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**An Investigation into the Evolution and Future of Digitalisation in Elite
Sports: It's Influence within On-Pitch Decision-making.**

Olatunbosun Olaniyan. T

A thesis submitted to the University of Huddersfield in partial fulfilment of the
requirements for the degree of Doctor of Philosophy.

The University of Huddersfield

January 2020

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Abstract

The sports industry has seen exponential growth in a number of areas (Heitner, 2015), the most evident of which is its capability to use data and technology to inform performance and decision-making (Agrawal, 2015; Hill, 2018). This trend has increased as a result of improved technological innovations and Horrocks et al. (2016) postulated that the sports industry is reaching a plateau in terms of physical fitness (measuring performance). There is therefore a need to better understand the acquisition of decision-making abilities and a need for players to make swift appropriate decisions in time constrained and high-pressured environments. However, a challenge present in sports is better informed individual and team decision-making skills. Although literature is published in this area, and has contributed to the understanding of the phenomenon (Williams, 2007; Horrocks et al., 2016), it has only really been explored with little reporting on how digitalisation influences the decision-making of coaches and players in a team setting (James, 2006; Richards et al., 2012, 2017). Consequently, the central purpose of this research is to investigate the utilisation of data and technology in sports, with a focus on how it influences decision-making of players and coaches. This research takes an evolutionary perspective by way of investigating the evolution and possible future of digitalisation in the sports sector.

The research employed a qualitative approach using the learning organisation theory as a lens. 33 semi-structured interviews were conducted with various stakeholders from elite football (Premier League, Championship), cricket (First-Class County Clubs) and rugby (Rugby League). These included: Sport Directors, Managers, Head Coaches, Players, Performance Analysts, Medical Staff and also some Sport Data Companies. The findings of this study produced an account of the ways in which data and technology is being utilised in sports from training, performance management, injury prevention to on-pitch decision making and implications for team and opposition strategy. This research demonstrates that digitalisation influences the decision-making processes of players and coaches and goes further to show how and to what extent this occurs. Furthermore, this research demonstrates how sports teams are learning entities and how effective use of digitalisation enables the development of learning capabilities. The actual level of utilisation of data within sports is very varied, with football appearing to have higher utilisations and more initiatives. Challenges such as lack of resources and expert personnel have been underlined as issues still being experienced by sports teams.

The findings are used to develop recommendations on how to best utilise data analytics and technology for on-pitch improvement of decision-making and how current methods can be improved. A conceptual framework is presented regarding the successful implementation and utilisation of data and technological tools. It is recommended that sports teams implement the framework and use it around their current team philosophy and strategies. However, it is equally important for sports teams to keep working and adjusting the framework. Moreover, the theoretical and practical contributions to the literature and the sports industry are highlighted. Finally, the limitations of the study are discussed, while also emphasising recommendations for future research.

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Acknowledgements

First and foremost, I would like to thank God Almighty for giving me the strength, knowledge and the ability to undertake this research from start to finish.

I would like to express my sincere gratitude to Dr Benjamin Dehe and Professor David Bamford at Manchester Metropolitan University for their knowledge and unwavering support throughout the duration of this project. I have been extremely lucky to have supervisors who care for my success and who were available every time I had questions or problems regarding the research. This thesis would not have been possible without them. They provided me with guidance, motivation, opportunities to learn and grow, and overall made me a better individual. I will be forever grateful to them.

I would like to use this medium to thank Dr Sara Ward at the University Academy 92 for her counsel and providing me with the opportunity to work with various sports teams. Completing this research would have been even more difficult were it not for her support and invaluable contribution. I am also very grateful to all the participants of this study for welcoming me to their office/ground and sharing vital information with me, it was key to completing the research.

I would also like to thank Dr Neelu Seetaram for coming in during the final stages of the project as my supervisor and providing me with support and valuable feedback.

I am extremely grateful to my parents for their love, prayers and sacrifices throughout my education and equipping me for future endeavours, words cannot express my gratitude and appreciation. Finally, to my sister and brothers, thank you for your continuous encouragement and valuable prayers.

List of Publications

- Dehe, B., Bamford, D., & Olaniyan, O. (2017). Sport Analytics Utilisation in The Sport Industry: A Structured Literature Review.
- Olaniyan, O., Dehe, B., Ward, S. and Bamford, D. (2018). World Cup VAR: technology is transforming the beautiful game. [online] theConversation.com. Available at: <https://theconversation.com/world-cup-var-technology-is-transforming-the-beautiful-game-97907>
- Olaniyan, O., Dehe, B., Ward, S., & Bamford, D. (2018). Evolution and Future of Sports with regards to Big Data and Technology: An On-Pitch Perspective. In Huddersfield University Business School Research Conference, Jan 10 – 13 Jan 2018, Huddersfield, UK.
- Olaniyan, O., Dehe, B., Ward, S., & Bamford, D. (2019). The utilisation and current practice of data analytics and technology in elite sports. In Huddersfield University Business School Research Conference, Jan 9 – 11 Jan 2019, Huddersfield, UK.
- Olaniyan, O., Dehe, B., Ward, S., & Bamford, D. (2019). The utilisation and current practice of data analytics and technology in elite sports. In POMS 30th Annual Conference. May 2-6 2019. Washington D.C., USA

Chapter 1: Introduction

This first chapter will give an overview of the thesis and introduce some of the important concepts, literature and findings that underpin this research. Firstly, the background to the phenomenon being investigated will be provided, followed by the research aim, objectives and the research questions. Additionally, this chapter will also outline the methodology employed, the findings, the contributions and conclude with the structure of the thesis.

1.1 Background to the Investigation

The sport sector is a continuously evolving world-wide phenomenon that generates income from sponsorship fees, media right fees, gate revenues and supporter merchandise, and is projected to reach \$83.1 billion over the next few years in North America alone (PwC, 2019). In the world today, where organisations strive to stay competitive, they seek new effective tools that can be utilised to create new growth opportunities and ultimately outperform competitors. Data analytics and technology appears to be giving adept organisations this all-important competitive edge (McGuire, Manyika, & Chui, 2012). In a study conducted by Phillips (2013), 96% of the respondents who participated indicated that analytics will become more crucial in running their organisation over the next 3 years. Several organisations are now embracing more analytical techniques toward decision-making, for example Assurant Solutions, a company that sells credit insurance, discovered they were losing customers and utilised analytics to improve their customer retention rate (Mondello & Kamke, 2014). These innovations are now being implemented across other sectors such as healthcare, retail, banking, manufacturing and now, even the sports sector (Gaitho, 2017; Ricky, 2019). The sudden motivation behind the utilisation of analytics in sports and other sectors is attributed to the availability of massive amounts of data and advancements in computing power and technology. Sports teams now use analytics for different purposes ranging from player evaluation to performance monitoring and game management (Davenport, 2014; Vassakis, Petrakis, & Kopanakis, 2017, p. 3).

The sports sector has no doubt seen exponential growth over recent decades (Heitner, 2015; Giorgio, 2019), and an area of equally rapid development is the capability to use data and technology to inform performance and decision-making (Agrawal, 2015; Hill, 2018). The interest in this area has doubled with operations research publishing more papers, placing focus on “*scheduling events*” and “*on-field*” results. Furthermore, a significant amount of research has been

done in an effort to understand how data, video and technology impacts performance and decision-making in sports such as football, rugby, netball and cricket (Mohr, et al., 2003 ; Williams, 2005 ; Müller et al., 2006 ; Groom, 2012 ; Richards et al., 2012, 2017 ; Maxcy & Drayer, 2014 ; Wright, 2015 ; Caya & Bourdon, 2016 ; Martin et al., 2018). Horrocks et al. (2016) postulated that the sports industry is now reaching a plateau in terms of physical fitness (measuring performance), and there is a pressing need to better understand the acquisition of decision-making abilities and a necessity for players capable of making swift appropriate decisions in time constrained and high-pressured environments. Relvas et al. (2010, p.166), corroborated the aforementioned statement by postulating that the sport industry's focus is on "*performance, entertainment and financial profit*". Consequently, one of the main challenges still present in sports is the development of individual and team decision-making skills. Although a number of papers published in this area have contributed remarkably to the understanding of this phenomenon in sports (Williams, 2007; Horrocks et al., 2016; Richards et al., 2012, 2017), it has, however, been typically explored in an isolated environment with very little thought to how data and technology influences decision-making abilities of coaches and players in a team style setting. James (2006) postulated that there is very little research investigating how data and technology influences decision-making abilities of coaches and how it impacts the players and ultimately performance in matches. A pressing question that arises and seems to be unanswered relates to how digitalisation influences the decision-making abilities of players and coaches in elite sports.

Moreover, even though there is now considerable amount of research within this realm, there is still a need to better understand how information is shared between the people involved in the process (Wright, 2015). Also, as it is difficult to establish a relationship between performance analysis use and performance enhancement (especially when employing positivistic approaches), it has been suggested that interpretive research approaches could possibly demonstrate the impact of performance analysis in a particular club. Implicitly, there is a need to employ this approach in order to provide insight into: learning and development of players, specifically decision-making, and the transfer of information from analysis to training and preparation for games (Wright, 2015). Consequently, it seems important to investigate how digitalisation influences on-pitch decision-making and to what extent it can aid in its development.

Furthermore, there is dearth of literature on the level of utilisation of digitalisation in sports, as far as the researcher knows. With that in mind and the aforementioned context, it seems pertinent to investigate this phenomenon from an evolutionary and future perspective.

1.2 Theoretical lens: Learning Organisation

In recent years, a number of management theories such as resource based view (Amis et al., 1997; Smart et al., 2000; Anderson et al., 2011), stakeholder theory (Friedman et al., 2004 ; Laplume et al., 2008; Esteve et al., 2011), social cognitive theory (Wallace et al., 2000) and Sense-making (Rafaeli et al., 2009; Macquet et al., 2015) have been borrowed in an attempt to understand the dynamic nature of sports from different perspectives and to make a contribution to knowledge. However, there is dearth of literature investigating on-pitch sports from a learning organisation theory perspective. The concept of organisational learning and learning organisation emerged in the 1980s, however its ideologies are inherent to many perspectives of management (Garratt, 1999). Furthermore, its practices put emphasis on various factors such as, culture, employee participation, organisational strategy and absorptive capacity. The premise behind a learning organisation is that it aims to adapt organisations processes via specific and detailed activities and facilitates the learning of its employees. It is important for organisations operating in unpredictable and volatile environments to respond to unanticipated situations more quickly than competitors (Garvin et al., 2008). The implementation of learning at the organisational level was mainly conditioned as a collective of individual learning, training and development (Wang & Ahmed, 2003, P. 9). Sports is a dynamic and complex environment with often unforeseen and unpredictable outcomes. Consequently, Caya & Bourdon (2016) suggest that researchers should endeavour to use theories and concepts in studying sports analytics. Given that sport organisations fit this context, the learning organisation theory was employed in understanding and explicating the phenomena of data and technology in terms of this research. Specifically, employed in investigating how a learning organisation acts as an enabler of knowledge enhancement through the use of data and technology.

The sections above have highlighted the research motivations and are equally linked to the overall contribution of this thesis. The subsequent sections will outline the research aim, objectives and questions.

1.3 Research Aim and Objectives

The researcher's interest has been to investigate the utilisation of data and technology in sports, with a focus on how it influences decision-making of players and coaches. This research aims to investigate the evolution and possible future of digitalisation in the sports sector, and its influences within on-pitch decision-making and its role in enabling knowledge development and dissemination within a team. As stated in **section 1.2** above, the learning organisation theory is used to explicate this phenomenon. In order to satisfy the aim stated above, a set of objectives has been identified, outlined below:

- To investigate how digitalisation has influenced the sports ecosystem, specifically within the on-pitch domain.
- To analyse how digitalisation enables sports teams to develop learning capabilities and increase their knowledge base.
- To establish the influence of digitalisation within on-pitch decision-making of players and coaches.

1.3.1 Research Questions

RQ-1: How has digitalisation changed the sports ecosystem (a past, current & future perspective) and what are the current technological practices and their level of utilisation?

RQ-2: How does digitalisation enable sports teams to develop learning capabilities and increase their knowledge base?

RQ-3: How does digitalisation influence on-pitch decision-making abilities of players and coaches?

1.4 Research Methodology Employed

To answer the research questions (stated above) – a qualitative research methodology fused with semi-structured interviews as a method for data collection was employed. The data collection process was initiated on May 10th, 2017 and lasted through January 29th, 2019. The researcher spent a number of months creating a potential participant list and as a result collected data through convenience and snowball approach. Participants were carefully selected using stakeholder analysis while taking into cognisance the limitations of the study in terms of access and

geographical issues. Emails were sent to about 100 sports elite teams identified, 33 replied and agreed to participate in the study. The researcher's interview protocol was meticulously designed and subsequently used to collect data while also incorporating triangulation for data validation. Prior to field work being conducted, ethical approval was obtained, with anonymity and confidentiality a main priority throughout the study. NVivo12 was subsequently used in the transcription and also the analysis of data. Nvivo12 software proved to be very useful in the transcription and subsequent data analysis. Audio recorded interactions with participants were transcribed verbatim and framework analysis was used in the management and analysis of the data.

1.5 Research Findings

This evidence-based research demonstrated and produced a comprehensive account of the different ways in which data and technology is being utilised in sports from training, performance management, injury prevention to on-pitch decision making and implications for team and opposition strategy. This research has - through the findings and discussion - found out that digitalisation has had a significant influence on sports ecosystem both on and off the field. Digitalisation goes beyond the network of sport organisations and this is as a result of there being new entrants/stakeholders in sports, such as the sport data companies. The organisation of sports is typically structured around - "*sport producers*" - players and coaching staff with particular roles who can be considered "*assets*" and are tasked with producing "*sport situations*". However, the introduction of data and technology has seen the list of sport producers increase significantly, and it currently extends to data scientists, strength and conditioning coaches, physiotherapist, performance analysts and sport scientists. Confidential information pertaining to game strategies and other technical information are now public knowledge, sport teams now have unfettered access to data regarding their performances and even other team's performances. The findings have highlighted that invariably all elite sports teams now utilise some sort of data-driven approach, whether it be in-house, or third party sourced. From the study it was apparent that SportsCode and Catapult are the most commonly utilised software and technology. One unexpected surprised was that the level of utilisation within football, rugby and cricket based on the software utilisation is very disproportionate, with football appearing to have higher utilisations and more initiatives. The findings suggest a digital divide between the sports examined as a result of imbalanced financial

clout and resources. Challenges such as lack of resources and personnel have been underlined as issues still being experienced by sport teams.

Furthermore, the findings have demonstrated that digitalisation enables sports teams to develop their learning capabilities and ultimately increase their knowledge. The whole process of knowledge creation is fully supported and enhanced by the use of data and technology. Sports teams now use a combination of technologies for collection, analysis and visualisation of data. This data is converted to information which then becomes knowledge when sent to specific player's phone and they start reflecting on it. However, the findings also revealed that data and technological approaches should not be used in isolation, core elements such as leadership, culture, communication and learning organisation are equally important. Moreover, utilising this knowledge effectively will be dependent on the players ability to self-reflect and take on board the information. This no doubt points to the role of the coach in this process, the coach must have the capability of catering to different learning styles and ensure that the players are put in the forefront of learning to help them hone their abilities.

Finally, following on from the above discussion of findings, it is evident that knowledge creation is not the final process but rather the means through which the final goal can be achieved. The final goal for most elite sports teams is to improve performance and enhance decision-making. Consequently, digitalisation influences the decision-making processes of players and coaches, and the findings of this study have demonstrated the extent to which this occurs. A model developed by Awasthi & Varman (2003) towards studying the influence of information technology on decision-making within business sector has proven effective in exemplifying the influence of digitalisation on decision-making processes of player and coaches in sports. The findings are used to develop a conceptual framework (**presented in chapter 6.4**), this framework identified the factors which have potentially the most impact when implementing a sports analytics programme. Additionally, it showcased all the key elements that must be present to ensure successful implementation and utilisation of data and technology in any sports team's practice.

1.6 Review of Contributions

This thesis seeks to make a number of contributions which fall into the following categories: contribution to knowledge and contribution to practice. **Chapter 3.14** of this thesis identified and highlighted the types of contribution strategies in research (Nicholson et al., 2018), and further

outlined which strategies the researcher aimed to use in explicitly stating the contributions of this thesis. The researcher believes that incremental (*neglected area*), revelatory (*using multiple lenses*) and consolidatory (*traditional literature reviews that advance knowledge*) are contributions strategies applicable to this thesis. Further explanation of these will be proffered below using the contribution to practice and contribution to knowledge categories. Explanations of these terms have been provided in **chapter 3.14**.

1.6.1 Contribution to Knowledge

The present study contributes towards the continuing discourse of digitalisation utilisation within the sports industry. This study falls into the category of consolidatory contribution, more specifically, the researcher believes that the traditional literature review conducted in this thesis advances knowledge by way of summarising the current trends and presenting multidisciplinary approaches. This study answers the call for more qualitative approach within the realm of sport analytics and performance analysis (Wright, 2015, p. 113), this approach proved to be effective and rewarding in providing a unique insight and adding knowledge to the academic field. The study also follows an incremental contribution strategy, specifically, a traditional gap spotting approach by way of reviewing pertinent literature to identify gap and effectively embed the thesis within the existing literature. Horrocks et al. (2016) postulated that the sports industry is reaching a plateau in terms of physical fitness (measuring performance), and there is a pressing need to better understand the acquisition of decision-making abilities. Moreover, James (2006) postulated that there is very little research investigating how data and technology influences decision-making abilities of coaches and how it impacts the players. Therefore, this research makes a defined contribution by answering the call of previous research, and advances understanding of decision-making within the sport sector. Additionally, this study involved the collection of data from elite clubs in the English Premier League, Championship and Rugby League, thereby allowing for the generation of rich findings.

This study also falls into the category of revelatory contribution, more specifically, it employed multiple lenses in an effort to explicate the research questions. This research draws from the operations management body of knowledge and it borrows the learning organisation management theory. As there is a dearth of literature investigating on-pitch sports from a learning organisation theory perspective, this study makes a contribution by starting a discourse within this

untapped area and paves the way for more discussion. Furthermore, the unique findings generated through employing this theory led to understanding of sporting organisations as learning entities.

1.6.2 Contribution to Practice

This thesis made a defined contribution to practice, firstly by presenting information on how digitalisation has changed the sports ecosystem and the current technological practices within sports such as football, cricket and rugby, while also identifying current best practices. The rate at which digitalisation is growing in sports necessitates the need to fully understand it so sports stakeholders can effectively utilise it. Alamar (2013) stated that it is imperative for sport organisations to better understand analytics techniques, approaches, and also discover how to incorporate it into their operations and policies. Sport teams who do not embrace and practice analytics successfully are at a risk of falling behind. However, as accentuated by Maxcy & Drayer (2014), implementing and utilising analytics is not a direct and easy process, there are some challenges and the sport industry has much to learn. Majority of sport teams encounter a series of challenges while introducing and using data analytics to inform their practice. The findings of this study also confirm this, as seen in **chapter 4.7**. Consequently, this thesis makes a defined contribution by way of identifying current best practices which will enable sports to learn and adapt their practices. Furthermore, the conceptual framework presented in **chapter 6.4** will show sports stakeholders the most effective technologies, the conversion contingences to be aware of during the implementation and utilisation and finally the value that can be potentially realised. The researcher believes that this conceptual framework will allow directors, managers, coaches and even players to effectively utilise data and technology. There is a dearth of academic research investigating this recent phenomenon. The thesis makes a well-defined contribution by influencing sports policy makers and certainly club managers. Additionally, this research has given insight into the future of sports with regard to data and technology utilisation. The researcher believes that this unique look into the future of sports will enable sports teams to anticipate emerging technologies and as such have strategies in place to not only implement and utilise them but to also be conversant with which technologies are applicable to their need and suitable to their overall team strategy and philosophy.

