 15. Web site.

Imgrad, S., & Wobl, K. (2011). *Virtual Reality*. Humans and Computer, London.

Example 16. Unpublished Presentation.

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APPENDIX C: INFORMED CONSENT FORM: ARTICLE ONE

STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Utilisation of Performance Analysis among Western Province Club Rugby Coaches. Article One

You are asked to participate in a research study conducted by Heinrich Painczyk (MSc Sport Science) from the Department of Sport Science at Stellenbosch University. The results obtained from the study will contribute to my Master's Thesis in Sports Science. You were selected as a possible participant in this study because you fit the criteria of being a Head or Assistant Coach of a first or U20 team in a Western Province Super League (WPSL) rugby club. This study consists of two parts and, therefore, has two consent forms. This consent form refers to the first part of the study.

1.   PURPOSE OF THE STUDY

The objective of this study is to determine the utilisation of performance analysis among WPSL club rugby coaches.

2.   PROCEDURES

If you volunteer to participate in this study, we would ask you to complete a questionnaire. The questionnaire will gather information on your engagement with computerised notational system's (CNS's) and your perception of the performance analysis process. The survey will also attempt to gather information on the time spent on analysis and the extent to which it is used by the participant and his/her club.

3.   POTENTIAL RISKS AND DISCOMFORTS

This study does not carry any risks to the participants who partake in this study.

4.   POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Participating in this study will provide the rugby environment with significant insight on WPSL club rugby coach's perception of performance analysis and how performance analysis is integrated in various WPSL club rugby structures.

5.   PAYMENT FOR PARTICIPATION

You will not receive any payment or remuneration for participating in this study.

6.   CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be

maintained by means of storing the data on a password protected personal computer. The study researcher and study leader will have access to the data. The data will remain anonymous at all times.

If the article is published, no participant names will be mentioned, only results will be made known.

7. PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. The researchers may terminate participation of an individual if, at any time during the study, it is discovered that the individual was untruthful regarding inclusion and exclusion criteria.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact:

Heinrich Painczyk:
Phone: 082 213 8818
E-mail: rugbyresearch@sun.ac.za

Wilbur Kraak:
Phone: (021) 808 2448
E-mail: kjw@sun.ac.za

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to me by Heinrich Painczyk in English and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study. I have been given a copy of this form.

_____
Name of Subject/Participant

_____
Name of Legal Representative (if applicable)

_____   _____
Signature of Subject/Participant or Legal Representative   **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ and/or his/her representative _____. He/she was encouraged and given ample time to ask me any questions. This conversation was conducted in English and this conversation was translated into _____ by _____.

_____   _____

Signature of Investigator   **Date**

APPENDIX D: INGELIGTE TOESTEMMINGSVORM: ARTIKEL EEN

UNIVERSITEIT STELLENBOSCH
INWILLIGING OM DEEL TE NEEM AAN NAVORSING

Benutting van prestasie-ontledings in Wes-Kaap klubrugby afrigters. Artikel Twee

U word vriendelik versoek om aan 'n navorsingstudie uitgevoer deur Heinrich Painczyk (MSc Sport Wetenskap), van die Departement van Sportwetenskap aan die Universiteit Stellenbosch deel te neem. Die resulate verkry sal bydrae tot my Meesters Tesis in Sport Wetenskap. U is as moontlike deelnemer geïdentifiseer omdat u aan die kriteria voldoen deurdat u 'n Hoofafrigter of Assistent afrigter vir of 'n eerste of U20 span in 'n Westerlike Provinsie Super Liga (WPSL) is. Hierdie studie bestaan uit twee dele en het daarom twee toestemmings vorms. Hierdie toestemmings vorm verwys na die eerste deel van die studie.

1. DOEL VAN DIE STUDIE

Die doel van die studie is om die gebruik van prestatsie analise onder Westerlike Provinsie Super Liga (WPSL) klubrugby afrigters te bepaal.

2. PROSEDURES

Indien u toestemming verleen om aan die studie deel te neem sal u gevrae word om 'n vaelys te voltooi. Die vraelys is gerig op inligting versamel rakende u betrokkenheid met gerekenariseerde notileerings stelsels en u persepsie van prestatsie analise. Hierdie opname sal ook poog om inligting te bekom rakende die tyd wat daar aan analise spandeer word en die mate waarin dit deur die deelnemer en sy/haar klub gebruik word.