1.7 Structure of Thesis

This thesis is composed of six chapters: Introduction, Literature Review, Research Methodology, Findings, Discussion and Conclusion. The aforementioned chapters will be further outlined below.

The first chapter (Introduction) basically provides the background of the research and delineates the aim and objectives, the research questions as well as the chosen methodology. This chapter concludes with a brief snapshot of the findings while also outlining the contributions of the study.

The second chapter (Literature Review) establishes and reviews the extant literature. It starts with and discusses important operations management concepts such as business strategy, operations strategy, leadership, change management, innovation. Furthermore, it introduces digitalisation and also decision-making theories. These concepts provide a backdrop for the main sport literatures around digitalisation and decision-making. It is in this chapter that the theoretical lens is presented and discussed in relation to the research questions. The learning organisation theory is employed in explicating the findings, discussion and also to support the contribution to knowledge. This chapter concludes with a holistic conceptual framework of the literature.

The third chapter (Research Methodology) outlines and provides substantial details about the chosen methodology. This chapter employs a top down-approach, starting from the research paradigm (i.e. *interpretivism*), followed by research methodology, methods, population and sample, data collection and how that leads into the analysis. The reason for presenting this chapter in such a manner is to demonstrate the link and orientation between the research paradigm, the aim and objectives, the research questions, the findings and the theoretical lens borrowed (This is demonstrated in the research framework presented in **chapter 3.5**). This chapter concludes with sections on ethical consideration, limitations and research contribution strategies.

The fourth chapter (Findings) presents the main findings of the thesis. This chapter solely relies on the primary data collected by the researcher through 33 semi-structured interviews conducted with participants. It starts by shedding some light on the impact digitalisation has had on the sports ecosystem, the factors that influenced these changes, and challenges currently being experienced in terms of data and technology implementation and utilisation. The subsequent section presents findings on the role and influences of digitalisation on decision-making, while also identifying the

current technological practices of football, cricket and rugby. Furthermore, best practices were delineated as well. This chapter concludes by providing some findings on the future of sports with regard to digitalisation. Some of the technologies that will potentially revolutionise on-pitch practices were identified.

The fifth chapter (Discussion) is structured around the three research questions. A detailed discussion answering the research questions is provided along with applicable frameworks to help add credibility and richness to the discussion of the findings.

The sixth and final chapter (Conclusion) summarises the main findings of the thesis and examines them in congruence with the research aim, objectives and questions. This chapter also presents a final conceptual framework towards the effective implementation and utilisation of data and technology in sports such as football, cricket and rugby. The contributions, limitations, recommendations and suggestions for future research were also discussed.

Chapter 2: Literature Review

2.1 Introduction

In order to achieve the research objectives presented in **chapter 1**, it is necessary to conduct a thorough and detailed literature review. As this thesis aims to investigate the evolution and possible future of digitalisation in the sports sector using a learning organisation theory, critically examining the relevant theories and literature will help situate this study and provide all-important context. Consequently, the purpose of this chapter is to discuss literature pertaining to the evolution and possible future of digitalisation in the sports sector, the literature focuses on three main bodies of knowledge: digitalisation, sports and decision-making, with a fourth intersecting body of knowledge which is the learning organisation theory. However, this chapter will begin by reviewing some of the overarching disciplines and lenses borrowed to complete this research. The chapter starts with an overview of some operations management concepts such as business strategy, operations strategy, leadership, change management and innovation. This is followed by sections on digitalisation and decision-making theories. The aim of the preceding sections is to provide a general background of these concepts prior to reviewing them in relation to the sports sector. The subsequent sections reviewed literature on the history of sports, its main components and the implications of digitalisation on those components. This is then followed by a deep dive into the specific aspects of digitalisation such as sport analytics, performance analysis, and other technological practices. A review of decision-making in relation to sports is also provided in detail.

Finally, the chapter discusses the theoretical lens and provides a conceptual framework showcasing the four main bodies of knowledge and concludes with a critical summary.

2.2 Business Strategy

Strategy plays an important role in any organisation, one of the main roles it plays is to help achieve competitive advantage (Baroto et al., 2012). Competitive advantage can be viewed as that which enables an organisation to meet customer's needs and gain an edge over its rivals. "*its source may derive from a number of factors including its products or services, it's culture, it's technological know-how, and its processes*" (Henry, 2008, p.4). To remain sustainable, however, organisations need to ensure that the competitive advantage cannot be easily imitated by competitors. Henderson (1989, P.1), points out that "*your most dangerous competitors are those that are most like you.*

The difference between you and your competitors are the basis of your advantage". The main way in which managers take into account of the continuously changing external environment is to use strategy during the decision-making process. A successful strategy will enable an organisation to use their resources and capabilities to exploit opportunities and reduce threats within the external environment. The definition of strategy and how it is formulated seems to cause debate amongst researchers and scholars alike, this debate has continued for years and is ingrained in the desire for managers to carry out improved strategic thinking and as a result improved strategic decision. Henry (2008), opined that strategy can be defined in various ways and any definitions will probably be ingrained within different perspectives, depending on the author. Consequently, the definition of strategy is not as black and white as it might seem. People often create strategies to help them realise certain goals or tasks. Strategy at the organisational level is rather complex, Porter (1996, P.1), emphasises that "*competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value*". Markides (1999), contends that the main idea behind strategy is for an organisation to choose one strategic position it can declare as its own. The strategic position of any organisation will embody their answers to questions such as: "*who should the company target as customers? what products or services should the company offer the targeted customers and how can the organisation do this efficiently*" (Henry, 2008, p.5).

2.2.1 Operations Strategy

Operation strategy fits within the functional level of all organisations. A number of researchers, most notable of all Slack et al. (2010), distinctly identified three essential core function that are responsible for an organisation's competitive advantage: marketing, operations and service development. They further stated that other functions support the aforementioned dimensions within the organisation, this is depicted in figure 1.

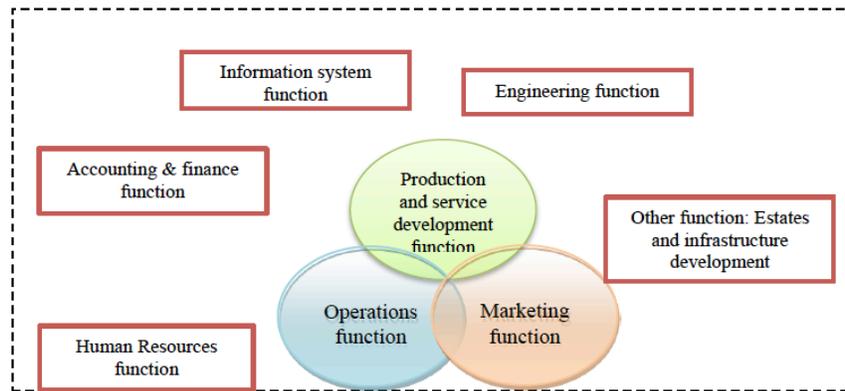


Figure 1 - Core and Support Functions of an Organisation (adapted from Slack et al.,2010)

Slack & Lewis (2002, p.16) defined operations strategy as “*the pattern of decisions which shape the long-term capabilities of any type of operations and their contribution to overall strategy, through the reconciliation of market requirements with operations resources*”. This definition is similar to the one postulated by Boyer et al. (2005, p.442), they defined operations as a “*set of decisions and plans involving the developing, positioning, and aligning of managerial policies and resources so that they are consistent with the overall business strategy*”.

Consequently, operations strategy is implemented by way of communicating the three core functions of the organisations and incorporating other supporting functions, which include human resources, finance, information system and accounting, to name a few. The main role of operations strategy is to implement two elements: “*the content and the process*” (Dehe, 2014, p. 44). According to Rytter et al. (2007, p. 1094) and Martín-Peña & Díaz-Garrido (2008, p. 200), “*content deals with how operations can contribute to the creation of the competitive advantage; whereas, the process deals with its deployment throughout the functions*”. These two elements will be discussed below.

2.2.1.1 Operation Strategy Content

Martín-Peña & Díaz-Garrido (2008, p.200) put forward that there are two rudimentary elements that can be identified within the operations strategy content: “*competitive priorities and operations decisions*”. They posit that competitive priorities “*define the area in which the operations must be focused to support gaining the competitive advantage*”. Conversely, operations decisions are “*the*

set of actions that help in achieving the operations and corporate goals". Moreover, the authors adapted the research by Hayes & Wheelwright (1984) and Hill (1989), in an effort to explicate that key decisions can be divided into structural and infrastructural decisions. This was further emphasised by Boyer et al., (2005, p.444), they explicated that the *"most important and central concerns are the need to link structural and infrastructural decisions with overall business plans, and thus guide business by building capabilities essential to the formulation and achievement of the firm's overall strategy"*. This particular process can help develop and sustain competitive advantage, using a top down approach shown in figure 2 below.

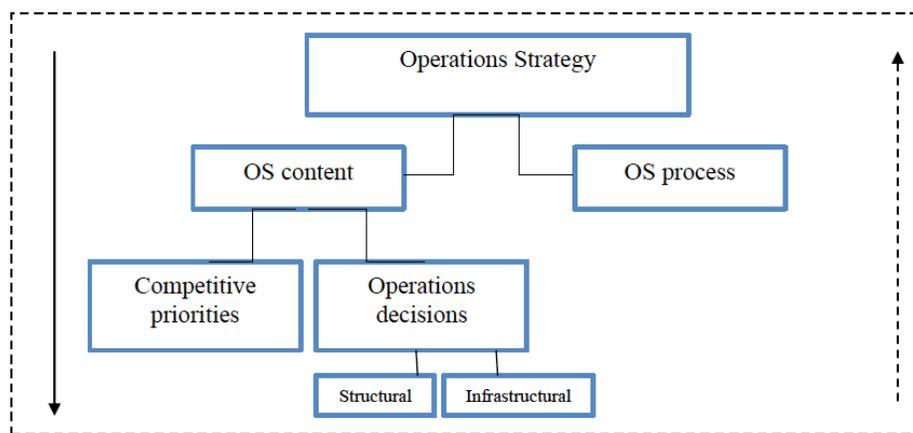


Figure 2 - The top down approach to Operations Strategy Content (adapted from Dehe, 2014)

2.2.1.2 Operation Strategy Process

Operations process is integrated in a bottom-up approach. Slack & Lewis (2002, p.16) postulate that the operations strategy process enables *"the pattern of decisions which shape the long-term capabilities of any type of operations and their contribution to overall strategy"*. It is complex and dependent on external uncontrollable factors.

2.2.2 Leadership

The move towards appreciating the significance of human capital in the industrial age has led organisations to alter their orientation and paradigm on how to manage people (Aalateeg, 2017). organisations no longer perceive their employees as a resource *"whose primary function is to provide goods and services"*, instead they are viewed as crucial parts of delivering quality products/services and their aptitude to progress and evolve constantly (Farzad, 2006, p. 12). The

level of success of an organisation will be dependent on a group of individuals, such as the leaders and the followers, and the extent to which each individual does their job appropriately. In an effort to understand organisational effectiveness, a number of scholars and practitioners have conducted studies to establish theories regarding leadership, organisational commitment and job satisfaction (Cheng, 2003, p. 1). According to Wallace & Weese, (1995, p. 182), “*ineffective leadership is the major cause of declining industrial productivity and a downward positioning of North American corporations on a global scale*”. Burn (1978) highlighted that leadership is one of the most perceived phenomena in the world, but it is rarely understood. Leadership is regarded as a highly important factor in determining the success or failure of an institution, hence, leaders must recognise their influence on employees and ultimately the organisation as a whole (Gardner, 1993). Leadership as a field is one that has long been an interest to organisations. The term itself evokes images of influential, dynamic individuals who lead armies into victories, “*direct corporate empires from top gleaming skyscrapers, or share the course of nations*” (Yukl, 1992, p. 1). Review of literature has brought to light the definitions of leadership, it has been defined in terms of behaviour, influence, traits, and interaction patterns (Yukl, 2002, p.2). Table 1 below summarises some of these definitions.

Table 1 - Leadership Definitions

Leadership Definitions	
1	Leadership is “ <i>the influence increment over and above mechanical compliance with the routine directives of the organisation</i> ”. (Katz & Kahn, 1978, p. 528).
2	Leadership “ <i>involves giving purpose to collective effort, and causing willing effort to be expended to achieve purpose</i> ” (Jacobs & Jaques, 1990, p. 281)
3	Leadership is the skill of an individual to impact, stimulate, and facilitate the process of contributing towards the effectiveness and success of the organisation. (House et al, 1999, p.184).
4	Leadership is an all-encompassing process, where leaders enable others to get astonishing things done. To accomplish this, “ <i>leaders engage five practices: model the way, inspire a shared vision, challenge the process, enable others to act, and encourage the heart</i> ”. (Kouzes and Posner, 2006, p.14)
5	Leadership is the process of motivating and inspiring others to accomplish organisational goals. (Bartol & Martin, 1998, p. 415).

2.2.3 Change Management

Organisations in the past were designed for stability rather than change and the focus used to be on creating a specific outcome or product. However, this orientation is fast changing as organisations now focus on improving the process. Competitive edge and profit maximisation are the main goals of all organisations, and one of the approaches to achieve those goals through “*rapid change in technology, communication and information is managing change within the organisation*” (Malek & Yazdanifard, 2012, P. 150). Altering the principles that organisations abide by, values such as teamwork, awareness, responsibility and information are vital, change readiness and flexibility are equally important (Baekdal et al.,2006). This happens as a result of being knowledgeable concerning change management implementation and its practices.

Change management has been defined as “*the process of continually renewing an organisation’s direction, structure, and capabilities to serve the ever-changing needs of external and internal customers*” (Moran & Brightman, 2001, p. 111). Malek & Yazdanifard (2012, p.150) defined change management as the “*process of planning and coordinating the implementation of all changes through individuals, teams and organisations*”. This process is essentially referred to as the problem-solving process, which is a move from the problem state to the intended future state (Ash, 2009). It involves the utilisation and application of various concepts from fields such as business administration, psychology, system engineering and sociology. Burnes (2004), stated that change is an ever-present characteristic of any organisation, both at the strategic and the operational level. Consequently, its importance in organisations is very critical in terms of short term and long-term success. Furthermore, it plays an important role in identifying where organisations need to be in the future and how to get there while managing the changes required to do so (Todnem, 2005). Change management is a way in which people who will be affected by the impending change such as the employees are made ready to accept the change. Additionally, it is a way to make them fully understand their roles and responsibilities while ensuring them that it is worthwhile to be a part of it (Lawson & Price, 2003). The importance of organisational change has made its management an extremely required managerial skill (Senior, 2002). Graetz (2000, p. 550), stated that “*against a backdrop of increasing globalisation, deregulation, the rapid pace of technological innovation, a growing knowledge workforce, and shifting social and demographic trends, few would dispute that the primary task for management today is leadership of organisational change*”. The need for change is usually unpredictable and it tends to be reactive,

sporadic and often prompted by a state of organisational crisis (Burnes, 2004). The successful management of change is viewed as necessary to survive and thrive in a highly competitive and constantly evolving environment (Luecke, 2003), research has revealed that around 70 percent of change programmes initiated ultimately fail. Consequently, it is important to have policies and procedures for the effective management of change (Leal-Valias, 1999). Malek & Yazdanifard (2012, p.150), provided a different perspective by stating that change management is a process that involves “*unfreezing, moving and refreezing values, practices, and procedures*”. However, this process is not always straightforward, as people within organisations naturally do not accept change, due to one reason or the other, and view it as a negative thing. Thus, their initial reaction is to resist the change. Change management is an effective way to mitigate the negative response, while also making the change process more adequate. According to Lewin (1951), change management involves unfreezing, effecting change and refreezing. The main goal of the unfreezing stage is to create an awareness of how the existing state of affairs is impeding the organisations progress. Dated methods, techniques, processes, people and organisational structure must be scrutinised in order to highlight and show employees how essential the change is for the organisation to remain competitive in the market. Communication is an important element in this phase so that employees can be adequately informed regarding the impending change, why it is important and what they stand to benefit from it being successfully implemented (Hartzell, 2019). The second phase, *effecting change* also referred to as transitioning or moving is denoted by the implementation of the change. This is usually the most difficult to overcome as it involves learning new behaviours, attitudes and beliefs. Therefore, an organisation has to provide adequate training education and support to the employees as they become familiar with the change (Burnes, 2004). Throughout this phase communication is key and employees need to be reminded of the rationale for the change and what they stand to benefit from it being successfully implemented. The final phase is *refreezing*, and it represents the act of establishing, stabilising and solidifying the new patterns. The new changes made to the organisational structure, processes and goals are acknowledged and *refrozen* as the new norm. Lewin (1951), postulated that the refreezing is important, and organisations must ensure that they do not revert back to the old ways of thinking prior to the implementation of the change.

2.2.4 Innovation

According to Dodgson (2017, p. 2), “*innovation is the means by which organisations survive and thrive in uncertain and turbulent conditions*”. The term innovation is often confused with the term invention, but researchers and policymakers postulate that there are important distinctions between the two terms. Invention is “*the first occurrence of an idea for a new product or process*”, while innovation is “*the first attempt to carry it out into practice*” (Ramadani & Gerguri, 2011, p.2). According to Lin (2006), innovation originated from the Latin word *innovare* which literally means “*to make something new*”. Drucker (2014), described innovation as an entrepreneur’s tool that can be utilised to exploit change in business or service. Innovation must be central to the process of management in all organisations. He further stated that innovation can be viewed as its own discipline and can therefore be studied, mastered and implemented. Consequently, innovation is any practice new to organisations, which include projects, policies, products and services (Lin, 2007). Organisations typically operate within rapidly changing environments and circumstances, and technological change, globalisation and ever-changing trends are compounding and constantly making this environment even more complex. Consequently, innovation often shows the resilience and ability of organisations to recognise, react to and lead the changes required to survive and succeed in such environments. Innovation give rise to economic performance, sustainability, corporate competitiveness and largely, the overall quality of life. Furthermore, it offers social and economic benefits. However, the organisational returns from innovations are directed towards those apt at handling the risks and complexities (Dodgson, 2017). Dodgson et al. (2014, p. 3) summarised the challenges of innovation management in the statement below:

“The risks, costs, and timescales of innovation often conflict with the financial objectives, operational routines, and managerial incentives found in most organisations. The best returns to innovation may be accrued not by the innovator, but by those that emulate and copy. Innovation disrupts markets, technologies, and workplaces. It requires levels of collaboration across professional and organisational boundaries, and tolerance of failure, that organisations find difficult to coordinate and sanction. In many instances it involves efforts to manage activities and events that are beyond the control of even their most influential contributors.”

Nevertheless, despite the difficulties highlighted in the aforementioned statement, the authors suggest that innovation can be the most stimulating and worthwhile activity within an organisation. Innovation, however, is not something that is stumbled on or magically happens. The positive outcome and effects of innovation is usually as result of managing it successfully, and this often

helps alleviate the negative results as well. Productivity, growth and competitiveness are some of the positive outcomes of innovation, while the negative outcomes include workplace insecurities, job loss, and environmental damage, to name a few. Organisations that are adept in being innovative have vigour, direction, drive and the work environment is usually fun to work in. The term innovation seems to be a vague term. Dodgson et al. (2014), summarised innovation as an *outcome* (e.g., a novel way of organising) and a *process* (the way in which the resources and capabilities are incorporated over a given time to create positive innovative results). Innovation can be somewhat transformative, radical and disruptive towards the status quo, or it can involve taking small gradual steps in order to enhance what is currently being done, i.e., a matter of just doing things better.

2.2.5 Overarching Concepts Illustrated

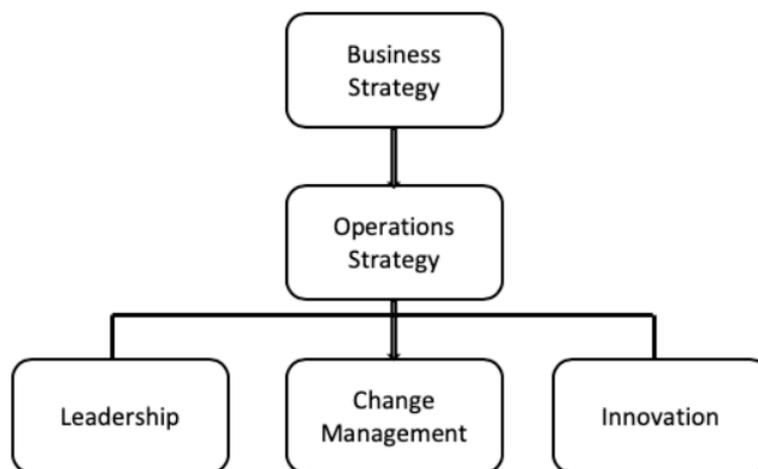


Figure 3 - Overarching Concepts Illustrated

The above discussed overarching concepts are all crucial and essential elements for organisations in their pursuit of competitive advantage. Each and every one of the components play a distinctive role in helping organisations stay competitive in an ever-changing and unpredictable environment. The common themes identified from the above reviewed concepts are “*competitive advantage*”, “*individuals*” and “*teams*”, specifically the role that the latter the plays in organisational success. This suggests that these concepts explored above are fundamentally ingrained in all successful and thriving organisations. Organisations now operate in an era where it is imperative to have a solid digital presence, to the extent that technology has the potential to make or break an organisation

Jones et al., 2015). Consequently, another important concept proving to be a game changer is **digitalisation**. Digitalisation encompasses everything that has to do with utilisation of data analytics and technology to improve processes, increase productivity and efficiency while reducing cost and maximising revenues (Gassmann et al., 2014). According to McGregor (2017, p. 1) “*technology is about innovation, and innovation in business is all about doing things differently in order to provide better products and solutions, and an improved service to customers*”. Furthermore, at the core of all successful organisations is evidence-based decision processes. **Decision-making** is another important element that usually determines the success or failure of every organisation. Decisions can impact an organisation’s culture, customers and ultimately their income. Accordingly, “*data analytics uses data for quantitative and/or qualitative analysis to help an organisation better understand its business and markets (**‘knowledge discovery’**) and to make timely business decisions*” (Chen et al., 2012; Holsapple et al., 2014; Thirathon et al., 2017, p. 776).

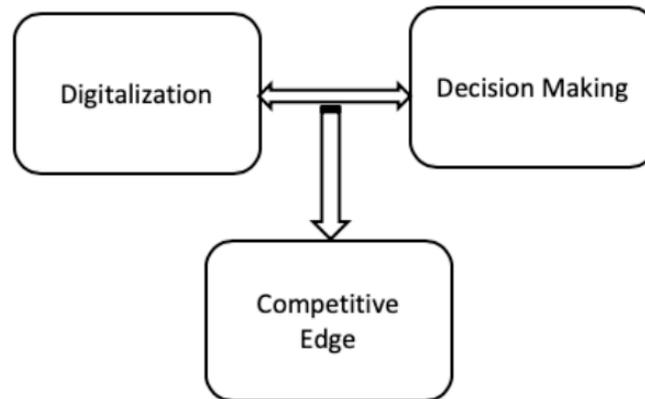


Figure 4 - Overarching Concepts

2.2.6 Overarching Concepts Link to Sports

This research is primarily investigating elite sports teams, but it is important to initially explore the overarching business concepts prior to reviewing literature pertaining to the three main bodies of knowledge in relation to sports. Sports teams are similar to businesses in the sense that they are both built to “win” or be successful. Success for sports organisations is winning trophies and staying competitive, while success for a business is gaining more market share and maximising

profits. Consequently, the concepts discussed above can help guarantee success if implemented correctly and meticulously. These concepts (digitalisation and decision-making) will be further discussed in the subsequent sections.

2.3 Digitalisation

Digitalisation is considered to be one of the most crucial on-going transformations in the world today and it incorporates different levels and elements of business and everyday life (Hagberg et al., 2016). The past few decades have ushered in a growth in technology that has led to opportunities and have dramatically transformed the society. The term digitisation (*“process of converting analogue into digital data sets”*) (Schumacher et al., 2016, p. 3) is the framework for digitalisation, which is described as the utilisation of digital opportunities. According to literature, digitalisation refers to *“the changes associated with the application of digital technology in all aspects of human society”* (Stolterman & Fors, 2004, p. 55). It is also known as the *“ability to turn existing products or services into digital variants, and thus offer advantages over tangible product”* (Gassmann et al., 2014, p. 1). According to Brennen & Kreiss (2014, p. 1), digitalisation refers to the *“adoption or increase in use of digital or computer technology by an organisation, industry or country”*. Digitalisation takes advantage of a combination of technologies (e.g. big data, sensors and cloud technologies) to create and open unforeseen opportunities while offering the possibility of making radically new products and services (Rachinger et al., 2018).

2.3.1 Big Data

Big data refers to large sets of data that cannot be handled by traditional storage methods. It requires advanced and easily accessible technology to gather and process, so as to extract insights. The thing that comes to mind considering the question “what is big data” is obviously the size, but big data has other characteristics such as volume, variety and velocity. A popular model referred to as “The Three V’s” – denoting volume, variety and velocity - has materialised as a way of defining big data (Gandomi & Haider, 2015). Volume is used to describe the size of the data. They are often quantified in multiple terabytes and petabytes. Time and type are some of the factors that make big data volumes differ, in that what is seen as big data today may not conform to the quota in the coming years. This is because facilities used for storing data will increase and create room for even “bigger data” to be captured. Variety simply means that data comes from different sources

such as text, video and audio. Velocity means data is being generated exceptionally fast and it is a never-ending process (EYGM, 2014). The rate at which data is generated and the speed at which it is processed and interpreted is referred to as the velocity of data. Consequently, it is only when the potential in big data is unlocked that it can be used to drive decision-making. Data must be analysed using advanced analytical tools and techniques. Examples of big data analytics techniques include text analytics/ text mining, audio analytics and video analytics. (Gandomi & Haider, 2015). Big data analytics is “*where advanced analytics technique operate on big data set*” (Vassakis et al., 2018, p. 8). Therefore, big data analytics encompasses two main areas – analytics and big data (Russom, 2011). According to Dmonte & Dmello (2017), the process of big data analytics can be categorised into three phases. Phase 1: Collection of data: The first phase is to collect data from the field/court of play via technology such as sensors and internet of things (IOT). Phase 2: Analysis of data: data collected will be analysed to reap benefits. Especially in sports, data analysis will go a long way in helping teams improve performance. Tools such as visualisation and data mining tools are utilised during the analysis process. Phase 3: Applying the knowledge: the main aim of analysing big data should be to gain meaningful insights that can be used to make smarter decisions and anticipate future events.

2.3.2 Data Analytics

The term “analytics” is to some extent new and comprises of tools attributed to the business world. However, these tools are becoming more prevalent in the sport industry (Alamar, 2013). Currently, in the sport world there seems to be a sudden trend around the word “analytics”. Many believe the major reason for this is the availability of huge volumes of unprocessed data (Agarwal & Mehrotra, 2016). The key goal of analytics is to help decision-makers in organisations make well-informed decisions. Analytics can be defined as the science of examining raw data with the intention of gleaning conclusion regarding particular information. It encompasses applying a somewhat algorithmic procedure in order to obtain insights (Monnappa, 2016) and can be categorised into descriptive, predictive and prescriptive. Descriptive analytics entails collecting, organising data and then describing the qualities of the data. Although this kind of analytics has its advantages, it does not give information as to why an event occurred or what may happen in the future. Predictive analytics involves using previously gathered data to support trends or patterns in the future. Predictive analytics can be valuable when forecasting future trends, however one cannot assume

any clear “cause/effect” relationship (Davenport & Harris, 2007). Finally, prescriptive analytics involves incorporating methods which include an investigative design. Prescriptive analytics offers a supplementary level of analysis by providing recommendations for implementing solutions to issues. Considering these categories, it is safe to say that organisations must endeavour to integrate all three, as they complement each other. Davenport (2014), suggested that sports organisations should move toward predictive and prescriptive analytics. He stated that most analytical activities in the sports industry tend to be descriptive and that provides no direction and guide as to the future. Predictive and descriptive analytics are more effective and beneficial. There are three key phases when it comes to analytical thinking: the first phase is to frame the problem; the second phase is to solve the problem while the last stage is to convey and make decisions based on the results. The first of any phase is always important and often determines the end phase. If the problem is framed the wrong way, this will affect subsequent analysis and make it less meaningful. In the second phase, how the data will be collected and analysed is identified. The final phase involves disseminating the results and agreeing upon how action will be taken (Mondello & Kamke, 2014). There is no limit to who can use analytics, it can be utilised by various organisations. Though its use will differ from organisation to organisation, Alamar (2013) stated that no two teams will use analytics in completely the same manner. Nevertheless, possessing knowledge about opportunities of analytics, and how to manage them with respect to the strategic plan of the organisation will go a long way in helping teams realise competitive advantage.

2.4 Decision-Making

Decision-making is a cognitive process resulting in the selection of a course of action among several alternatives. It is very wide ranging, for instance, decisions can be made regarding our personal life, decisions can be made regarding business entities as well. The decision-making process involves making judgements that informs decisions (Edwards, 1954). Judgements are our opinions or predictions and usually vary in terms of the extent to which they are an accurate reflection of reality. Managers within every organisation are usually the individuals tasked with making scheduled routine decisions as a result of organisational policy change and strategy often due to uncontrollable external factors. The unpredictable nature of the environment sometimes leads decision-makers to make decisions based on incomplete information and this can cause uncertain and risky conditions. Making a decision often means following a set of principles which

adhere to the philosophy adopted by the organisation (Petrescu, 2012). Applying management decisions in organisations has paved the way for new dimensions in terms of management theory; organisational learning, organisational culture, creativity and innovation among others are all being used within organisational decision-making. Contributions of the development of organisational learning (Smith, 2012), and organisational change theory (Queen, 2005; Kottler, 2011) highlight the renewal and evolution of organisational management decision-making. In an organisational setting it is important to note that decision-making requires the right kind of information and the ability to combine and understand the information.

2.4.1 Decision-Making Model

Decision-making process usually involves the presence of a problem which has to be understood by the decision-maker and correctly defined in order to find opportunities to solve it (Negulescu, 2014). This process of deduction usually happens in well thought out stages. Awasthi & Varman (2003) developed a model to study the influence of information technology on decision-making in the business sector, while highlighting the stages of decision-making. Their model was based on extensive literature and was validated by way of case studies and questionnaires administered in an IT based organisation. Their model in figure 5 below shows that decision-making process involves three main stages, *input, process and output*.

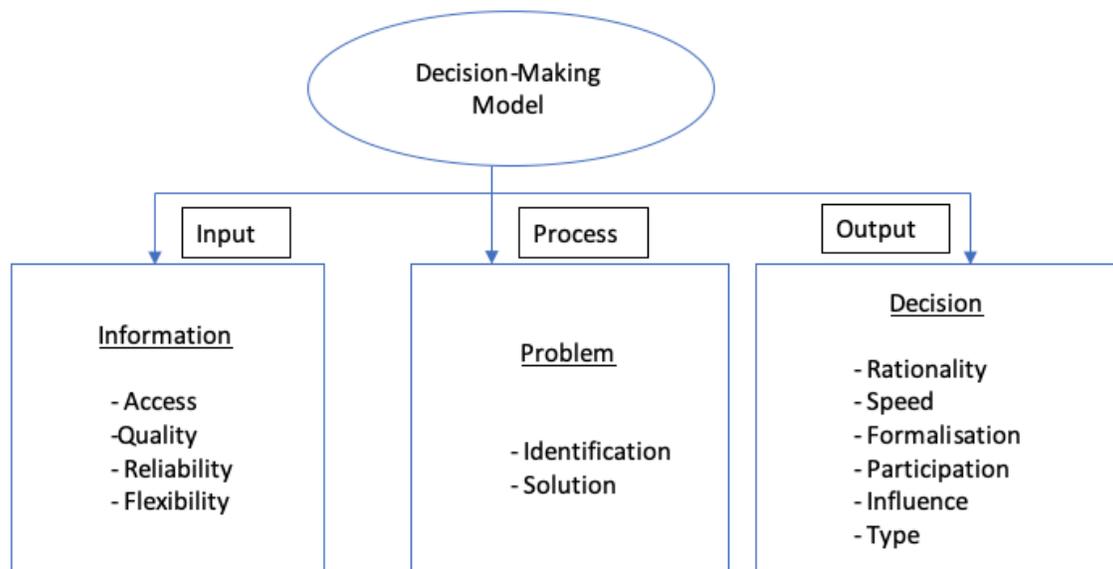


Figure 5 - Model for studying decision-making (adapted from Awasthi & Varman, 2003)

The first stage which is the “*input*” is where the information is gathered by the individual. Consequently, this information will be defined by ease of access, quality of the information, reliability of the information and flexibility in terms of ability to receive varying information.

The second stage which is the “*process*” is where the user identifies the problem and also solution to the problem. Third and final stage which is “*output*”, is where the decision is finally made based on the “*input*” and “*process*” stages. Furthermore, the final decision will be based on the rationality of the decision maker, the speed at which the decision is made, the formalisation of the decision, the number of people involved in the process (participation), the external influences, and the type of decision made.

2.4.2 Decision-Making Theories

2.4.2.1 Rationality and Logic

Salaman (2008) and Nutt & Wilson (2010) explicated that the key idea to understanding decision-making is the concept of rationality. Rationality can be defined as “*the quality of thinking behind the decision-making process and outcome*” (Dehe, 2014, p. 100). It is important to note that rationality has been linked with decision-making which follows numerous features such as: thoroughness, logic and systematic. According to Weber (1964), there exists three types of rationality, divided into two categories: formal and substantive rationalities. The author defines formal rationality as the “*degree to which an action happens as a result of quantitative and appropriate calculations*” (Dehe, 2014, p. 100). Weber posits that an action is rational because it has a coherent structure, all of its component point in a single direction, no component impedes the other. Substantive rationality refers to a combination of values that guide individuals in their day to day lives, especially how they select the “*means to ends*”. Substantive rationality can be divided into two types. The first type is connected with the “*appropriateness of means to the achievement of chosen ends*”. This is typically associated with common sense. This type places emphasis on the outcome or on the interactions between the approaches the decision-maker chooses in order to achieve a given goal. That said, this type of rationality is dependent of external factors and is very perceptive toward the fact that individuals make errors, that knowledge is inadequate, and truth is relative (Salaman, 2008). The second type of substantive rationality is that it “*does not refer to the suitability of means to ends but to the choice of ends themselves*” (Salaman,

2008, p.4). In essence, because the ends are dependent on culture, among other factors, they may appear illogical to other individuals and decision-makers.

2.4.2.2 Decision-Making and Rationality

Decision-making is a process that starts with the identification of a decision problem and ends with a recommendation (Sharifi et al., 2006). This “*process*” takes place in the mind of the decision-maker and involves selecting the most appropriate decision (Hollnagel, 2007). Nevertheless, in order to choose the most appropriate decision, there are three assumptions involved. According to (Hollnagel, 2007), those three assumptions are that i) decision-makers are adequately informed, ii) decision-makers are completely sensitive and iii) decision-makers are logical. Correspondingly, Simon (1955) put forward in his book that there are three main concepts involved in selecting a logical choice: “i) the requirement of the identification and clear presentation of a set of alternatives and their courses of action to be given to the decision-makers; ii) the knowledge and the information, allowing the individual to predict the consequences of choosing any of the alternatives, being available and understood by all the decision makers, or stakeholders involved; and iii) the decision-makers being able to determine the criteria to justify their preferred options and alternatives” (Dehe, 2014, p. 100). Dehe (2014) further suggested that satisfying these assumptions are next to impossible. Additionally, it has been postulated that individuals prefer to reflect about themselves as “*rational and informed*”, however reality is slightly different (Pomerol, 2012; Simon, 1976). Consequently, the aforementioned concepts back up the notion that decision-makers are inadequate rational individuals. These impediments inhibit the decision-makers from being rational because the outcome of the process is “*universally logical, objective and measurable*” (Dehe, 2014, p. 101). In terms of logical, it is presumed that the decision-maker is consistent and not persuaded by the emotions of individuals. In terms of objective, it is assumed that the decision-makers are adequately informed, however it is impossible to contemplate that individuals possess comprehensive knowledge about the options they have and the probable consequences (Hollnagel, 2007; Pomerol, 2012). Lastly, in terms of measurable, it is assumed that the benefits of the outcomes can be measured to evaluate the usefulness with regard to consequential value (Pidd, 2003). Thus, in the subsequent sections the problems and reasons inhibiting an individual from being rational are further discussed.

2.4.2.3 Issues Preventing Rationality

Cohen (2013) and Nutt & Wilson (2010) underlined the natural behaviours which inhibit individuals and decision-makers from being rational. They classified these natural behaviours into three categories. The first is the non-deliberate decision. This category of decision includes imprudent actions and choices that an individual makes at a certain time. Furthermore, there is a possibility that the decision-maker will stop as soon as they get a satisfactory result, based on the decision-makers perspective, morals and cultural assumptions. There is also a possibility that the decision-maker will choose the first appropriate option (Pomerol, 2012). Secondly, lack of information is also an issue to be considered. The dearth of information and information failure as well as bias are challenging to evaluate and may create narrow-mindedness and distort the decision-making results (Yang, 2001). Thirdly, the mental errors or miscalculation as a result of the decision-makers choices. To illustrate, it is natural for decision-makers to favour the initial information they receive, this is referred to as anchoring. Moreover, it is natural for a decision-maker to select an option that leads to the slightest amount of change, this is referred to as the status quo. Lastly, it is important to recognise that there are flaws in the human cognitive system, responsible for individuals making decisions in an effort to justify a past error or flawed choice. This is referred to as sunk costs (Pomerol, 2012; Salaman, 2008). All the aforementioned issues unquestionably create elements of subjectivity within the decision-making process and hinder rationality. This is connected to the theory of bounded rationality which emphasises uncertainty and risks within the decision-making process.

2.4.2.4 The Bounded Rationality Model

Bounded rationality model is the idea that individuals make decisions that are rational, but those are usually within the limits of the available information and our mental capabilities (Mullainathan, 2001). Simon (1955), stated that reality is often complex but human cognition is limited. Therefore, decision-makers do not possess the exhaustive knowledge to adequately think of all possible alternatives, and they won't possess all the essential knowledge to properly rank and calculate the respective "*cost and benefits*": as a result, rationality is bounded. Accordingly, the decision-maker does not attempt to unearth the best solution to a particular problem, rather he will search for a satisfying choice.