3. MOONTLIKE RISIKO'S EN ONGEMAKLIKHEID

Die studie hou nie risiko's vir die deelnemers in nie.

4. MOONTLIKE VOORDELE VIR PROEFPERSONE EN/OF VIR DIE SAMELEWING

Deelname aan die studie sal die rugby omgewing voorsien met beduidende insig rakende WPSL klubrugby afrigter's se persepsie van prestasie analise en hoe prestasie analise geïntegreer is met verskeie WPSL klubrugby strukture.

5. VERGOEDING VIR DEELNAME

U sal geen betaling of vergoeding ontvang vir deelname aan die studie nie.

6. VERTROULIKHEID

Enige inligting wat deur middel van die navorsing verkry word en wat met u in verband gebring kan word, sal vertroulik bly en slegs met u toestemming bekend gemaak word of soos deur die wet vereis. Vertroulikheid sal gehandhaaf word deur middel van die storing van data op 'n wagwoord beskermende persoonlike

rekenaar. Slegs die studie ondersoeker en studie leier sal toegang tot die data hê. Die data sal ten alle tye anoniem bly.

Indien die artikel gepubliseer word, sal geen deelnemer se naam bekend gemaak word nie, slegs resultate sal bekend gemaak word.

7.   DEELNAME EN ONTTREKKING

U kan self besluit of u aan die studie wil deelneem of nie. Indien u inwillig om aan die studie deel te neem, kan u te eniger tyd u daaraan onttrek sonder enige nadelige gevolge. U kan ook weier om op bepaalde vrae te antwoord, maar steeds aan die studie deelneem. Die ondersoeker kan u aan die studie onttrek indien omstandighede dit noodsaaklik maak. Die ondersoeker mag die deelname van 'n deelnemer beëindig indien, gedurende enige periode van die studie, dit ontdek word dat die deelnemer leuenagtig was met betrekking tot die insluiting en uitsluiting van kriteria.

8.   IDENTIFIKASIE VAN ONDERSOEKERS

Indien u enige vrae of besorgdheid omtrent die navorsing het, staan dit u vry om in verbinding te tree met:

Heinrich Painczyk:
Phone: 082 213 8818
Epos: rugbyresearch@sun.ac.za

Wilbur Kraak:
Phone: (021) 808 2448
Epos: kjw@sun.ac.za

9.   REGTE VAN PROEFPERSONE

U kan te eniger tyd u inwilliging terugtrek en u deelname beëindig, sonder enige nadelige gevolge vir u. Deur deel te neem aan die navorsing doen u geensins afstand van enige wetlike regte, eise of regsmiddel nie. Indien u vrae het oor u regte as proefpersoon by navorsing, skakel met Me Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] van die Afdeling Navorsingsontwikkeling.

VERKLARING DEUR PROEFPERSOON OF SY/HAAR REGSVERTEENWOORDIGER

Die bostaande inligting is aan my gegee en verduidelik deur Heinrich Painczyk in Afrikaans en ek is dié taal magtig of dit is bevredigend vir my vertaal. Ek is die geleentheid gebied om vrae te stel en die vrae is tot my bevrediging beantwoord.

Ek willig hiermee vrywillig in om deel te neem aan die studie. 'n Afskrif van hierdie vorm is aan my gegee.

_____
Naam van proefpersoon/deelnemer

_____
Naam van regsverteenwoordiger (indien van toepassing)

_____   _____
Handtekening van proefpersoon/deelnemer of regsverteenwoordiger   Datum

VERKLARING DEUR ONDERSOEKER

Ek verklaar dat ek die inligting in hierdie dokument vervat verduidelik het aan _____ en/of sy/haar regsverteenwoordiger _____. Hy/sy is aangemoedig en oorgenoeg tyd gegee om vrae aan my te stel. Dié gesprek is in Afrikaans gevoer en die gesprek is in _____ vertaal deur _____.

_____   _____

Handtekening van ondersoeker   **Datum**

APPENDIX E: INFORMED CONSENT FORM: ARTICLE 2

STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Reliability of EncodeProRX performance analysis system to assess rugby performance. Article Two

You are asked to participate in a research study conducted by Heinrich Painczyk (MSc Sport Science) from the Department of Sport Science at Stellenbosch University. The results obtained from the following study will contribute to my Master's Thesis in Sports Science. You were selected as a possible participant in this study because you fit the criteria of being a Level 2 qualified Western Province Super League (WPSL) club rugby coach and have no current computerized notational system (CNS) in place within your coaching structure. This study consists of two parts and, therefore, has two consent forms. This consent form refers to the second part of the study.

1. PURPOSE OF THE STUDY
The first objective is to determine inter and intra-reliability of the EncodePro rugby coaching software. The second objective is to determine and compare the coding ability of a novice versus an experienced coder.

2. PROCEDURES

If you volunteer to participate in this study, we would ask you to do the following things:

You will be required to complete the coding/computerized notation of 15 recorded Rugby Union fixtures at your own time and place of convenience over a period of 3-4 months.

3. POTENTIAL RISKS AND DISCOMFORTS

This study does not carry any risks to the participants who partake in this study.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

The scientific community will gain insight on the reliability of the EncodeProRX as a research tool, and its reliability as a coaching tool in the Rugby Union environment. Participants who participate in this study will benefit from the studies remuneration which is explained in the following section.

5. PAYMENT FOR PARTICIPATION

You will not receive payment for your involvement in the study, however, remuneration will be received. Remuneration will be received in the form of a year's free EncodeProRX license to the value of R4400. This remuneration will only be given to participants who complete the study fully. To complete the study fully, participants need to complete all questionnaires to the best of their ability as well as code and submit all 15 Rugby Union fixtures.

6.   CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of storing the data on a password protected personal computer. The study researcher and study leader will have access to the data. The data will remain anonymous at all times.

If the article is published, no participant names will be mentioned, only results will be made known.

7.   PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. The researchers may terminate participation of an individual if, at any time during the study, it is discovered that the individual was untruthful regarding inclusion and exclusion criteria.

8.   IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact:

Heinrich Painczyk:
Phone: 082 213 8818
E-mail: rugbyresearch@sun.ac.za

Wilbur Kraak:
Phone: (021) 808 2448
E-mail: kjw@sun.ac.za

9.   RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to me by Heinrich Painczyk in English and I am in command of this language or it was satisfactorily translated to me. I was given the opportunity to ask questions and these questions were answered to my satisfaction.

I hereby consent voluntarily to participate in this study. I have been given a copy of this form.

_____
Name of Subject/Participant

_____
Name of Legal Representative (if applicable)

_____   _____
Signature of Subject/Participant or Legal Representative   **Date**

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ and/or his/her representative _____. He/she was encouraged and given ample time to ask me any questions. This conversation was conducted in English and this conversation was translated into _____ by _____.

_____   _____
Signature of Investigator   **Date**

APPENDIX F: INGELIGTE TOESTEMMINGSVORM: ARTIKEL TWEE

UNIVERSITEIT STELLENBOSCH
INWILLIGING OM DEEL TE NEEM AAN NAVORSING

Benutting van prestasie-ontledings in Wes-Kaap klubrugby afrigters. Artikel Twee

U word vriendelik versoek om aan 'n navorsingstudie uitgevoer deur Heinrich Painczyk (MSc Sport Wetenskap), van die Departement van Sportwetenskap aan die Universiteit Stellenbosch deel te neem. Die resulate verkry sal bydrae tot my Meesters Tesis in Sportwetenskap. U is as moontlike deelnemer gekies omdat u aan die kriteria voldoen deurdat u 'n vlak 2 gekwalifiseerde Westerlike Provinsie Super Liga (WPSL) klubrugby afrigter is en omdat u geen gerekenariseerde notileerings sisteem in plek het in u afrigting struktuur nie. Die studie bestaan uit twee dele en het dus twee toestemmings vorms. Hierdie toetemmings vorm verwys na die tweede deel van die studie.

1. DOEL VAN DIE STUDIE

Die eerste doelwit van die studie is om die inter en intra-betroubaarheid van die EncodePro rugby afrigtings program te bepaal. Die tweede doelwit is om die kodering vermoë van 'n ervare kodeerder en 'n beginner te bepaal en te vergelyk.

2. PROSEDURES

Indien u inwillig om aan die studie deel te neem, vra ons dat u die volgende moet doen:

Daar sal van u verwag word om 15 opgeneemde Rugby Unie wedstryde volledig te kodeer op u eie tyd oor 'n periode van 3-4 maande.

3. MOONTLIKE RISIKO'S EN ONGEMAKLIKHEID

Die studie dra geen risiko's vir die deelnemers.