Furthermore, Cousins et al., (2008, p. 31), proposes that "*bounded rationality is due to the*

individual's neurophysiologic limits, as well as linguistic restrictions". This implies that individuals have limited rationality, consequently when a problem arises, it can be difficult to reach an optimum solution. Nevertheless, a rational solution can be chosen by evaluating contradicting objectives (Cousins et al., 2008, p.69). According to Dehe (2014, p. 103), *"It is important to identify the differences between best, associated with the optimal, and satisfactory, associated with the optimum, which is not the best solution as such, but considers the environment, the constraints and the partial, or the asymmetry of the information, in order to select an acceptable and reasonable alternative"*. This is similar to a statement put forward by March & Simon (1958, p.141), they stated that *"most human decision-making, whether individual or organisational, is concerned with the discovery and selection of satisfactory alternatives; only in exceptional cases is it concerned with the discovery and selection of best alternatives"*. The word *"satisfactory"* in this particular context translates to the inclination for individuals to stop seeking optimal solution as soon as a satisfactory alternative is reached, instead of pursuing the best performance (Grant, 2010, p.281). Consequently, bounded rationality theory recognises the restrictions hindering decision-makers from reaching a logical state by taking into cognisance the quality and accessibility of information to decision-makers, by acknowledging time constraints and also by recognising the cognitive limitations of individuals in terms of creating and finding solutions to complicated problems (Sorensen, 2012).

2.4.2.5 Complexity, Risks and Uncertainty

It is important to elucidate that the world is not deterministic but rather dynamic and complex. A deterministic setting would enable decision-makers to envisage the outcome of a specific action followed and to recognise the various courses of action (Selten et al., 2012). Pidd (2003, p.38), stated *"that a mechanical system can be considered as deterministic, but that this assumption cannot be true in a business or management system, which, ultimately, enhances the complexity element associated with it"*. Thus, a non-deterministic system is one that involves the use of statistics and probability so as to measure and evaluate how probable the occurrence of an event may be (Osman, 2010), as a result of this it is associated with risk and uncertainty. According to (Meredith & Mantel, 2006; Starmer, 2000), *"decision-making under risks or under uncertainty can be differentiated"* (Dehe, 2014. p. 105). Decision-making in relation to risk assumes that the likelihood of an event can be identified. On the other hand, decision-making in relation to

uncertainty assumes that the likelihood of an event is unknown. It has been argued that, except the probability is identified it should not be considered. In a situation like the aforementioned, a payoff table can be used to represent and analyse different scenarios. Furthermore, Pidd (2003, p.40), postulated that “*there is the concept of subjective probability, which assumes that the probability relates, and is subjective, to the decision-maker’s belief and knowledge about a particular event. This will lead the decision-maker to assign the probability based on a subjective, yet informed, notion*”. This suggests that the probability can be altered, on the basis that there is availability of information and knowledge. In this situation, the assumption is that the concept of decision-making, under risk, involves decision-making under uncertainty (Pidd, 2003).

Furthermore, Nutt & Wilson (2010), clarified that in several complicated situations, there are significant uncertainty and risk in the results of choices. This can be attributed to the absence of adequate information and will need to be estimated or forecasted. It is also important to note that factors such as the external environment and other stakeholders can equally influence the result of a decision (Eldridge et al, 2014).

2.4.2.2 Naturalistic Decision-Making Perspective

The past couple of years have seen the development of models for understanding how people make decisions in the real-world settings. Naturalistic decision-making is another attempt to comprehend how human beings make decisions in a complex ever-changing world. Experience is the focal point of the naturalistic decision-making perspective. Klein (1999), postulated that decision-making process does not conform to a rigorous method of solution identification, which is an essential stage of the mainstream decision-making theories. He further stated that the context in which a problem is posed is essential. Decision-makers recognise a certain situation, its context, its probable outcomes and the solution. Therefore, experience is imperative because the higher the level of experience the more versed the decision-maker will be in terms of identifying a problem and coming up with potential solution. Once the situation has been identified and acknowledged, the decision-maker creates a scenario, which will be modified until he is comfortable with it. Naturalistic models, tools and techniques are quite prevalent in the fields of banking, defence, oil and gas, aviation and aerospace (Gore et al., 2015).

2.4.3 Data, Information, Knowledge and their Inter-Relationships

According to Spiegler (2000, p. 4) knowledge management “can be viewed as turning data (raw material) into information (finished goods) and from there into knowledge”. Furthermore, researchers such as Davenport and Prusak define knowledge as “a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experience and information” Spiegler (2000, p. 4). In organisations, knowledge can be ingrained not only in documents but also in practice, routines and rules (Davenport & Prusak, 1998, p.5). The aforementioned description is a practical explanation of the meaning of knowledge in organisations. Alavi & Leidner (1999) postulate that knowledge management is a methodical and structurally specified process for obtaining, organising, and conveying tacit and explicit knowledge of individuals with an organisation in order for others to utilise it, in an effort to be more effective and productive. The authors further described a knowledge management system as an information system developed to enable the structuring, collection, integration and dissemination of organisational knowledge. It is imperative to note that any definition of knowledge must start from data and information, information is data exploited and given relevance and purpose.

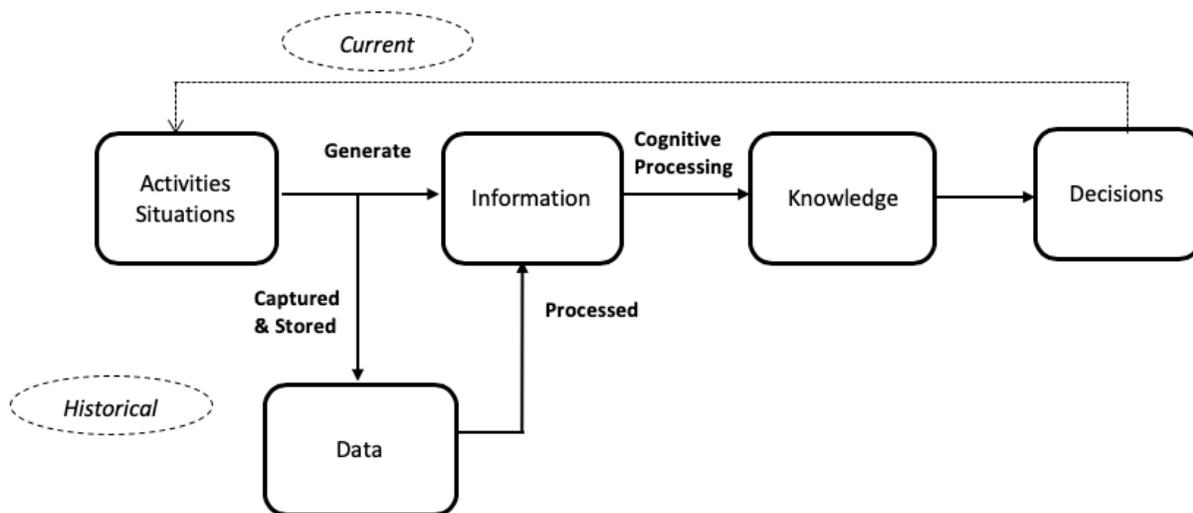


Figure 6 - Data, information, Knowledge Process Model (adapted from Liew, 2007)

Figure 6 above illustrates the typical process of the transformation of data into knowledge which is then used to make informed decisions.

2.5 Sports

2.5.1 Sports History and Evolution

A review of history shows that sports originated from games being played for entertainment and leisure purposes and gradually transformed into an industry worth over \$1.5 trillion globally. A look back at that time shows that there were only 7 sports, which included, equestrian events, javelin, long jump and running, among others. Fast forward to today we have over 8,000 different sports (Liponski et al., 2003), and still counting. While there is no agreement in literature over the definition of “*sports*”, a common definition shows it usually includes “*characteristics of competitiveness*”, “*non-hostile nature*”, “*physicality*” and “*conformance of predefined rules*” (Wright, 2009). Sports long history has demonstrated its growth and evolution from “*an activity of game to an activity of organisation*” which has been systemised, professionalised and commercialised (Baca, 2014). Correspondingly, the field of sport science came to existence in Germany in the 1960s (Link & Lames, 2014). It is made up of a collection of research methods, knowledge and theories that deal with the subject matter and phenomenon linked to sports. According to Ryall (2013, p. 129) “*sport is a human enterprise that represents a multitude of human compulsions, desires and needs: the urge to be competitive, to co-operate, to excel, to develop, to play, to love and be loved, and to find meaning in one’s existence.*” Sport is “*playful*” or a form of play (Caillois 1961; Huizinga 1955), in that it is “*spatially and temporally limited*” and it takes place at a specific time and space (Loy, 1968). The result and sequence of play is “*uncertain*” (this is said to be one of the most attractive features of sports – one that spawns excitement). It is “*governed by rules*” that guide the “*process*” and the “*result or outcome (i.e winners or losers)*” and lastly it occurs outside of “*real life*” and bears resemblance to what may be referred to as “*make belief*” (Loy 1968; Veblen 2009). Additionally, there is competitive element involved in sports and games, where two or more parties play against each other for a final result. To put into simple terms, sport or games cannot exist without the competitive element. Sports and games often necessitate “*physical skill, strategy and chance*” (Loy, 1968, p.2). The only noteworthy difference between sports and games is the need to exhibit “*physical prowess*” in sports, and often requires methodical training at an elite level. Taking into cognisance the above-mentioned similarities, (Xiao et al., 2017; Weiss 1969) postulated that “*sports is rooted in game*”, that is to say, a “*game is an occurrence*” while a “*sport is a pattern*”. The long-standing patterns

linked to sports comprise of *organisational, technological, symbolic and educational* components.

To start with, **organisational components** involves the organisations of sport in regard to government, sponsorship and teams. Sport is usually undertaken by cautiously selected “teams” that can be perceived as “*stable social organisations*” (Xiao et al., 2017), recognised as a business and sometimes to a greater extent traded on the stock market. Sports “*organisations*” are made up of players with particular roles (for example, a centre forward and a defender in Premier league football). Similar to other organisations in other sectors, sports organisations have assets (the players) who are tasked with producing the “*sport situations*”. Nevertheless, there are other “*producers*” involved in the form of coaching staff, medical staff and trainers. With the growth of sports, the list of producers continues to increase to include the data scientists, physios and medical staff. Furthermore, the continuous commercialisation of sports has made it necessary for sports organisations to be assessed based on both its sport performance and its financial performance (Caya & Bourdon, 2016).

The second component in sports is the **technological component**, which involves and highlight the “*material equipment, physical skills, and body of knowledge which are necessary for the conduct of competition and technical improvements*” (Loy, 1968, p.8). More specifically, technology in sports encompasses the knowledge possessed by the players and the teams (i.e. team play & spirit, cooperative capability) the physical equipment (i.e. training facilities, ball, stadium), the physical skills (i.e. resilience, strengths & endurance, control ability) and finally the skills and knowledge possessed by the manager, coaching staff, team physios and other producers of sports in effort to enhance the “*technological component*”.

The third component in sports is the **symbolic component**, and this covers features around “*secrecy, display and rituals*”. The sports sector like the business sector is known for its strict confidential conducts, secrets pertaining to game strategies and several other technical aspects are handled with high priority. Loy (1968) equated this to “*approved clandestine behaviour*” and put it into perspective by stating that, the starting line-up of a football match will not be published by sports teams until a few minutes before the start of the match. Nevertheless, the main distinctions between the sports and business sector in relation to its symbolic features is the deep rootedness of display throughout a particular sporting event. The final feature of the symbolic component which is “*ritual*” is imperative in developing “*solemnity*” between all sport producers (players,

coaches, physio, media, referees) involved in the sporting event. Said rituals could be in the form of shaking hands before a match or the chanting of supporters while the game is going on (Serazio, 2013), some rituals even extend to the superstitious behaviours exhibited by the players (Bleak et al., 1998). Dissimilar from organisation in other sectors, consumers of sports - politically referred to as “fans” - play a major role in the symbolic component of sports, as spectators and also partakers, although this is contingent upon their roles and level of engagement. Sport consumers are driven by sentiment, social values and emotions, while consumers in other sectors are usually driven by the utility of a particular product or service (Biscaia et al., 2012; Underwood et al., 2001). Ranadive, head of NBA’s Sacramento Kings put it into perspective by stating that “*fans will paint their face purple, fans will evangelise, every CEO in every business is dying to be in our position – they are dying to have fans*” (Cohen, 2017).

The final component of sports is the ***educational component***, and this involves the activities of obtaining skills and knowledge (discussed in the technology component above). These skills and knowledge are usually obtained through some form of rigorous and repetitive instruction termed training. Sport producers such as players take part in this training, but it also applies to other sport producers such as the coaching staff, managers and even referees (Loy, 1968). This is particularly accurate for the latter category as they often have to hold appropriate certifications before they can take up work. Additionally, the educational component is ingrained in the everyday routine of all sports clubs, it is quite evident that training takes up a large portion of what sport producers do from day to day. Consequently, it can be said that the educational component is linked to the technology component – the need for technological brilliance (both in “*intellectual knowledge and physical skills*”) in events and the need for incessant technical improvement exemplify the significance of “*formal education*” (Xiao et al., 2017).

The above discussion has proffered background and context that has portrayed how sports organisations work within an idiosyncratic environment of standards, programmes, procedures and structure. Parallel to other sectors like retail and manufacturing, the sports industry has been undergoing some changes in terms of digitalisation. Gray & Rumpe (2015, p. 1319) defines digitalisation as “*the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business*”. The latest developments in digital technologies has stimulated enormous interest and transformation in the sports sector, a sector which is sometimes perceived as traditional in approach (Smith &

Stewart, 1999). Consequently, this has brought about profound recognition and appreciation of the use of data and technology in sports throughout all the aforementioned components. The implications of digitalisation on all four components will be discussed in the subsequent sections.

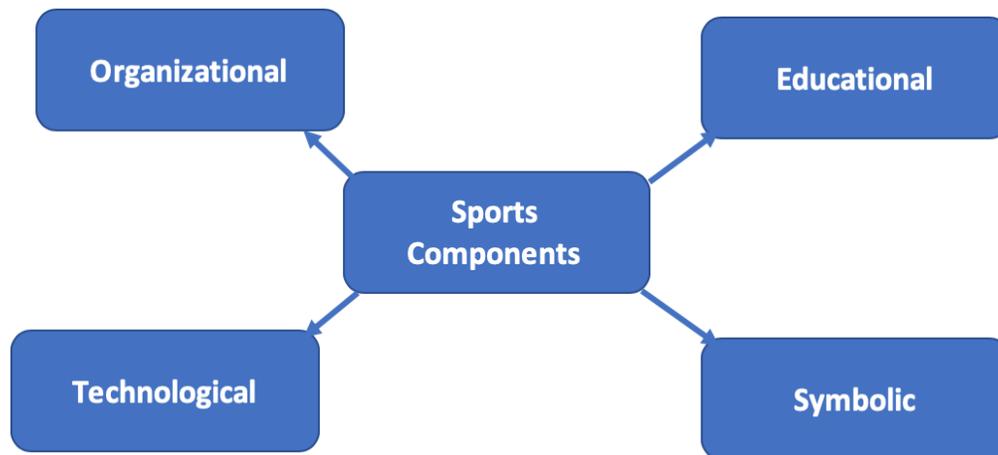


Figure 7 - Sports Components

2.5.2 Sports Ecosystem Defined

An ecosystem is a term frequently used in the information technology sector and is defined as a system or network of organisations that drives the creation and delivery of information technology, products and services (Iansiti & Richards, 2006). In a similar vein, a number of research papers have investigated sports from an “*ecosystem*” perspective (KPMG Report, 2014; Rundh & Gottfridsson, 2015) giving credence to the applicability of this term. The study conducted by KPMG Report (2014) affirmed that the sports ecosystem “*comprise different dimensions or segments that go into establishing and developing a sport and there are various stakeholders in each segment*” (Da Silva et al., 2017, p. 414). These dimensions or segments have been identified as: *Sport Governance, Fans, Media, Sponsors, Leagues, Clubs and Players*. Taking into cognisance the above definitions, it can be surmised that the sports ecosystem is essentially made up of the important segments that make up sports and ensure its adequate operation and continuous advancement. Due to the scope of this research, only certain stakeholders relevant to the research aim and objectives were considered, these have been delineated in **Chapter 3.9**.

2.6 Implications of Digitalisation on Sports Components

2.6.1 Implications of Digitalisation on the Organisational Component of Sports

The changes that ensued from the digitalisation of sports organisations are varied. First of all, the most evident implication is that new wave of digitalisation allows for the use of touchpoints which facilitates the integration of numerous stakeholders of sports organisations. That is, sports digitalisation combines a number of organisational functions like player registration and tournament into an extensive information communication technology system with various mechanisms like webpages and mobile phone applications (Xiao et al., 2017). Digitalisation goes beyond the network of sport organisations and this is because there are new entrants/stakeholders in sports like the software providers and data providers coming into the sports ecosystem. For instance, a relatively new sports data provider paving the way for sport digitalisation is SAP – a Germany-based software company. In 2014, they developed a “Match Insight” software system during the FIFA world cup for the German National team. The German national team were able to analyse data collected from the video cameras installed in the stadium and process it into useful information that the coaching staff and even the players could view on their portable devices. It has been claimed that the use of this software aided them in winning the FIFA world cup (McKenna, 2014). Undeniably, Davenport (2014) did make note of the fact that, in order for sports organisations to be able to capitalise on these new wave of technologies they will have to depend on a far larger network, due to the fact that most sports teams are relatively small “*businesses*” that cannot afford to invest in data analytics and technology. Thus, the introduction of new entrants will allow for further growth and complexity of sports network or ecosystem. Governance in sports can also benefit from digitalisation in the sense that digital technologies helps eliminate the tedious manual process, thereby allowing real time access to match results and also historical data (Premier League, 2018).

2.6.2 Implications of Digitalisation on the Technological Component of Sports

The most evident of the impact of digitalisation on this particular component is specifically on the physical equipment. Information technology hardware and software are now crucial parts of this component. In contrast to a few years ago, sport is now heavily reliant on what is referred to as “*Digital Assets*”. The latest developments in technology has allowed for more data to be generated

and collected, which has further inspired interest in the area (Travassos et al., 2013). These latest developments can be attributed to the growing use of Internet of Things (IOT) technologies which includes sensors, wearables (pocket-sized devices that has capability to send and receive information) and tools for analysis. Davenport (2014) and Xiao et al. (2017, P. 9) put this into perspective by stating that “*hidden information on the technological component of sports (e.g. the level of physical skills of certain players, performance data of players and team) has become increasingly accessible, traceable, and visible to the public*”. For example, Major League Baseball (MLB) installed a camera-and-radar-based system in every stadium of the MLB teams and this allows for the tracking of real time data about baseball (e.g. ball speed & trajectory) and also the performance of each individual player in great detail (Neyer, 2014). Likewise, stadiums in National Basketball Association (NBA) have all been fitted with cameras that allow teams to track players movements, combine the data collected and analysed in an effort to generate state-of-the-art statistics on performance of players. This information is not only used by the teams but also by policy makers of the league, the commentators, pundits and even the fans (Steinberg 2015). According to Xiao et al., (2017) the prevalence of data and technology in sports has three main implications. Firstly, the “*technological component*” which is crucial to the vying of the sports is now affected by digital means. That is, it is important in the development of physical skills of players and teams, and also in the “codifying” of said skills into data and information which can then be utilised to assess performance and aid in the preparation of forthcoming games. The second implication is the way that scouting and talent identification has been influenced. Scouting and recruitment department used to be fully reliant on intuition and experience when identifying and recruiting players, they would have to travel across the globe to watch players in their natural setting. However, with the massive amounts of data being generated through digital means, this is a thing of the past. Scouting departments can now sit in the comfort of their offices and scout, additionally there is now little reliance on “gut instinct” when recruiting players and a shift toward data reliance for more objectivity (Steinberg, 2015). Lastly, the ever-increasing presence, accessibility and visibility of real time performance data can now be utilised in engaging with fans (both in the stadium and outside), commercial endeavours and improving game-day experience (Klug, 2015).

On a final note, digitalisation is also influencing and giving rise to the popularity of electronic-sports (E-sports) and this in some regard represents the “*commercialisation of physical*

skills and knowledge possessed by sports producers” in developing digital products. E-sports is now an industry of its own worth over \$600 million that boasts of hosting competitive tournaments featuring world-class professional gamers (Gray, 2018).