4. MOONTLIKE VOORDELE VIR PROEFPERSONE EN/OF VIR DIE SAMELEWING

Die wetenskaplike gemeenskap sal insig rondom die betroubaarheid van die EncodeProRX program as 'n ondersoek hulpmiddel verkry, en die betroubaarheid van die program as 'n afrigters hulpmiddel in die Rugby Unie omgewing. Deelnemers aan hierdie studie sal voordeel trek uit die studie se vergoeding, wat in die volgende seksie verduidelik word.

5. VERGOEDING VIR DEELNAME

U sal geen betaling ontvang vir deelname aan die studie nie, maar u sal wel vergoeding ontvang. Vergoeding sal in die vorm van 'n jaar EncodeProRX lisensie met 'n waarde van R4400 ontvang word. Hierdie vergoeding sal slegs aan delenemers gegee word wat die studie voltooi. Om die studie volledig te voltooi moet deelnemers alle vraelyste voltooi na die beste van hul vermoëns, asook om al 15 Rugby Unie wedstryde te kodeer en in te dien.

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6.   VERTROULIKHEID

Enige inligting wat deur middel van die navorsing verkry word en wat met u in verband gebring kan word, sal vertroulik bly en slegs met u toestemming bekend gemaak word of soos deur die wet vereis. Vertroulikheid sal gehandhaaf word deur middel van die storing van data op 'n wagwoord beskermende persoonlike rekenaar. Slegs die studie ondersoeker en studie leier sal toegang tot die data hê. Die data sal ten alle tye anoniem bly.

Indien die artikel gepubliseer word, sal geen deelnemer se naam bekend gemaak word nie, slegs resultate sal bekend gemaak word.

7.   DEELNAME EN ONTTREKKING

U kan self besluit of u aan die studie wil deelneem of nie. Indien u inwillig om aan die studie deel te neem, kan u te eniger tyd u daaraan onttrek sonder enige nadelige gevolge. U kan ook weier om op bepaalde vrae te antwoord, maar steeds aan die studie deelneem. Die ondersoeker kan u aan die studie onttrek indien omstandighede dit noodsaaklik maak. Die ondersoeker mag die deelname van 'n deelnemer beëindig indien, gedurende enige periode van die studie, dit ontdek word dat die deelnemer leuenagtig was met betrekking tot die insluiting en uitsluiting van kriteria.

8.   IDENTIFIKASIE VAN ONDERSOEKERS

Indien u enige vrae of besorgdheid omtrent die navorsing het, staan dit u vry om in verbinding te tree met:

Heinrich Painczyk:
Phone: 082 213 8818
Epos: rugbyresearch@sun.ac.za

Wilbur Kraak:
Phone: (021) 808 2448
Epos: kjw@sun.ac.za

9.   REGTE VAN PROEFPERSONE

U kan te eniger tyd u inwilliging terugtrek en u deelname beëindig, sonder enige nadelige gevolge vir u. Deur deel te neem aan die navorsing doen u geensins afstand van enige wetlike regte, eise of regsmiddel nie. Indien u vrae het oor u regte as proefpersoon by navorsing, skakel met Me Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] van die Afdeling Navorsingsontwikkeling.

VERKLARING DEUR PROEFPERSOON OF SY/HAAR REGSVERTEENWOORDIGER

Die bostaande inligting is aan my gegee en verduidelik deur Heinrich Painczyk in Afrikaans en ek is dié taal magtig of dit is bevredigend vir my vertaal. Ek is die geleentheid gebied om vrae te stel en my/sy/haar vrae is tot my/sy/haar bevrediging beantwoord.

Ek willig hiermee vrywillig in om deel te neem aan die studie. 'n Afskrif van hierdie vorm is aan my gegee.

_____
Naam van proefpersoon/deelnemer

_____
Naam van regsverteenwoordiger (indien van toepassing)

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_____   _____
Handtekening van proefpersoon/deelnemer of regsverteenwoordiger   Datum

VERKLARING DEUR ONDERSOEKER

Ek verklaar dat ek die inligting in hierdie dokument vervat verduidelik het aan _____ en/of sy/haar regsverteenwoordiger _____. Hy/sy is aangemoedig en oorgenoeg tyd gegee om vrae aan my te stel. Dié gesprek is in Afrikaans gevoer en die gesprek is in _____ vertaal deur _____.

_____   _____
Handtekening van ondersoeker   **Datum**

APPENDIX G: PERFORMANCE ANALYSIS QUESTIONNAIRE

MSc Sport Science study – Performance Analysis Questionnaire

To whom it may concern:

Thank you for participating in this MSc Sport Science study and giving your valuable time to assist.

This questionnaire will help us to investigate the use of Performance Analysis amongst coaches of Western Province Super League rugby clubs.

Scientific journal publication may follow, with the results/findings presented purely from a group perspective: participant anonymity assured.

Before commencing, please ensure that you have read and **understood** the questionnaire, and **signed** the 'Informed Consent Form'.

The questionnaire should take approximately twenty minutes.

Please scan, and email to rugbyresearch@sun.ac.za the:

- Completed Performance Analysis Questionnaire
- Signed 'Informed Consent Form'

Alternatively, I can collect the material. If any problems/questions arise, contact using the above email.

Please familiarise the Glossary of Terms below.

Read the questions carefully and circle your selected answer/s.

Kind Regards,

Heinrich Painczyk (Study Investigator)

Dr. Wilbur Kraak (Supervisor)

Dr. Sharief Hendriks (Co-supervisor)

Glossary of Terms

- **Match/notational analysis** – Procedures used for disciplines (Rugby in this case), which require assessment and analysis of performance (Hughes and Franks, 2004).

- **Performance analysis** – Systematic observation creates an accurate record of performance; which is analyzed with an objective of promoting positive change (Bishop, 2003).

- **Performance Analyst** – A person responsible for Performance analysis on behalf of the coach, this may involve recording matches, performing Match/notational analysis and providing feedback to players, the Performance Analyst forms part of the coaching staff.

- **Performance analysis agency/service provider** – A third–party, contracted to provide performance Match analysis services, this may involve anything from match video recording to performing Match/notational analysis. Employed on a per-match or contractual basis the third-party does **not** form part of the coaching or management staff.

- **Performance Indicator** – An objective 'variable' typically used to assess a player's performance; these indicators, selected by the coach, Performance Analysts, and players, are tested for reliability and validity (Butterworth *et al.,* 2013).

- **Coding** – The process where a coach or Performance Analyst, using a computerized notational analysis system, captures the Performance Indicators and links these indicators to video footage for viewing and technical analysis.

- **Coding errors** – These are errors where the coder selects the wrong event or outcome and realises that he has logged an event incorrectly.

- **Movement analysis/assessment** – Used to assess and improve the techniques and skills required of the player.

- **Individual technique analysis** – Analysing specific skills or actions of a player, for example, a kicker's kick, or a hooker's throw.

- **Computerised notational system** – A system used to code matches to produce match statistics, video clips, or to flag events during a game for review and feedback.

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Name: _____   Date: ___/___/20___

Club: _____

<div align="center">

*** **START OF QUESTIONNAIRE** ***

</div>

1. **What is your gender?**
   a. Male
   b. Female

2. **How old are you?**
   a. 18 – 24 years
   b. 25 – 29 years
   c. 30 – 34 years
   d. 35 – 39 years
   e. 40 – 44 years
   f. 45 – 49 years
   g. 50 years or older

3. **What is your highest current coaching qualification?**
   a. IRB (World Rugby) Level 1
   b. IRB (World Rugby) Level 2
   c. IRB (World Rugby) Level 3
   d. SARU Level 1
   e. SARU Level 2
   f. SARU Level 3
   g. Other, please specify:

   _____

4. **What coaching qualification (if any) are you working towards?**
   a. None
   b. IRB (World Rugby) Level 1
   c. IRB (World Rugby) Level 2
   d. IRB (World Rugby) Level 3
   e. SARU Level 1
   f. SARU Level 2
   g. SARU Level 3
   h. Other, please specify:

   _____

5. **How many years, of rugby coaching experience, do you have?**
   a. Less than 5 years
   b. 6-10 years
   c. 11-15 years

d.   16+ years

6. **What is the highest level you have coached at?**
   a.   International – Teams representing their country
   b.   National – Super Rugby
   c.   Provincial – Vodacom Cup
   d.   Varsity Cup
   e.   Super League – Club rugby
   f.   1st Team High school
   g.   Other, please specify:

   _____

7. **What is your current level of coaching?**
   a.   Super League A
   b.   Super League B
   c.   Super League C
   d.   Other, please specify:

   _____

8. **Which of the following best describes your current coaching position?**
   a.   Full-time coach
   b.   Part-time coach
   c.   Part-time coach, supplemented by other activities within the same organisation
   d.   Volunteer

9. **How many years, of coaching experience do you have with your current team?**
   (Please fill in the current year you are completing with your team, for example, if you have completed 2 years and this is the 3rd year; your answer is 3 years.)