2.6.3 Implications of Digitalisation on the Symbolic Component of Sports

This can be perceived as the change in the way in which sports organisations showcase and build their identity. There are numerous channels to do this now due to digitalisation. That said, digitalisation can sometimes alter the symbolic qualities of a particular sport, specifically sports that are known to have long standing traditions. For instance, an example that epitomises this is the move by Juventus FC - one of the oldest sports team – to change their jersey emblem from what was used for decades to a more progressive modern emblem that represents a minimalistic design (Guardian Sport, 2017). This particular change received mixed reactions from fans, with some stating that it alters the values associated with the club’s traditions and history, and others saying that the new emblem is personalised for and suits the modern world dictated by commercialisation and of course digitalisation (Guardian Sport, 2017). Furthermore, various digital channels make it easier for stakeholders to access sporting events and other pertinent content better than before. An example of this is the livestreaming of electronic sport (E-sports) through channels such as Twitch.tv. The implications of this are countless. Firstly, sports have been extended to another platform regarded to as “online sphere”, and as a result this presents new opportunities for diversification for sports organisations by engaging in this new trend. Another instance where sports ritual was undertaken via digital means was when Francesco Totti, Ex-player of As Roma Fc scored a crucial goal in a local derby, during the celebrations he decided to take a selfie with the joyous fans in the background and posted the picture in real-time on his social media platform (Bandini, 2015). This particular moment was later publicised by the media as an historical one, a moment when a mobile device and social media was part of a very popular sports ritual. This has facilitated the online consumption of sports for fans of the game (Seo & Green, 2008). Nowadays, the role of social media in sports and sports culture can never be underestimated. It is viewed as essential for all sport teams including other stakeholders like players to have a social media presence. The sports industry is known for its high passion, emotions and its sentimental attachment to the game, therefore it would make sense for sports organisations to utilise social

media platforms as a tool to increase their reach and while also enhancing the way sports is consumed by fans.

2.6.4 Implications of Digitalisation on the Educational Component of Sports

The educational component of sport can be seen as the “*development and continuous improvement of the physical skills and knowledge that are deemed essential to be competitive*” (Xiao et al., 2017, p. 11). As previously alluded to in the technological component section, the collection and analysis of data about players, teams and their performance have been massively enhanced due to digitalisation. Sports organisations now utilise the data for training and match preparations. Performance analysis and injury prevention are some of the ways in which data analytics is used in the educational component of sports (Davenport, 2014). There is now a trend of data analytics moving from just descriptive data (describing what happened) to diagnostic and prediction elements (what is going to happen and how can we prepare for it). To give an example, Bayern Fc and data company OPTA collect around 70 million data points from one single match, these data will then be incorporated and used in unison with data collected from training sessions through sensors and cameras installed at the ground, this data can then be used to assess and observe the team’s performance (Tan et al., 2017). However, in order to completely take advantage of data analytics, sport stakeholders must fully embrace technology and utilise it to the best of their ability (Davenport, 2014). The aforementioned statement by Davenport (2014) is quite pertinent because the sport industry is one that is seen to be very traditional and digitalisation might pose a threat “to the way we’ve always done things” mentality in sports (Smith & Stewart, 1999). According to Lewis (2004), the dichotomy between how things used to be done (“*heavy reliance on intuition and tacit knowledge*”) and the new way of doing things (“*reliance on technology and evidence*”) is very much real and challenges the central tenets of the industry. The advancement of technology and subsequently the accessibility of data and information also enables the democratisation of sports. But this can be a doubled edged sword situation, because on one hand, customised training for individuals based on instructional technologies has the potential to lower the learning curve or barrier such that in the future the average sportsman would be able to gain education and training. On the other hand, this might lead to a situation where “*information asymmetries*” (no more tactical edge or secrets) is massively reduced because of all the performance data available to the public. This can admittedly be a difficult issue for sports being a naturally secretive industry but the

advancements in technology show no signs of slowing down anytime soon and this will no doubt get to a point where every club has all performance data of their opponents. To put this into perspective, even the fans and the media now partake in the analysis and interpretation of the data on numerous websites. That is, an area that used to be exclusive to only experts can now be accessed by basically any and everybody (Giorgio, 2019).

The sections above have given an account of how digitalisation has stimulated massive change in the sports industry and consequently sports teams, with data and technology becoming more and more ingrained into the fabric of all sports; from football, cricket, rugby, baseball to the newly established domain of E-Sports. Since the focus of this research is to investigate digitalisation within on pitch decision-making and this is directly related to the technological and educational component of sports (“*development and continuous improvement of the physical skills and knowledge that are deemed essential to be competitive*”), emphasis will be placed only on the technological and educational component via the digitalisation of sports rather than the other components. Decision-making is considered to be one of the main skills essential to be elite and competitive in sports. The subsequent sections will delve into the specifics of digitalisation of sports such as sports analytics/performance analysis.

2.7 Sport Analytics, Performance Analysis and Technology

In 2003, a book titled Moneyball was released describing how Oakland Athletics Baseball team used statistical techniques to create a roster of cost-effective players. The term Moneyball is often attributed to Billy Bean and Oakland Athletics of Major League Baseball. Basically, a baseball team with a very limited budget and a very ambitious manager realised they could not compete with the likes of Boston Red Socks, so they decided to find a more cost-effective way of buying the right players and ultimately competing. Billy Bean employed a method known as sabermetrics; which is the empirical analysis of baseball. They were able to use statistics to find good players other teams overlooked. This system worked for them as the team won over 15 games in a row, an event that had never happened before in the history of the club. As one would expect this method drew the attention of other teams in the baseball league, who started to implement this same method. In the world today, Major League Baseball hires the highest number of analytics experts (ESPN, 2015; Maxcy & Drayer, 2014). That said, the Moneyball phenomenon actually transcends Major League baseball, as other parts of the sports sector such as the National Basketball

Association (NBA), National Hockey League (NHL) and English Premier League (EPL) all have started to utilise analytics. According to (Holman, 2018, p.1), sports analytics “*refers to the use of data and advanced statistics to measure performance and make informed decisions, in order to gain a competitive sports advantage*”. Performance analysis is another term generally used to refer to the use of data, advanced statistics and video technology to inform performance and decision-making. O’Donoghue (2009, p. 3) defines performance analysis “*as the investigation of actual sports performance, with the aim being able to develop an understanding of sports that can inform decision-making, enhance performance and inform the coaching process*”. It can be deduced from the definitions above that sports analytics and performance analysis are basically the same and have the same end goal – improve performance/gain competitive advantage. What distinguishes performance analysis from other fields is simply the fact that it is concerned with actual sports performance as opposed to activity undertaken within the confines of a laboratory or data collected by means of questionnaires, interviews and focus groups. Nevertheless, there are circumstances within performance analysis setting that allows for laboratory-based exercises to be conducted, but with the condition that what is being investigated (a particular skill) is of interest within that particular sport. For instance, within golf, collecting detailed data relating to the golf swing of an athlete is next to impossible during actual competition (O’Donoghue, 2009). Hughes & Bartlett (2008) cited in Hughes & Franks (2008) postulated in a book entitled “*What is performance analysis*” that investigation which involves the analysis of sports performance (during training and competition) can be referred to as “*performance analysis*”. Crucial physiological variables like heart rate response can be collected in many circumstances including one that allows for such measurement to be made like in sports competition. The intricacies and ever-changing nature of sports necessitates the need to observe and measure performance in order to understand it fully. Although, coaches and other sports stakeholders have long observed and analysed performance subjectively ever since sports existed. That said, observations based on only subjective evidence have limitations, as the observations can be swayed by bias and previous experiences (Hughes & Bartlett, 2008). The coaching process shown in figure 8 is a continuous cycle of performance and repetition, in which the coach is required to assess, intervene and provide useful feedback to players with the aim being to improve their current and future performance (Carling et al., 2005). Franks et al. (1983) demonstrated how performance analysis and feedback technology could be integrated into the coaching process.

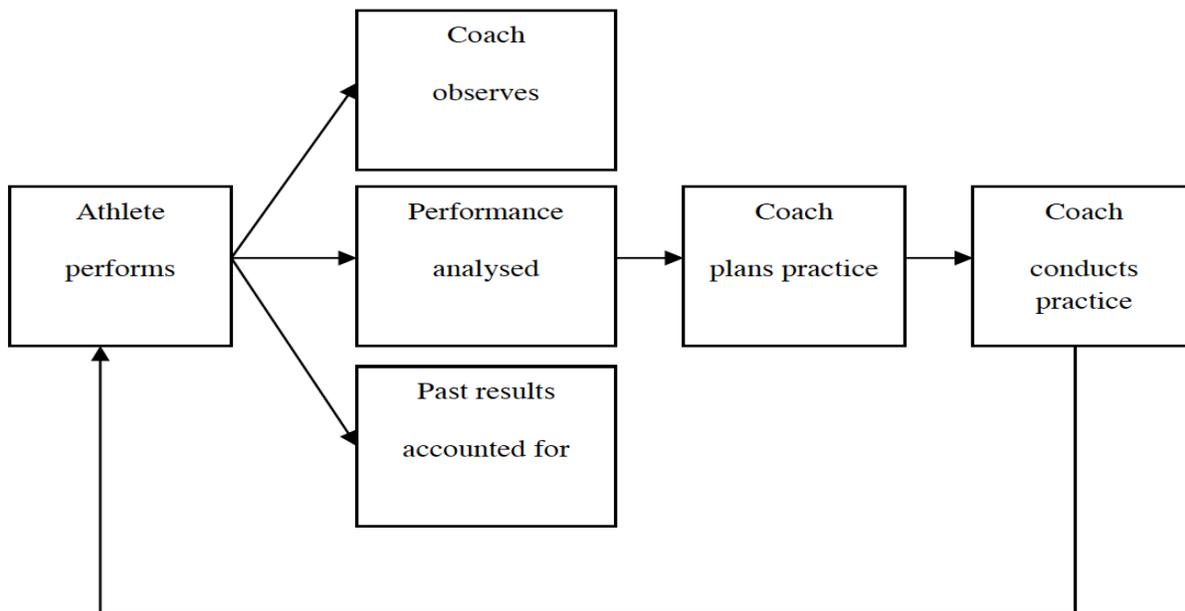


Figure 8 - Coaching Process (adapted from Franks et al., 1983)

Feedback is of the utmost importance within the coaching process and can sometimes dictate performance of a player and the team (Cassidy et al., 2008). Subjective observation has been shown to be undependable and inaccurate, as even the most knowledgeable coaches are only able to recollect just 59.2% of crucial events happening during a 45-minute match (Laird & Waters, 2008). The above process was further developed by Hughes (2008) - referenced in Groom (2012) - depicted in figure 9. Understandably, this process depicted in figure 9 would have improved and changed to meet the needs and current demands of sports today.

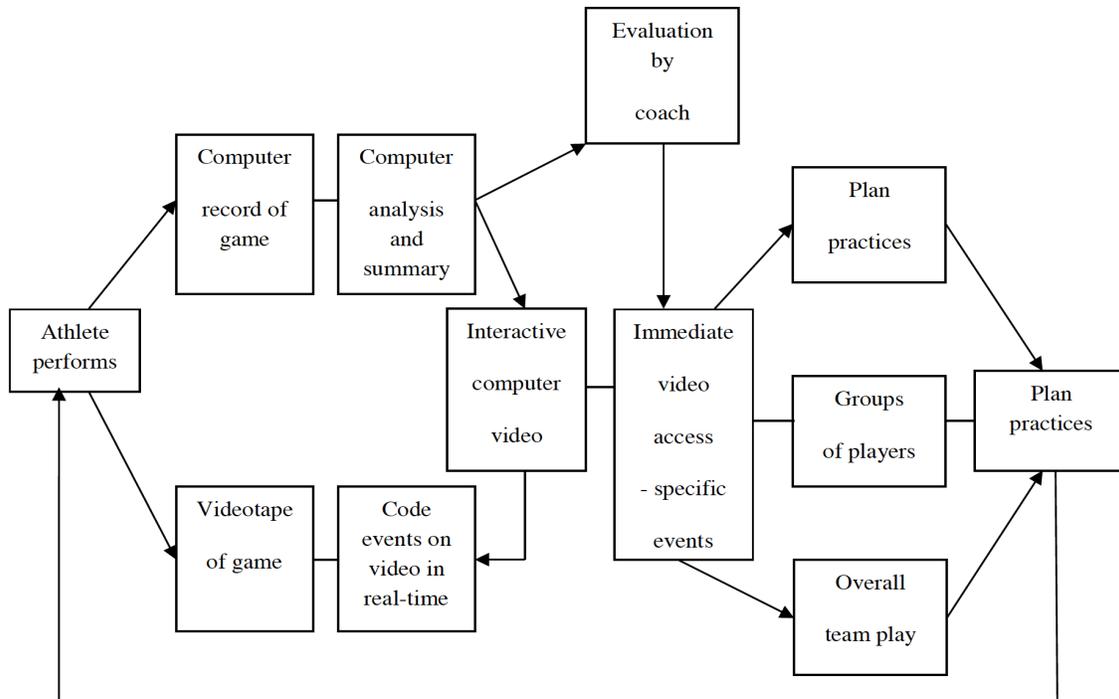


Figure 9 – Use of video feedback within the coaching process (adapted from Hughes, 2008; Groom, 2012)

This inability to recollect key events during the match certainly highlights the need for a more unbiased, comprehensive and objective view of performance. A study conducted by Franks & Miller (1986) corroborates the aforementioned statement, they discovered that international soccer coaches only recollected about 42% of key factors accurately. Consequently, the rationale for utilising performance analysis is to overcome the limitations of only utilising subjective observation and to provide “*objective information*” in order to realise a next level understanding of performance (O’Donoghue, 2009). The use of objective information can potentially influence decision-making and can consequently enhance performance. Performance analysis is typically done in order to offer support to players and also the team. The analysis of sport performance is often undertaken by a professional performance analyst whose role is to liaise with the coaching staff so as to provide them with adequate feedback, which they in turn use to provide feedback to players. Accurate and well-timed feedback is crucial in professional sports and this has no doubt increased the interest and utilisation of performance analysis systems (McGarry & Franks, 2003). Performance analysis feedback can be quantitative or qualitative in nature, with quantitative being the application of statistical analysis to the player and team’s performance, and qualitative being the use of video analysis which allows for the observation of technical (passing, shooting), tactical

(decision-making, emotional state) and physical (movements, work rate) aspects of performance (Carling et al., 2005). Nevertheless, feedback can have a negative effect on players and as such the player skill level must be considered when providing feedback. Hughes & Frank (2004) stated that in order to facilitate development of performance, expert players require additional detailed feedback compared to those less skilled, however there should be a balancing act, because if feedback is too exhaustive it can have an adverse reaction on performance. According to Lewis (2014) the coaching culture within sports, especially football, has been known to have a traditional approach towards performance. However, the current environment seems to be more progressive and appreciate the value obtainable as a result of adopting an objective approach. Sports like football typically have staff which includes strength and conditioning coaches, physiologists, performance analysts, nutritionists and psychologist. Though the structure of performance analysis is dissimilar between clubs (Reilly, 2006; Lewis, 2014). There has been an evident increase in the use of performance analysis within professional football clubs (Carling, 2009; Lewis, 2014). A study conducted by Blaze et al. (2004) found out that nine out of ten Premier League Managers who answered questionnaires utilised “*computerised notational analysis*”. Performance analysis is now becoming increasingly available, especially in terms of the utilisation of software programs such as SportsCode and Dartfish. These applications do not require a coach to possess statistics knowledge to use it (James, 2006). Furthermore, other sport data companies such as Prozone and OPTA now offer services where data from matches are now collected and analysed on the club’s behalf. According to Hodges & Franks (2008), performance analysis is generally accepted as an educational tool to enhance coach’s ability to recognise, analyse and assist in the improvement of technical and tactical problems.

2.7.1 Timing of Feedback

One of the main benefits of collecting data in professional sports is that it can underline areas of strengths and weaknesses in the game and provide a holistic picture of what is to be expected in forthcoming matches (Carling et al., 2005). This enables the players and the coaches to be well prepared, devise a strategy to counteract the opposition so as to neutralise any threat and exploit their weaknesses, and this of course will be planned and worked on prior to match in training. Modern performance analysis systems enable matches to be coded, identify crucial events during the game and shared on mobile devices and iPads which allows for review by coaches in real-time

and players at the half-time break. Although the rules of the game set by Football League forbid the live transmission of video directly to the technical areas, they can be transmitted somewhere else within the stadium. One way this can be done, suggested by Haines (2013), is that Apple devices can be used to create a wireless hotspot which member of staff will be connected to and therefore will have access to the footage and statistics through an iPad. This information is then used to inform the half-time team talk. Such methods provide the coach with objective information which forms the basis of decisions made during the game. A single game of sports generates a lot of data and video footage of critical event that happened during the game, such as successful passes and shots. As a result of this, quite a lot of time is dedicated to the analysis of the data collected from each game so as to analyse the players and team performance thoroughly, evaluate the overall performance from both sides and most important of all, plan adequately for future training and matches (Carling et al., 2005). Post-match analysis and feedback plays an important role within the coaching process (Thelwell, 2005). However, this can be a difficult task, since the turnaround time is always short, previous data collected on opposition is unusable while preparing to play a totally different team. Consequently, the timing of feedback must be swift and given at the appropriate time, otherwise it can be ineffective and confuse players even more.

The section above has proffered literature on the importance of sport analytics and performance analysis on the feedback process within sports coaching practice. Plausibly, the main aim of any performance analysis programme is to facilitate the process of feedback for the coach, who is tasked with giving feedback to the players. This feedback is used to inform future performances; therefore, feedback is arguably one of the most important elements in terms of decision-making of coaches and the players. As this research is looking at how digitalisation increases knowledge and influences decision-making abilities of coaches and players, it is conceivable to assume that feedback plays a crucial role in this process, and important in understanding decision-making processes. The sections below will proffer more literature on performance analysis applications.

2.7.2 Performance Analysis Applications

Performance analysis has many applications in sports, one of which is the capability to detect and identify injury risk factors in players. According to Drawer & Fuller (2002), the overall injury risk to professional sports players has been reported to be 1,000 times higher than the risk of industrial

occupation, and this has been echoed in the ever-increasing significance given to performance analysis in the area of injury prevention (Bartlett, 1999). “*The application of performance analysis software within injury prevention screening can assist medical staff in identifying risk factors and developing performance plans in collaboration with a strength and conditioning coach to correct any issues*” (Haines, 2013, p. 4). Another application of performance analysis is within the area of injury prevention, it can reveal trends and patterns in declining physical performance in the late stages of a match, highlighting a need for more training or an injury risk. An example of performance analysis influencing the coach’s decision-making is showcased in the 2002 English Premier League, with Arsenal FC’s coach regularly substituting Dennis Bergkamp in the latter stages of the matches because the data had indicated the player’s performance typically declines after the 70th minute of a typical match (Kuper, 2011). However, James (2006) cited in Wright (2015) stated that there is very little research investigating how data and technology influences decision-making abilities of coaches and how it impacts the players and ultimately performance. This can somewhat be attributed to the secretive nature of sports, (discussed in the symbolic component of sports in **section 2.5.1**) as teams are naturally apprehensive of losing their competitive edge. Global Positioning Systems (GPS) and other electronic tracking systems enable coaches to monitor training load to see if the players are being overworked or underworked and helps them make decisions accordingly. These devices can collect data relating to heartrate, position and speed concurrently (Valter et al., 2006; Arastey, 2018). This real-time data enables coaches to tweak the volume and intensity for specific players based on available evidence. For return from injury, data can also be used to create a benchmark, and such will inform coaches as to when a player has fully recovered from injury and is available for selection (Carling et al., 2008).