   ☐   Years

10. **Please identify the age group of players you currently work with.**
    a.   Under 20's
    b.   Seniors

11. **Do you have access to, or are you provided with a video / DVD / edited clips, following each match?**
    0-   Not at all
    1-   Rarely
    2-   Occasionally
    3-   Often
    4-   All the time

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12. On average, how long does it take before you receive the above video/DVD after a match?
   a. Not applicable
   b. The same day as the match
   c. The following day
   d. Two days after the match
   e. Three days after the match
   f. Four days after the match
   g. Five days or more after the match
   h. Other, please specify:

   _____

13. Do you use a Performance analysis agency/service provider for performance analysis services? (see Glossary of Terms)
   a. Yes
   b. No

14. If you answered 'Yes' to the previous question, what services do they provide? (SELECT AS MANY AS APPROPRIATE):
   ☐ Video of own performance
   ☐ Videos of the opposition
   ☐ Recruitment videos
   ☐ Scouting reports
   ☐ Match statistics of own game
   ☐ Match statistics of the opposition's game
   ☐ Player statistics/work rate of own game
   ☐ Player statistics/work rate of opposition's game
   ☐ Other, (please specify)

_____
_____

15. Do you or your club have a computerised notational system which is used for analysis? (see Glossary of Terms)
   a. Yes
   b. No

16. Which computerised notational system, do you have access to?
   a. None
   b. EncodeProRX
   c. Dartfish
   d. Sportcode
   e. ProZone
   f. Verusco
   g. Fairplay

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     h. Stratus
     i. Statspro
     j. Do not know
     k. Other, (please specify) _____

17. Do you have access to a Performance Analyst? (see Glossary of Terms)
     a. Yes
     b. No

18. If you answered 'Yes' the above question, with what does your Performance Analyst provide you?
     a. Match/notational analysis
     b. Individual technique analysis
     c. Both (a & b)

19. How important would you consider a good working relationship with your Performance Analyst, to be?
     0- Not at all
     1- Not very
     2- Undecided
     3- Somewhat
     4- Extremely

20. If Match analysis (videos, clips, reports, shooting percentages, etc.) are provided by a Performance Analyst; how much time is spent reviewing this information per week?
     a. Does not apply
     b. 0 – 30mins (Less than 0.5 hours)
     c. 31 – 60mins (0.5 – 1 hour)
     d. 61 – 90mins (1 – 1.5 hours)
     e. 91 – 120mins (1.5 – 2 hours)
     f. 121 – 150mins (2 – 2.5 hours)
     g. 151 – 180mins (2.5 – 3 hours)
     h. 181 – 210mins (3 – 3.5 hours)
     i. 211 – 240mins (3.5 – 4 hours)
     j. 241 – 270mins (4 – 4.5 hours)
     k. 271 – 300mins (4.5 – 5 hours)
     l. More than 300mins (More than 5 hours)

21. Do you complete your own analysis of matches?
     a. Yes
     b. No

22. If you answered 'Yes' to the previous question, how much time on average do you spend on Performance analysis following a match?

    a. Does not apply

    b. 0 – 60mins (less than 1 hour)

    c. 61 – 90mins (1 – 1.5 hours)

    d. 91 – 120mins (1.5 – 2 hours)

    e. 121 – 150mins (2 – 2.5 hours)

    f. 151 – 180mins (2.5 – 3 hours)

    g. 181 – 210mins (3 – 3.5 hours)

    h. 211 – 240mins (3.5 – 4 hours)

    i. 241 – 270mins (4 – 4.5 hours)

    j. 271 – 300mins (4.5 – 5 hours)

    k. More than 301mins (more than 5 hours)