Performance analysis can also play an important role in talent identification (Williams & Reilly, 2000). Coaches and scouts typically claim they can “*see a good player*” and therefore sometimes sign players based on subjective evaluation or intuition (Carling et al., 2005). Performance analysis can offer data relating to technical, tactical and physical performance which can be utilised to make objective decisions toward recruiting a player. Third party companies such as OPTA and Prozone offer a wide-ranging scouting program, that can potentially assist with player recruitment. An example of the utilisation of data to inform recruitment is showcased by Manchester City FC, they used data to sign Yaya Toure, Carlos Tevez and David Silva, who all then allegedly went on to lead the club to premier success that season. Similarly, Liverpool FC

utilised data to inform the signing of Stewart Downing in 2011, when they discovered that he was one of the best midfielders in the premier league due to pass success rate and chances created in the previous season. Stewart Downing, however, did not have a particularly fruitful season, as the player was unable to replicate the success he had at his old club. This seems to imply that performance data should be utilised as a guide rather than solely during the recruitment process.

2.7.2.1 Performance Analysis Stages

Performance analysis involves routine stages of analysis that occurs after a system has been implemented and adopted by those utilising it (O'Donoghue, 2009). The initial stage of performance analysis is data gathering, this can be done during or after the game. There are a number of methods that can be used to collect data during and after sports performance. Notational analysis is a method through which dynamic and complex circumstances can be recorded and analysed. This method allows the data to be collected in an efficient way, while also providing a holistic and crucial view of the game. Computerised notational analysis systems like Hawkeye capture important information and even allows the ball to be tracked in sports like tennis and cricket (James, 2006). Carling et al. (2010) highlights that advance systems are now used for tracking multiple players at the same time during training and matches. Such systems include GPS based systems and video tracking techniques. While some systems require human interference and manual operation, majority of the systems are fully automated. Player tracking systems such as Prozone can gather physical data, which includes distance covered and number of sprints. This provides a good indication of the demands of the game, which the coach can use to create individualised training plans for each player, preparing them for the intensity of the game (Carling et al., 2009). This is done after the data analysis stage, which is in the second stage explicated below. The second stage is the analysis of data that has been collected, this can be done during or after the game depending on the game situation at the time and the efficiency of the performance analysis systems put in place. The information gleaned from the data analysis can then be used to inform decisions going forward. The details gleaned from the performance analysis systems allows the coach to identify position specific demands and the factors that cause variability (such as fatigue) between players playing the same position (Mohr et al., 2003), the quality of the opposition, playing methodology and pattern, the environmental and game conditions (Rampinini et al., 2007). The third stage involves the communication of the information gleaned to the relevant

stakeholders such as the coaches, players and sporting director. Each stakeholder will receive information specific to their needs or what they have requested previously. The method of delivering the information will vary from stakeholder to stakeholder. For instance, a player or team can be shown relevant video of events that occurred during the game. O'Donoghue (2009) highlights a feed-forward mechanism where a player can be analysed during training and the information gleaned in training will be used to prepare the player for the next game.

According to Alamar (2013), sport analytics has two key goals: The first is to save the decision-maker's time by making all the pertinent information available and easily accessible. So instead of wasting time on gathering data, the decision maker can focus on analysing relevant information. The second is that sport analytics offers new insights to decision makers. As data increases in size/volume, so does the possibility of gleaning new information with the help of analytic models put in place.

2.7.3 Virtual Reality

A virtual environment can be referred to as an amalgamation of technologies that offer people the possibility of interacting – in an efficient manner - with 3D computer generated models in real-time by using their organic skills and senses (Burdea, & Coiffet, 2003). In essence, a virtual environment can be utilised in a number of ways, which include: to offer the user an “*immersive experience*” for entertainment reason, it can be used in designing a new product or service, it can be used to investigate and glean useful information from data in a perceptive manner, it can also be used to train people around complex and maybe even dangerous situations in a safe, comfortable and applicable setting (Vignais et al., 2015). The aeronautic, entertainment, health, oil and gas and automotive industries have been identified as the early adopters of this technology. With the advancement of technology, increase in computing power and availability at lesser cost, virtual environments can only get better. This has become evident as more and more industries have started to take advantage of it for the added value it is capable of providing. A particular industry where virtual environment seems to be very applicable is sports (Vignais et al., 2015). Sport performance is one area where sports teams are trying to understand better with the aid of virtual environment. According to Miles et al., (2012, p. 715), “*the effectiveness of any virtual environment used for training can reasonably be measured against three criteria: it must be realistic enough, it must be affordable, and it must be validated to show that it works as designed*”.

The authors stressed the need to satisfy the aforementioned criteria and stated that if these criteria are satisfied then and only then can the use of virtual reality in sports be an accepted and effective tool for training and other relevant purposes.

The manner in which people acquire and carry out motor skills has been a diverse and complex set of questions that has gained the attention of researchers and dates back to the 19th century (Woodworth, 1899). That said, in spite of research on skill acquisition that dates back over 100 years, the fundamentals of successful coaching have not been explicitly clarified. Although, what is explicit is that before one can develop expert performance, people must spend substantial amount of time practicing. This can take between five to ten years, (Starkes, et al., 1996), and this “practicing” must be tailored to the skills needed and “sport specific”. Through research it has been identified that the process of skill acquisition and coaching are quite similar in that they normally follow three distinct processes, which includes; “*conveying information (observation learning)*”, “*Structuring practice (contextual interference)*” and the “*nature & administration of feedback (feedback frequency, timing and precision)*” (Farley et al., 2019, p. 1). Furthermore, the pressure and time constraints put on players and coaches often means that they need to learn and train more than one skill during training. Therefore, during training sessions it is usually required of the players to learn and practice a number of skills. The literature on skill acquisition also implies that learning is usually augmented when players are obligated to practice and learn a number of skills in a single training session. Additionally, literature suggests that these skills must be practiced in an arbitrary manner, in essence, making sure the real-life games are replicated during training session, to provide the same level of challenges (Vickers, 2007). However, according to Miles et al., (2012), replicating real life games in training session can be a bit difficult and inefficient because most times in order to simulate the real-life event during training sessions other players have to be inactive. As a result, not all players get the same amount of benefits from training. Basically, more could be done in terms of accurately recreating real life scenarios that is not only specific to a player’s need but a scenario where other skills can be learned in the process. This is perhaps where virtual reality can be a real game changer for sports in terms of training. For instance, virtual reality allows coaches to be able to recreate standardised situations that help the players gather more information about the environment they are playing in and also their performance.

2.7.3.1 Virtual Reality and Computer Games

Computer gaming has been popular since the 1980s (Metro, 2015) and thinking back now no one would have thought that they would inform virtual reality in professional sports. This is in part because of the fact that more computer games are considered to have “*low functional fidelity* -” (This is essentially how much a simulated task is similar to reality). That said, a lot of tools and technique used in the computer gaming industry are applicable and relevant for the success of virtual reality in professional sports. These include computer graphics and hardware peripherals. For instance, the introduction of the Nintendo Wii led to a noteworthy evolution in the computer gaming market. Nintendo Wii comes with a “Wii Remote” which has embedded sensors and accelerometer, and this allow users to play games using physical gestures in addition to physical buttons. The next version of the Wii brought with it more features which allowed users even more control over how they interacted with and played the game. Wii MotionPlus for example was designed to be used for fitness purposes and as such can measure the weight of the user, which allowed them to improve their fitness as well as enjoy the game. There is also a popular version of the Wii that offers sports packages such as baseball, tennis, golf and bowling, and according to research conducted by Dörrfuß et al. (2008) there is evidence that the Wii is helping users acquire skills that are applicable in real life sports. Similarly, Microsoft Kinect for the Xbox console, utilises a camera to keep track of user’s movements. The Kinect can create a map showing all movements of the user and can track about twenty different points of articulation of each user within its radius. For example, in a game like boxing, the user stays in one spot but imitates the movements, actions and gestures of the actual athlete using their arm or leg.

Video games offers state-of-the-art technology which is not only fun and interactive but also affordable. They also have the capability of creating a particular sport setting and atmosphere, from the stadiums to the balls, commentary and fans. This provides an immersive experience for the users and make them feel like it’s the real thing. However, a particular drawback of the video gaming setting is that a user can pause the game to make several choices about how they wish to proceed. In a virtual reality environment, this would not be possible or ideal because the idea behind virtual reality environment is to help athletes develop skills applicable to real life setting, as such it has to be as real as possible.

2.7.4 Research on Sports Analytics & Performance Analysis

Previous research within the domain of sports analytics and performance analysis have a propensity to focus on more quantitative aspects such as the identification of movement and performance patterns (Ronglan & Bahr, 2010 ; Hughes & Franks, 2005), the identification of key performance objectives (KPIs) (Hughes & Bartlett, 2002; Csataljay et al., 2009), developing notational analysis systems and the significance of guaranteeing reliability and validity within the data (James, 2006; O'Donoghue, 2007) and the measurement of workloads (Dennis et al., 2005). The aforementioned body of work is founded by the positivist research paradigm which posits that reality can be verified through experiments and use of statistics.

Nevertheless, more recent research within this domain has redirected focus in an attempt to understand how data and technology is utilised in sports from an interpretivist perspective. Davenport (2014) conducted qualitative research with 25 representatives from professional sport leagues to assess how they use analytical approaches and techniques. The research was able to identify some of the challenges being faced in the sport industry around the implementation of analytics. The author concluded by giving some recommendations on how sports teams can improve their analytical capabilities.

Bampouras et al. (2012) conducted qualitative research to explore the in-practice application of performance analysis by interviewing a sport scientist, a coach and a former professional athlete. The participants were chosen from different sports (Tae Kwon Do, Netball and Rugby) in an effort to make their results more applicable to the broad use of performance analysis. The findings from this study suggested that, although the players are the object and receiver of performance analysis, they are not involved in the process itself, implying a more authoritative coaching practice. The coach and the sport scientist collect pertinent data and feedback to the players. The authors stressed the need for future research of the use of performance analysis across larger samples and contexts.

Similarly, Maxcy & Drayer, (2014) used a case study approach to present the current state of analytics in the sport industry. Their main focus was on competition analysis and business analytics. They stated that sport teams differ in terms of their use of analytics and also their interest towards it. Additionally, there is no “one system fits all” analytics system in existence. They concluded by stating that sport analytics approaches, and technologies will continue to develop, however it is imperative that sports organisations have a good understanding of these approaches.

Caya & Bourdon (2016) developed a framework emphasising the value of business intelligence and analytics for competitive sports. Their suggested framework was based on past studies related to “*business value of IT*” and “*IT-enabled*” competitive advantage. It describes three major levels of analysis (institution, organisation and individual) where business intelligence and analysis tools can be effective and the internal and external factors (conversion contingencies) that may hinder its effectiveness. They believe that their framework is beneficial in clarifying “how” and “where” business intelligence and analytics can be most effective in terms of creating value for competitive sport teams. However, they stressed a need for future research in terms of studying the entire process of value creation in sports context; “from perceptions towards the potentials of business intelligence and analytics to the realised value created from such investments”. They argued that a lot of doubt still exists in the world of sports about the real value of business intelligence and analytics tools. Figure 10 below depicts their framework.

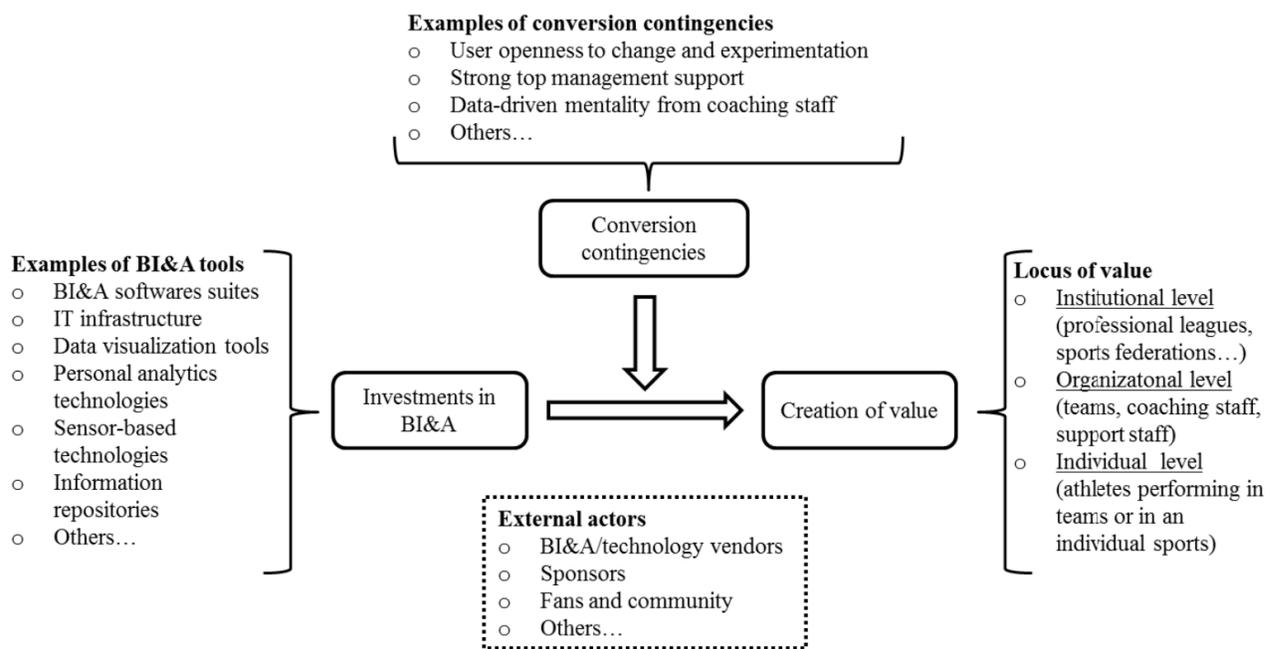


Figure 10 - Model for Value Creation from BI&A in Competitive Sports (adapted from Caya & Bourdon, 2016)

Their framework highlights important elements and concepts in the sports analytics sphere; analytics technologies and tools, key stakeholders, conversion contingencies and the benefits of implementing sport analytics. Nevertheless, as highlighted by the authors, as the paper was

conceptual, there is a need for further research, not only to improve on but to also test the utility of the framework.

Francis & Jones (2014) employed a mixed methods approach to gain an in-depth insight into the current views and opinions of elite rugby players towards performance analysis. Seventy-three elite rugby union players completed semi-structured questionnaire, additionally, four players completed semi-structured interviews. The findings from the study suggested that the players perceived performance analysis as a valuable and beneficial tool which can aid their development and preparation. The authors postulate that coaches should utilise different delivery methods to accommodate different learning styles within the team and foster engagement while also allowing the players to conduct analysis of their own performance (Francis & Jones, 2014). The authors underscored the importance of delivery methods and the way in which feedback is given to the players.

Wright (2015) conducted an investigation using a mixed methods approach involving forty-eight footballers from three different sports, additionally, twenty-two out of the forty-eight were chosen to complete a semi-structured interview. The findings from the study suggested that coaches will naturally have different methods in terms of how the feedback sessions are conducted, some coaches employ a player-centric approach while others are more coach-centric regarding how information is delivered to the players. Overall the players suggested that they were involved in the discussions and as a result this supported their learning and development. The author, however, was quick to emphasise that a panacea approach or “*one size fits all approach will not be effective when giving feedback*” (Wright, 2015, p. 134), because the players will have differing rate of information absorption and therefore the coaches need to consider different learning approaches and preferences. According to Wright (2015) even though there is now considerable amount of research within the performance analysis realm, there is still a need to better understand how information is shared between the people involved in the process. The author concluded by stating that it is difficult to establish a relationship between performance analysis use and performance enhancement (especially when employing positivistic approaches). Consequently, the author suggested that interpretive research approaches could possibly demonstrate the impact of performance analysis in a particular club. Furthermore, it was postulated that employing such approach could provide insight into learning and development of players, specifically decision-

making, and the transfer of information from analysis to training and preparation for games (Wright, 2015).

2.7.5 Examples of Implementations of Sports Analytics

Based on the review of literature conducted above, sports analytics can be classified into 3 categories in terms of its usage. It can be used in player and game performance, business development, and for player health and injury (Davenport, 2014; Maxcy & Drayer, 2014; Agarwal & Mehrotra, 2016; Mondello & Kamke, 2014). Some examples of how the sport industry is using sport analytics for the aforementioned categories will be presented below. It has been said that no other industry has the same type of analytical initiatives in progress like the area of professional sports. Various sports now use analytics for different purposes, from Formula 1 racing to Basketball. In football a monitoring device called OptimEye S5 is used to enhance performance and mitigate injury. In American football, wireless sensors are now being grafted into player's shoulder pads so that the medical team can receive real-time data, which is then analysed and acted upon. In Swimming, a device called XMetrics is used to track activities such as heart rate, number of strokes and number of laps. This device is worn on the head whilst swimming and provides real-time feedback to swimmers. The sport industry continues to invest in sport analytics as evidenced by the NBA's move to install camera system in all their arenas. The camera systems assist in capturing data about players and ball movement. An Australian company called Catapult developed a GPS system that can be used to monitor movement of players and make sure they are not overworked. The system has 3 main benefits; performance analysis, injury analysis and tactical analysis. A number of teams in the NBA, EPL and NHL have invested in this system (Arastey, 2018). Although the NBA and NHL do not allow teams to use this device during live matches, as a result analysis is limited to training sessions. Several third-party companies now provide data and analysis about games for almost every professional team in sports. For example, OPTA and Prozone provide data to teams in the EPL. Prozone partnered with Arsenal F.C. to install cameras at the Emirates stadium in London. The camera system similar to one installed in all 30 arenas of the NBA will capture player interactions, passes and tackles. In the NBA, teams now use analytics within several departments for business development. The Orlando Magic is a perfect example of this and are regarded as leaders when it comes to analytics. They implemented a remarkable fan promotion strategy in partnership with one of their sponsors – Tijuana Flats restaurant. During the

2012-13 season, they implemented a strategy whereby during home games, fans who possess tickets were entitled to free tacos from their sponsors whenever the team scored more than 9 three-pointers in a game. The idea behind this initiative was that whenever fans go to redeem their taco in exchange for the ticket, they would be able to analyse consumer information. They were able to detect that; *“26% of the fans had never been to Tijuana Flats Restaurant”, “66% would not have visited without the promotion” and “85% would visit again”* (Mondello & Kamke, 2014, p. 6). Insights such as the aforementioned can help both the corporate sponsors and professional teams know their return on investment and know what they stand to gain or lose working together.

In the NHL, it seems like Tampa Bay Lightning have mastered the art of using analytics for data-based decisions and this has helped them with transforming their overall brand. Tampa Bay use data analytics and technology to detect new ways to increase revenue and also to improve their customer relationship management (CRM). In the aspect of CRM, they are able to collect, organise and store data relating to consumer behaviour and demographic by using software solutions and vendors. Data is collected daily and that informs the advertising team about new consumers and their attributes. They have been able to increase sales transactions to astonishing levels using analytics initiatives which in turn increase revenue. The strategy they implemented was one that involved offering customised team jerseys to fans with season tickets. The jerseys were embedded with radio frequency identification (RFID) chip and this made it easy for Tampa Bay to monitor buying habits and preferences. Additionally, they use dynamic ticket pricing (DTP), which is a ticket pricing technique where the management set prices based on criterion such as team form, period of the season and seat location. This not only increases revenue but also helps reduce losses in that they will be able to know the games the fans are more likely to watch and which games they are not likely to come to the stadium to watch.

Correspondingly, in MLB, San Francisco Giants partnered with Qcue – a company that offers dynamic and time-based solutions – to introduce DTP. Ticket prices varied depending on the conditions of the market. This system was introduced in 2009, fast-forward to 2011, a number of teams in MLB started to implement this same system, and according to Dunne (2012) the number of teams further increased, and this practice even spread to the NBA and NHL (Tampa Bay Lightning – as discussed previously).

2.7.6 Section Conclusion

The preceding sections have presented background and contextual information on the utilisation of data and technology in sports. The subsequent sections will present literature on decision-making in sports and will introduce learning organisation theory as a theoretical lens. These concepts will be used to contextualise the research questions and justify the other concepts discussed so far.

2.8 Decision-Making in Sports

Perceptual cognitive skills such as decision-making and anticipation are very essential for successful performance in numerous complex and ever-changing situations (Van et al., 2016). According to Kaya (2014, p. 338), “*decision-making can be observed as the intellectual process resulting in the selection of a belief or a course of action among several different options*”. For example, in the military, in sports and even when driving a car, the ability to identify visual information and to choose and carry out the suitable action is crucial to achieving high-level performance (Williams & Ericsson, 2005). The domain of sports provides an extraordinary setting for the study of decision-making because of numerous compelling reasons. In sports, there are “*decision-agents*” in form of managers, coaches, referees, players and of course the fans. This offers an opportunity to investigate a number of exciting decision-making designs and approaches in sports. Among the countless forms of activities humans engage in, sports provide a specific context: whether it’s just for fun or a profession, people compete against themselves or others with the goal of outperforming each other. Gréhaigne & Godbout (1995, p.492), describing the essence of team sports stated that “*in an opposition relationship, each of two teams must coordinate its actions in order to recover, conserve, and move the ball so as to bring it in the scoring zone and effectively score*”. In sports, particularly team sports, playing well often means selecting the “*right course of action at the right moment*” and executing that course of action well and consistently during the course of a match (Gréhaigne & Bouthier, 2001). Marasso (2014), postulated that having a good understanding of the process underlying decision-making and problem solving can aid in explaining the reason behind why individuals choose one option over another given a set of alternatives when the outcome is unknown. Previous theories of decision-making have suggested that the human brain is capable of performing complex computations so as to solve decision problems. However, scholars like Simon (1955), demonstrated that the human brain is limited in

its “*computational abilities*” and that the human brain does not need to weigh up all available information so as to make decisions. Previous studies have also studied decision-making in the laboratory environments using controlled test (Williams, 2007). These studies have tackled “*cue utilisation*”, “*pattern recognition*”, “*visual search behaviour*”, and the use of “*situational probability*” as the basis for decision-making (Williams, 2007; Horrocks, 2016, p. 674).

The dynamic environment of team sports is defined by activities of high intensity involving a combination of perceptual cognitive functioning and motor skills. This “*dynamic*” environment often requires individuals to execute skills under certain time constraints and physical pressure which requires those individuals to be able to make quick and accurate decisions (Sunderland & Nevill, 2005). The capability to perform skills and make decisions quickly and correctly requires “*tactical understanding*” and “*game intelligence*” and usually includes a combination of decision-making and anticipatory skills (Elferink-Gremer et al., 2004). Due to this, a number of literatures have been published exploring the nature of decision-making in an effort to better understand it. Horrocks et al. (2016), conducted a case study to explore how a professional player achieved success in professional football through consistent decision-making on and off the field. This particular study was aimed at documenting the decision-making process of a former player from the point of preparation to when the player was physically making decisions on the pitch in order to achieve the utmost performance. The study produced a preparation cycle and cognitive process for decision-making in football through the accounts given by the player. The authors emphasised that what makes their study different is the fact that they took a qualitative approach in documenting the professional player’s deliberate practice activities and how it affects cognition and decision-making. The study was however limited to just one player and one sport, therefore making it difficult to generalise the findings. Additionally, the authors postulated that the sports industry is now reaching a plateau in terms of physical fitness (measuring performance), there is a pressing need to better understand the acquisition of decision-making abilities and a need for players who make swift appropriate decisions in time constrained and high-pressured environments. Relvas et al. (2010, p.166) corroborated the aforementioned statement by postulating that the sport industry’s focus is on “*performance, entertainment and financial profit*”.

Similarly, Richards et al. (2012) proffered a framework intended to help develop decision-making abilities of players, team and also the coach. Their paper demonstrates the incorporation of reflective practice principles and the link between “*off-court*” slow deliberate environment and

“on-court” performance environment. They postulated that the incorporation and collaboration of “off-court” and “on-court” training allows the coaches to structure and form their decisions and also that of the teams, as a result creating a more effective decision-making environment (“on-court”). Furthermore, they stated that decision-making development is attained through a “five-stage process”. The first stage is where the coach’s vision of performance is generated and the development of a mental model of the identified component. Stage two is all about empowering the players themselves by letting them contribute their understanding and experience to the selected component in stage one. This stage produces what is referred to as a “*Shared Mental Model*” and the development of a “*common language*”. The third stage shapes the shared mental model by adding detail to it and the player’s own “*internalised plans*”. This is the stage where the coach shapes the knowledge of the players. The fourth stage is regarding the maintenance and retention of the knowledge acquired when the players are away from the performance environment. The final stage is of course the utilisation, application and the transfer of the knowledge acquired through learning to the ultimate performance environment. The process can be seen in figure 11 below.

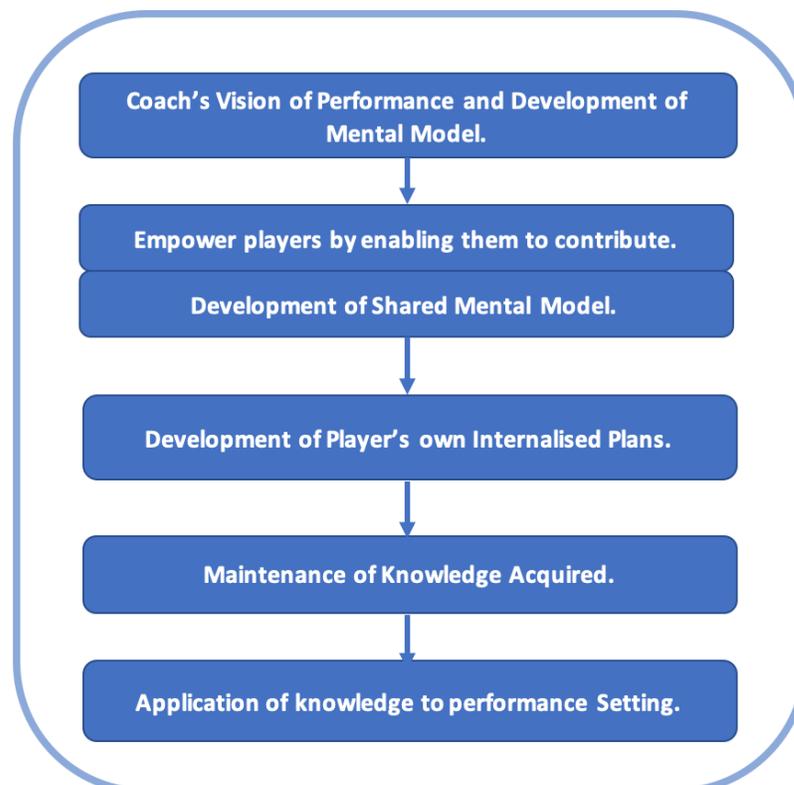


Figure 11 - Five Stage Process of the Development of Decision-making (adapted from Richards et al., 2012)

Furthermore, Abernethy et al. (2001) and a few other notable researchers have conducted studies comparing novice and expert performers and have produced a substantial amount of literature regarding performance of experts. According to Müller et al. (2006) one obvious conclusion to emerge is that individuals who are considered to be experts choose and use different sources of information in comparison to individuals who are considered to be novice performers.

Whilst this amassing literature discussed above has contributed remarkably to the understanding of this phenomenon in sports, it has, however, been explored typically in an isolated environment and with very little thought of how individuals can effectively connect with one another in a team style setting. A pressing question that arises and seems to be unanswered relates to how decision-making can be developed effectively across individuals in a team. This research therefore aims to proffer an answer by investigating how digitalisation influences on-pitch decision-making abilities of players and coaches. Additionally, a wide-ranging scope is being utilised so as to elicit in-depth qualitative accounts from different sports such as football, rugby and cricket. The researcher believes that including a wide range of sports in this study will improve on the previous studies which have been done in isolation and placed focus on one sport.

2.8.1 Key Decision-Making in Sports

This section will discuss the key decisions that coaches and players make before and during a match. The key decisions made within the sports ecosystem fall into two categories; decisions on the pitch and off the pitch. Figure 12 illustrates this and highlights the key decision-agents at the club level. This research will only be focusing on the on-pitch decisions made by the coaches, players and the team in general.

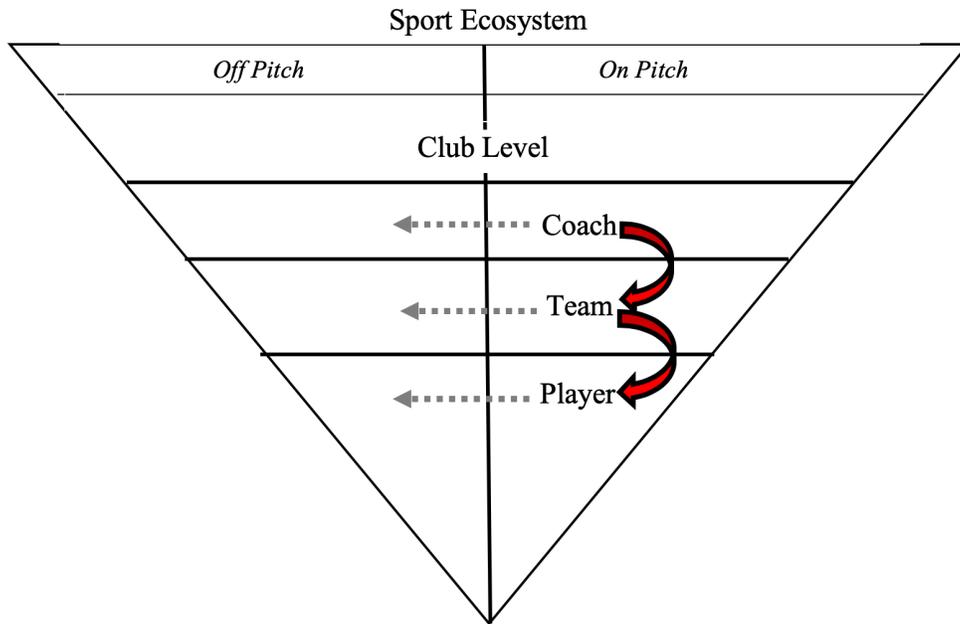


Figure 12 - Sports Pyramid

In the decision-making model above (figure 12), it can be seen that the decisions flow downwards (top-down) from the coach to the team and then the player. The coach is tasked with creating the game plan, which is then conveyed to the team and thereafter each of the players bear the responsibility of making decisions in order to successfully execute the game plan. Decision-making within on-pitch sports is divided into technical and tactical aspects (Kaya, 2014), these will be explored below.

2.8.2 Technical Aspect of Decision-Making in Sports

According to Martens (2012, p. 169), technical skills can be defined as “*the specific procedures to move one’s body to perform the task that needs to be accomplished*”. In an effort to improve team performance in sports, technical qualities of the player’s and coach’s skills and strategies need to be trained in game like situations. Thomas (1994) argued that the process of learning technical skills can be explicated with regard to volume of practice (repetition) and attention to appropriate skill technique during performance. Technical learning of decision-making is categorised into three stages for a player. In the first stage, a novice player is incapable of knowing what they are doing wrong and do not possess adequate knowledge to correct their errors. They require detailed instruction and feedback. In the second stage, the player then comprehends the basics of the technical learning and is in the process of improving their skill (Kaya, 2014, p. 335). They do not

make as many mistakes and start to detect errors on their own. Procedures are more logical, and the players start to understand what is applicable and what is not applicable. Lastly, in the final stage of technical learning, the player executes the skill intuitively in a more dynamic setting without giving much thought to execution.

2.8.3 Tactical Aspect of Decision-Making in Sports

According to Martens (2012, p. 170) tactical skill is defined as “*the decisions and actions of players in the contest to gain an advantage over the opposing team or players*”. Understanding tactical learning within decision-making of both coaches and players requires the appreciation of how precise and practical a tactic is. The successful application of a tactic encompasses executing the appropriate skill by the coach and the player at the appropriate time on the pitch to accomplish the overall strategic aims which were created prior to the start of the game. Strategies allude to the overall game plan while tactics are connected to the strategies created by coaches and players. Gréhaigne et al. (1999) argued that the major difference between tactics and strategy is time. They further stated that “*tactics operate under strong time constraints because they must be decided upon and then implemented under pressure during game play*” (Kaya, 2014, p. 335). On the other hand, strategies incorporate more cognitive processes because there are no time constraints, seeing as how they are determined before the start of the game. Consequently, tactical decisions must be made as quickly as possible, while strategic decisions allow for more slow decision-making. Figure 13 below illustrates this.

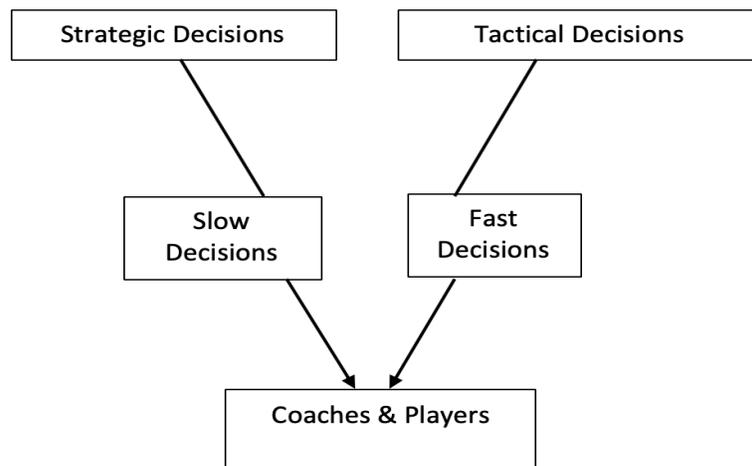


Figure 13 - Strategic and Tactical Decisions (adapted from Gréhaigne et al., 1999)

Technical and tactical skills are interdependent because a particular tactic can only be executed successfully if it is performed skilfully. The ability to be able to move one’s body effortlessly to execute a task or tactic (e.g. passing the ball to a teammate) is the difference between a great decision-maker and a novice decision maker in sports. A study conducted by Evans et al., (1979) investigating rugby players and coaches explained that strategy is the ability to devise a plan on how to utilise skills to gain advantage over the opposition. The authors postulate that a particular team’s strategy is created in an effort to map out the course of the game and dictate the competitive flow and tempo. Additionally, the authors link tactics with the execution of skills during a game and stated that tactics are the way in which strategy is implemented. Correspondingly, Thomas (1994), discovered that research on motor learning classify game performance into two elements: “*tactical learning (cognitive) and technical learning (skill)*” (Kaya, 2014, p. 337). These two elements interact with each other. It is generally recognised that training situations should be similar to real life game performance in an effort to maintain ecological validity. This implies that training sessions should incorporate technical and tactical learning, with a focus on enhancing quality of decision-making of players.

In light of the above discussion it is important to highlight the set of tactical and strategic decisions/actions coaches and players make prior to and during a match in an effort to outperform the opposition. Although, the decisions that players and coaches make before and during the game are numerous, the main decisions which may also encompass other decisions have been summarised in table 2 below.

Table 2 - Coaches and Players Decision-making

Coaches		Players	
<i>Before the game</i>	<i>During the game</i>	<i>Before the game</i>	<i>During the game</i>
<ul style="list-style-type: none"> • Reviewing tactics based on past and current team situation. 	<ul style="list-style-type: none"> • Making sure the game plan is executed correctly. 	<ul style="list-style-type: none"> • Understanding the game plan 	<ul style="list-style-type: none"> • Passing the ball
<ul style="list-style-type: none"> • Choosing the game plan. 	<ul style="list-style-type: none"> • Monitoring player performance. 	<ul style="list-style-type: none"> • Self-reflection 	<ul style="list-style-type: none"> • Shooting the ball
<ul style="list-style-type: none"> • Choosing the team players. 	<ul style="list-style-type: none"> • Making substitutions. 		<ul style="list-style-type: none"> • Dribbling the ball

<ul style="list-style-type: none"> • Making sure players understand the game plan. 			<ul style="list-style-type: none"> • Defending individually & collectively
			<ul style="list-style-type: none"> • Attacking individually & collectively

As alluded to in the discussion above, this table is by no means exhaustive and this is because it would be impossible to account for all the decisions that coaches and players make regularly. That said, the decisions accounted for in the table are typical decisions, which also encompass other decisions.

2.9 Emotion in Sports Decision-Making

It is evident that sport is an emotion laden environment. Sports players are constantly faced with different types of stressors and emotional challenges within and outside sports competitions, linked to their decisions and performance (Meyer & Fletcher, 2007). Emotion is an innate aspect of sports competition, according to Kleinginna & Kleinginna (1981) emotion can be defined as a complex set of interaction between subjective and objective factors. There is a general consensus that emotion can influence players performances, it impacts perception, decisions and as a result can either negatively or positively affect decision-making and performance of a player. Literature has indicated that players have to be cognisant of the feelings of teammates, coaching staff, opponents and even fans. It is imperative for players to effectively communicate and collaborate in an effort to achieve the best result (Kopp & Jekauc, 2018).

2.10 Performance in Sports

Although this research is more focused on the decision-making elements of sports rather than performance, it is equally important to define performance and explicate their relationship. The term performance does not have a standard definition because it can be viewed from different perspectives. It can be perceived as a verb or a noun. As a noun, it can be viewed as a situation where a performer(s) displays a series of developed knowledge, skills and abilities (KSA). As a verb, it can be viewed as the process of executing a plan of action for the implementation of knowledge, skills and abilities during a “*performance event*” (Portenga et al., 2011). Therefore,

performance as stated by Portenga et al. (2011, p. 10) means “using *knowledge, skills or abilities, as distinguished from merely possessing them*”. Aoyagi & Portenga (2010, p.254), also stated that “*successful performance requires both the development and mastery of KSAs and the capability to consistently and reliably deliver (i.e. perform)*”. It is important to note that performance in this context is not linked to the business setting, where performance would relate to financial status or productivity. Here, it is in terms of executing a particular action/plan by using knowledge, skills and abilities (KSAs) in order to outperform an opponent. From the above descriptions it can be extrapolated that in order to increase performance, “*knowledge, skills and abilities*” have to be elite level, and this points to superior decision-making.