23. Do you complete your own Individual technique analysis (computer/video aided) of your players? (see Glossary of Terms)

    a. Yes

    b. No

24. What elements of performance analysis do you use or have access to? (SELECT AS MANY AS APPROPRIATE):

- ☐ None
- ☐ View video of the full match
- ☐ View edited clips from the match
- ☐ View edited clips of key action points, i.e. set plays, scrums, line-outs
- ☐ View edited clips of specific players
- ☐ Use full video for feedback to other coaches and support staff
- ☐ Use video clips for feedback to other coaches and support staff
- ☐ Show full match to players and identify positive & negative aspects of play
- ☐ Use video or clips for feedback to the whole team
- ☐ Use video or clips for feedback to players individually
- ☐ Use video or clips for feedback to small groups of players
- ☐ Quantitative data, i.e. match statistics
- ☐ Written match reports, including statistics
- ☐ Motivational DVDS
- ☐ Videos of opposition
- ☐ Scouting reports on the opposition
- ☐ Videos of prospective players
- ☐ Live coding / analysis during the match
- ☐ Half time feedback
- ☐ Full time feedback available immediately in dressing rooms after full time
- ☐ Full time feedback shortly after full time (2-3 hours afterwards)
- ☐ Technical analysis of sporting actions

☐ Other, (please specify)

_____

_____

25. Does any of the above information (in Q24) that you receive, relating to Performance analysis, determine (SELECT AS MANY AS APPROPRIATE):

 ☐ Short term planning
 ☐ Medium term planning
 ☐ Long term planning
 ☐ Players you recruit
 ☐ Player selection for the next match
 ☐ Change of strategy for the following match
 ☐ None of the above

26. To what extent does the above information (in Q24) collected through performance analysis influence your coaching sessions?

 0- Not at all
 1- Rarely
 2- Occasionally
 3- Often
 4- All the time

27. Do you use Performance Indicators to code events from a match? (See Glossary of Terms)

 a. Yes
 b. No

28. If you answered 'Yes' to the previous Question, do your Performance Indicators:

 a. Remain consistent from match to match
 b. Change from match to match
 c. Vary - some (key ones) remain consistent while some are more flexible and will change from match to match
 d. Does not apply

29. What factors influence your selection of Performance Indicators? (SELECT AS MANY AS APPROPRIATE):

☐ Other coaches

☐ Your opposition

☐ Your coaching philosophy

☐ Coaching literature

☐ Academic literature (Performance Indicators proven to predict success)

☐ Gut instinct

☐ Performance Analyst

☐ Other, (please specify)

_____

_____

30. How confident are you that the Performance Indicators you measure are able to determine/predict the success of your team?

0- Not at all

1- Not very

2- Fairly

3- Very

4- Extremely

31. Please score the following statements about the usefulness of Performance analysis on a scale of 1 to 5 (1 representing unhelpful; 5 representing very useful). Evaluate each statement independently.

Evaluation of player performance	
Evaluating the effectiveness of your tactics, or game plan	
Evaluate players you are considering recruiting	
Evaluate technical weaknesses of players	
Evaluate player fitness	
Evaluate the effectiveness of the opposition	
Develop/introduce changes in your style/tactics/game plan	

32. How often do you video a training session?

0- Never

1- Rarely

2- Occasionally

3- Often

4- All the time

33. What are the benefits of videoing training sessions? (SELECT AS MANY AS APPROPRIATE):

- ☐ No benefit at all
- ☐ To assess effort
- ☐ To assess tactical/spatial awareness
- ☐ To assess technical capability
- ☐ To assess movement related activity
- ☐ To assess current form
- ☐ To use as a visual coaching tool for players
- ☐ Other, (please specify)

_____
_____

34. What factors affect your ability to provide feedback to your players and coaching staff? (SELECT AS MANY AS APPROPRIATE):

- ☐ Time taken to complete analysis
- ☐ Time lost from training/practice due to feedback
- ☐ General lack of time available
- ☐ Availability of appropriate room or space for feedback sessions to whole group
- ☐ Availability of laptops, PCs, data projector, projector screen, etc. for feedback sessions
- ☐ Player's receptiveness to feedback
- ☐ Other coaches'/support staff's receptiveness to feedback
- ☐ Usability of the information obtained
- ☐ Reliability of the information obtained
- ☐ None of the above
- ☐ Other, (please specify)

_____
_____

35. To what extent, in your opinion, does your team value the role of Performance or Match analysis?

- 0- Not at all
- 1- Not very
- 2- Fairly
- 3- Very
- 4- Extremely
- ☐ Not relevant

Please add any comments to help us understand why you selected this answer.

_____
_____

36. To what extent, in your opinion, does your team value the role of Individual technique analysis?

    0- Not at all

    1- Not very

    2- Fairly

    3- Very

    4- Extremely

    ☐ Not relevant

Please add any comments to help us understand why you selected this answer.

_____

_____

37. How much do you as a coach value the use of Performance analysis?

    0- Not at all

    1- Not very

    2- Fairly

    3- Very

    4- Extremely

    ☐ Not relevant

Please add any comments to help us understand why you selected this answer.

_____

_____

38. How much do you as a coach value access to a Performance Analyst?

    0- Not at all

    1- Not very

    2- Fairly

    3- Very

    4- Extremely

    ☐ Not relevant

Please add any comments to help us understand why you selected this answer.

_____

_____

39. **Please tick the following statements that best describe how up to date you are, with Performance analysis technologies (SELECT AS MANY AS APPROPRIATE):**

- ☐ You keep up to date with the latest technologies and latest developments in Performance analysis
- ☐ You keep up to date with developments in the technologies/techniques you are currently using
- ☐ You keep up to date with the technologies/techniques on an annual basis
- ☐ You keep up to date with the technologies and techniques every few years
- ☐ You liaise with your Performance Analyst to keep you informed about the key relevant developments in performance analysis and techniques
- ☐ You don't keep up to date with developments within Performance analysis as you leave this to your Performance Analyst
- ☐ You don't keep up to date with developments within Performance analysis
- ☐ Other, (please specify)

_____
_____

40. **In terms of achievements, please comment on the outcomes of your team's (or teams') performances, i.e. log standings, competition wins, etc.**

_____
_____
_____
_____
_____
_____

41. **Please share any additional comments that you feel may be beneficial to the research project.**

_____
_____
_____
_____
_____
_____

THANK YOU. WE APPRECIATE YOUR CONTRIBUTION.

*** <u>END OF QUESTIONNAIRE</u> ***

APPENDIX H: ETHICAL CLEARANCE LETTER

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Approval Notice

Amendment

18-Nov-2016
Painczyk, Heinrich HF

Proposal #: SU-HSD-002132

Title: Utilisation of Performance Analysis amongst Western Province Club Rugby Coaches

Dear Mr Heinrich Painczyk,

Your **Amendment** received on **08-Nov-2016**, was reviewed by members of the **Research Ethics Committee: Human Research (Humanities)** via   Expedited review procedures on **10-Nov-2016** and was approved.
Sincerely,

Clarissa Graham
REC Coordinator
Research Ethics Committee: Human Research (Humanities)

Investigator Responsibilities

Protection of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1. Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2. Participant Enrollment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use. If you need to recruit more participants than was noted in your REC approval letter, you must submit an amendment requesting an increase in the number of participants.

3. Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4. Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the continuing review report in a timely fashion to ensure a lapse in REC approval does not occur.** If REC approval of your research lapses, you   must stop new participant enrollment, and contact the REC office immediately.

5. Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, number of participants, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6. Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouche within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch Universtiy Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7. <u>Research Record Keeping.</u> You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC

8. <u>Provision of Counselling or emergency support.</u> When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

9. <u>Final reports.</u> When you have completed (no further participant enrollment, interactions, interventions or data analysis) or stopped work on your research, you must submit a Final Report to the REC.

10. <u>On-Site Evaluations, Inspections, or Audits.</u> If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

APPENDIX I: LANGUAGE EDITING LETTER

Blue Diamonds Professional Services (Pty) Ltd

Enhancing your brilliance
Tel: 031 916 1420
Fax: 086 627 7756   Email: jaybee@telkomsa.net
Website: www.jaybe9.wix.com/bluediamondsed

15 October 2017

Declaration of professional edit

UTILISATION OF PERFORMANCE ANALYSIS AMONGST WESTERN PROVINCE CLUB RUGBY COACHES

by

Heinrich Painczyk

I declare that I have edited and proofread this thesis. My involvement was restricted to language usage and spelling, completeness and consistency, referencing style and formatting of headings, captions and Tables of Contents. I did no structural re-writing of the content.

I am qualified to have done such editing, being in possession of a Bachelor's degree with a major in English, having taught English to matriculation, and having a Certificate in Copy Editing from the University of Cape Town. I have edited more than 100 Masters and Doctoral theses, as well as articles, books and reports.

Sincerely,

Dr Jacqueline Baumgardt
Member, Professional Editors Guild

Blue Diamonds Professional Services (Pty) Ltd (Registration Number 2014/092365/07)
Sole Director: J Baumgardt