2.11 Sports – At a Glance

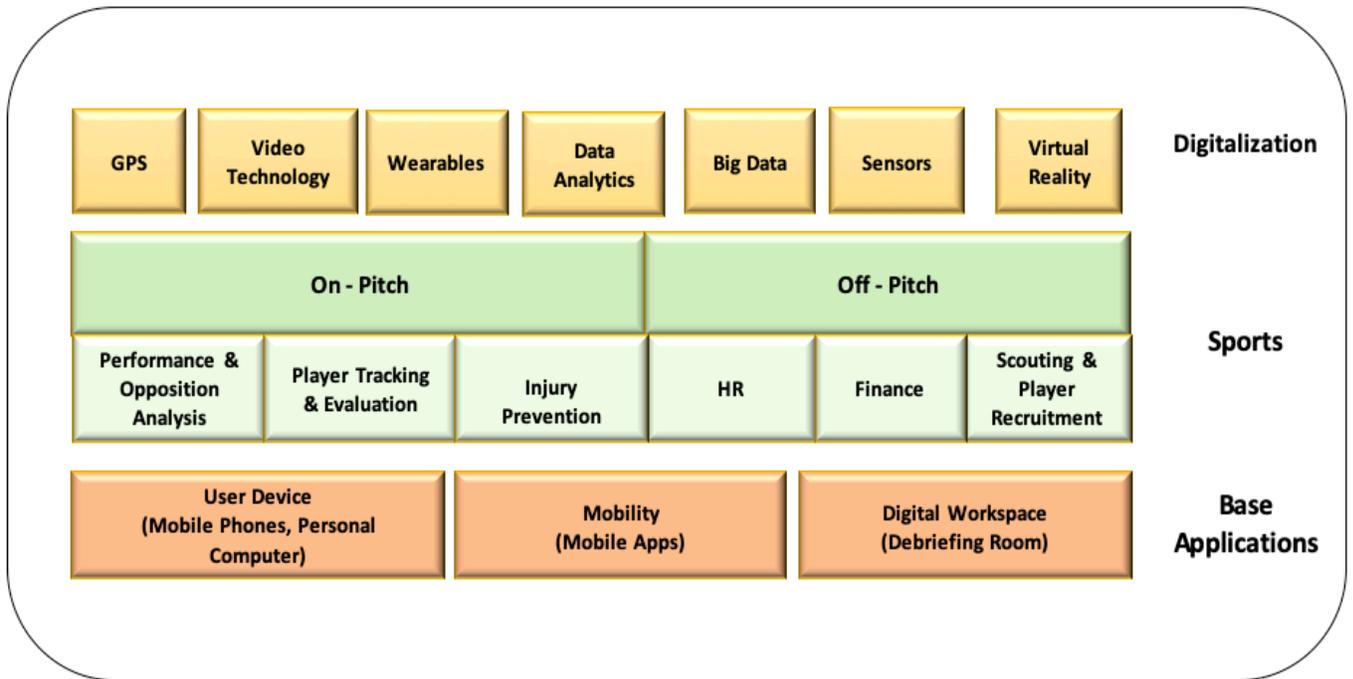


Figure 14 - Conceptual Model of the Reviewed Literature - Technology in Sports

Figure 14 above depicts and summarises the sports ecosystem with regard to digitalisation. The first layer enumerates the main technologies that make up the term “*digitalisation*” within the context of sports. The second layer highlights the two main areas in which digitalisation is being utilised (on and off the pitch). Additionally, the second layer further drives-down into specific categorisations of on-pitch and off-pitch utilisations. The third and final layer highlights the base

applications, this is the layer through which information (gleaned from data and technology) is disseminated and absorbed by the team.

2.12 Management Theory - Learning Organisation

The use of theory in research has become increasingly important, Caya & Bourdon (2016) postulated that researchers should utilise theories and concepts in studying sports analytics. Furthermore, Godsell et al. (2013) emphasised the importance of management theory and went further to suggest that it should be included in the research process of a study. Figure 15 below shows how this can be done and when to introduce the chosen theory.

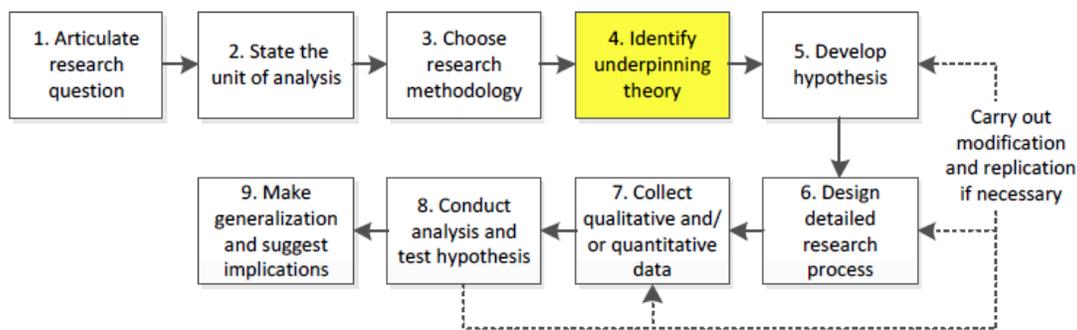


Figure 15 - Embedding MT within the research process (adapted from Godsell et al., 2013)

The concept of organisational learning and learning organisation emerged in the 1980s, however its ideologies are inherent to many perspectives of management (Garratt, 1999). Furthermore, its practices put emphasis on various factors such as, culture, employee participation, organisational strategy and absorptive capacity. A number of studies have contributed to the organisational learning debate and as a result created popular concepts. Notable concepts include Senge's (1991) *The Fifth Discipline*, Pedler et al.'s (1999) learning company model and Argyris & Schon's (1997) double-loop learning. The implementation of learning at the organisational level was mainly conditioned as a collective of individual learning, training and development (Wang & Ahmed, 2003, p. 9). Individual learning plays a significant role within the concepts and practices of organisational learning, as learning starts from individuals. The learning process of individuals in an organisation serves as the foundation of a learning organisation. Nevertheless, individual learning does not automatically lead to organisational learning (Ikehara, 1999), it is the

responsibility of the organisation to incorporate individual learning into organisational learning.

Organisational learning is “*the process through which organisations change or modify their mental models, rules, processes or knowledge, maintaining or improving their performance*” (Chiva, Ghauri, & Alegre, 2014, p. 689). According to Templeton et al. (2002) organisation learning aims to adapt organisations processes via specific and detailed activities. It is important for organisations operating in unpredictable and volatile environments to respond to unanticipated situations more quickly than competitors (Garvin et al., 2008). Organisational learning is seen as a foundation of creating new organisational knowledge, due to its nature as a process of developing new perspectives (Chiva et al., 2014). This ability is incessantly amassing significance because of the complexities and dynamic changes of the business settings (Loermans, 2002). Organisational learning can be seen as a management task that involves controlling and planning. The main focal points are “*organisational strategic creation, capture, and internalisation of knowledge*” (Basten & Haamann, 2018, p. 2). In order for organisational learning to have a positive influence on performance, management of information is key.

Knowledge management which is a similar research stream, uses a systematic process to enhance productivity and effectiveness of members of an organisation through systematic acquisition, organisation and communication of knowledge (Alavi & Leidner, 1999). Within the aforementioned field, organisational learning is perceived as essential for continuous improvement of knowledge creation and utilisation (Wu & Chen, 2014). At the intersection of the two fields of knowledge management and organisational learning is knowledge creation, retention and transfer of processes (Loermans, 2002; Wu & Chen, 2014). According to Wang & Ahmed (2003), the first step in understanding the learning process of an organisation is to understand the learning process of individuals within that organisation. However, organisational context provides a more complex and multi-layered environment than the individual learning environment. The authors proceeded to state that “*it is not simply a collectivity of individual learning processes, but engages interaction between individuals in the organisation, and interaction between organisations as an entity, and interaction between the organisation and its context*” (Wang & Ahmed, 2003, p. 15).

Organisational learning has grown and now spans over several facets of organisational management. A literature review conducted by Wang & Ahmed (2003) identified five main focuses of the organisational learning. These concepts will be discussed subsequently.

2.12.1 Focus on Knowledge Management

Knowledge management and organisational learning are two similar concepts and authors often refer to each concept when proffering definitions and describing their practices. This suggests that both are linked and complement each other. According to Fiol (1994, p .404), organisational learning is “*referred to as the changes in the state of knowledge and involves acquisition, dissemination, refinement, creation and implementation: the ability to acquire diverse information and to share common understanding so that this knowledge can be exploited.*” And the ability to create insights, knowledge and to link past and future activities. Bierly et al. (2000, p. 597) define learning “*as the process of linking, expanding, and improving data, information, knowledge, and wisdom*”. Within all organisations, what is referred to as “organisational knowledge” is somewhat stored into employees/individuals by way of experiences, personal proficiency and skill, and it is equally stored into organisations through regulations and standards, documents, records and rules. A portion of knowledge between organisation and employees/individual is congruent, while another portion of it is dissimilar to each other’s belief system.

Organisational memory maintains the organisational knowledge structure and serves as the basis of knowledge accumulation and creation and represents the ability of the organisation to absorb knowledge. Consequently, in order to foster an effective learning environment amongst individuals and the organisation, the main task for management is to successfully aid the interaction and strengthen each other’s knowledge base (Adler, et al., 1999).

2.12.2 Focus on Continuous Improvement and Incremental Innovation

According to Wang & Ahmed (2003, p. 12), extant literature on organisation learning “*has bias on continuous improvement*” (Buckler, 1996; Scarbrough et al., 1999; Oliver, 2008). The learning organisation is a state which is constantly being striven for and is more an “*aspiration for a continuous process rather than a single product*” (Wang & Ahmed, 2003, p. 12; Hodgkinson, 2000). A learning organisation is perceived as one where individuals incessantly develop their ability to create the results they want, where innovative and extensive patterns of thinking are cultivated, where shared aspiration is unleashed and where individuals are continually learning to learn together. (Senge, 1990, p. 3). Pedler et al., (1999) gave a corresponding definition: a learning organisation should deliberately and purposefully commit to the facilitation of individual learning in order to always transform the whole organisation and it’s setting. In this regard, embracing total

quality management (TQM) is a milestone in attaining a learning organisation state. Total quality management allows organisations to focus on realising and fulfilling customer needs by enhancing processes, understanding the internal customer concept, including all employees, implementing organisational extensive training and development and focusing on improvements in customer satisfaction, cost and quality (Evans & Lindsay, 1999).

Consequently, it has been postulated that total quality management and learning organisations are dependent on each other. While continuous improvement is intended to attain incremental innovation, a learning organisation contributes to incremental innovation via effective learning mechanisms.

2.12.3 Focus on Collectivity of Individual Learning

Previous research as indicated that the role of individual learning is crucial in organisational learning. The organisational learning model is viewed as a system completely dependent on individual learning (Shrivastava, 1983), predicated on individuals and considers them to be “agents” for organisations to learn. According to Argyris & Schön (1997, p. 16) organisational learning “*occurs when individuals within an organisation experience a problematic situation and inquire into it on the organisation’s behalf. They experience a surprising mismatch between expected and actual results of action and respond to that mismatch through a process of thought and further action that leads them to modify their images of organisation or their understandings of organisational phenomena and to restructure their activities so as to bring outcomes and expectations into line, thereby changing organisational theory-in-use*” (Wang & Ahmed, 2003). Learning and behaviour of individuals within an organisation plays a crucial role in the evolution of learning organisation (Senge, 1991). The ability of a group of individuals working together in an organisation to learn faster than individuals in other organisations is what constitutes the only sustainable competitive advantage readily accessible by a learning organisation (De Geus, 1998, p. 71). Organisational learning process should therefore be streamlined such that individuals knowingly engage with one another through education and as a result of experience. Consequently, the key focus of learning organisations should be on valuing, managing and improving the individual advancement of its employees. (Scarborough et al., 1998). Within this school of thought, organisational learning is in a manner the collectivity of individuals learning in

the organisation. Accordingly, it has been posited that learning organisation can be defined with regard to the sum of individual and collective learning accrued over time (Hyland & Matlay, 1997).

2.12.4 Focus on Process or System

Another stream of organisational learning places emphasis on the organisations themselves and states that an organisation is a “*learning system*” (Revans, 2017). Glynn et al. (1992) posits that organisational learning is the process by which organisations recognise and manage their experiences. Numerous perspectives and concepts have been underlined within the learning process such as: Senge’s (1990) five disciplines: “*personal mastery, mental models, shared vision, team learning and systems thinking*”, Popper & Lipshitz’s (2000) Leadership, and Crossan et al’s. (1994) 4I processes: “*intuiting and interpreting at the individual level, interpreting and integrating at the group level, and integrating and institutionalising at the organisation level*”. The system view of organisational learning was taken principally from the information processing perspective. Organisations are perceived as information processing systems, obtaining, interpreting, disseminating and storing information in the organisation. Consequently, four elements of organisational learning process are postulated: knowledge acquisition, information distribution, information interpretation and organisational memory (Huber, 1991).

Within the system view there are two “*sub-streams*”: open system or closed system organisations. Organisations considered to have a closed system have restricted organisational learning, while organisations considered to have open system takes into consideration situational factors and embraces inter-organisational learning as a crucial aspect of the entire organisation learning system (Wang & Ahmed, 2003). Knowledge is obtained extensively, in the organisation as well as outside it. The open system perspective mirrors the contingency approach to organisational management and a few practices from the new organisational models. The highest phase of the learning organisation includes three key aspects of learning: “*adapting to their environment, learning from their people and contributing to the learning of the wider community of which they are a part*” (Burgoyne et al., 1994). Nevertheless, within the system view, important factors necessary for an organisation to succeed such as creativity, flexibility and innovativeness need more emphasis.

2.12.5 Focus on Culture

Literature has indicated that there is a strong emphasis on the cultural standpoint of the learning organisation. Culture is an enabler for sensemaking mechanism which directs and forms the values, behaviours and attitudes of employees. It is through these values that behaviour flows and is guided (O'Reilly & Chatman, 1996). According to Weick (1985, p. 385), “*an organisation’s culture imposes coherent, order, and meaning and enables the institutionalisation of an appropriate sense-making structure to facilitate interpretation of unfamiliar events*”. Drew & Smith (1995), postulate that a learning organisation should be perceived as a “metaphor” as opposed to a unique type of structure, whose employees learn collective processes for constantly creating, maintaining and taking advantage of individual and shared learning to enhance performance of the organisational system in ways that are crucial to stakeholders. Conventional hierarchical cultures are opposed to learning and training and impede the ability of the organisation to keep up with increasing competition in the international marketplace (Jones, 1996). In the modern economy, it is important that knowledge is not just limited to individuals in managerial or professional positions. Every individual within an organisation needs to be a “*knowledge worker*”. Though, success against strong competition is not guaranteed by only having knowledge workers within an organisation. The culture needs to be apt to facilitate and realise their contribution. Consequently, it is imperative that organisations embrace a collaborative team culture as opposed to the no-training oriented philosophy and put emphasis on the process and involvement of individuals within the organisation (Mintzberg, 1994). All members of the organisation have a responsibility and must be able to positively contribute. Furthermore, Jones (1996) stated that “*in addition to the full utilisation of the technical skills and knowledge of employees, a team approach is essential for the effective acquisition of new knowledge and skills*” (Wang & Ahmed, 2003, p. 11). Thus, it is evident that team skills are inseparably connected to effective learning. Literature has indicated that there is a strong linkage between organisational performance and culture (Denison, 1990; Gordon & DiTomaso, 1992). Culture allows an organisation to effectively utilise its knowledge and experience in establishing and realising desired goals.

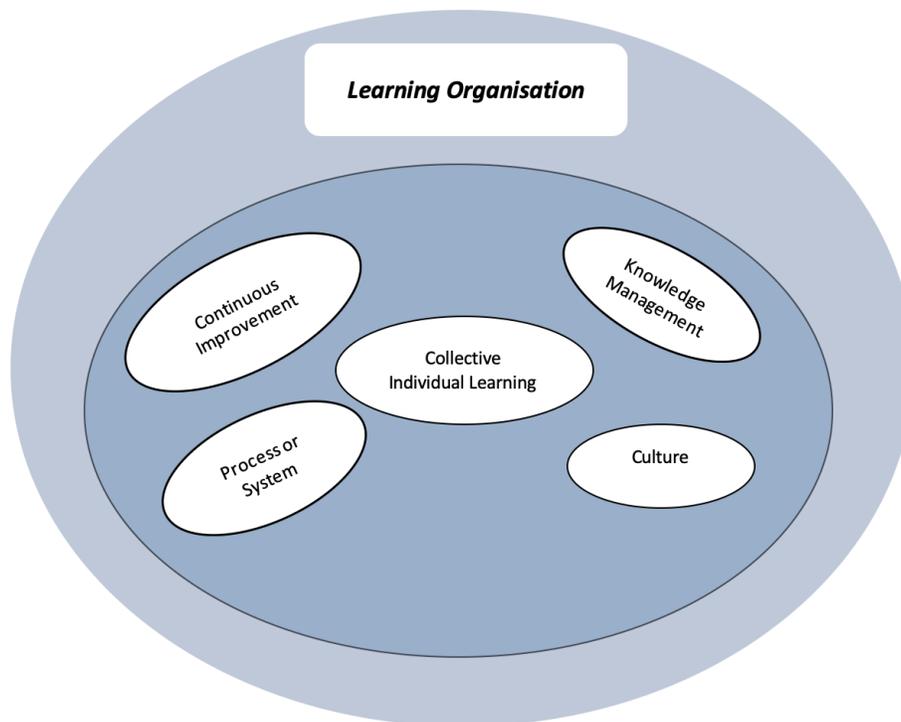


Figure 16 - Learning Organisation Building Blocks (adapted from Wang & Ahmed, 2003)

2.12.6 Relation of Theory to Research

The building blocks depicted in figure 16 above are essential for organisations operating in unpredictable and volatile environments to respond to unanticipated situations more rapidly than competitors. Sports is a dynamic and complex environment with often unforeseen and unpredictable outcomes. Researchers have postulated and emphasised the importance of data and technology in aiding sports team performance. The premise of the learning organisation theory is that learning and facilitating learning of its employees – in this case the coaches and players - can help organisations develop a continuous learning process and ultimately increase knowledge. This raises an important question: *How does digitalisation enable sports teams to develop learning capabilities and increase their knowledge base?*

Taking into consideration the aforementioned, this research utilised the learning organisation theory to drive the research, from the point of creating the research questions to how the data was collected and analysed. It has been suggested that sports organisations are utilising data and technology in everyday practice so as to realise marginal gains and as a result stay competitive in the unpredictable world of sports (Pritchard, 2015). Basically, in order to stay

relevant, sport organisations have to become learning organisations, one that continuously learn so as to improve decision-making and performance.

2.13 Conceptual Framework

The conceptual framework in figure 17 depicts literature that has been reviewed, it shows the different bodies of knowledge and how they interconnect to form the area under investigation, which is the question mark box. It also shows the theoretical lens being utilised to guide the research.

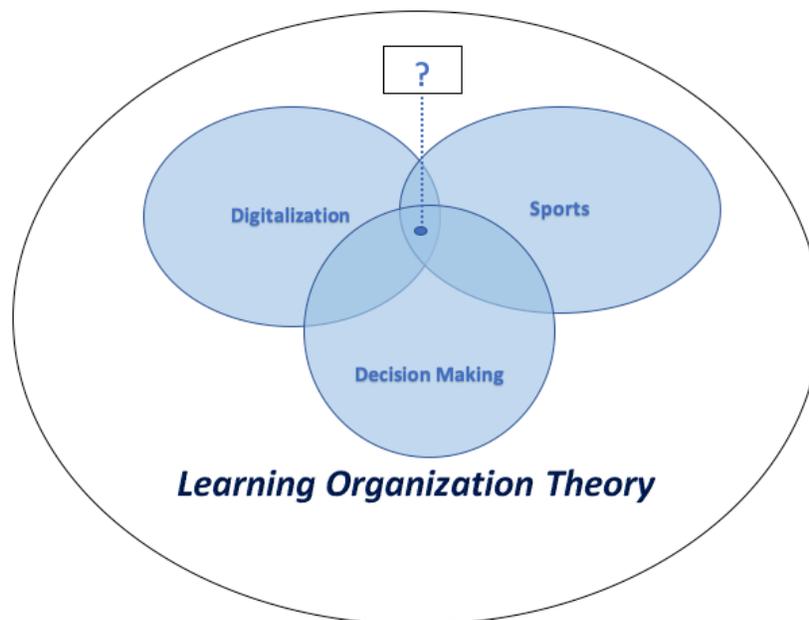


Figure 17 - Conceptual Framework of Study I

Figure 18 presents a more detailed conceptual framework highlighting the main bodies of knowledge and also important concepts within those bodies of knowledge.

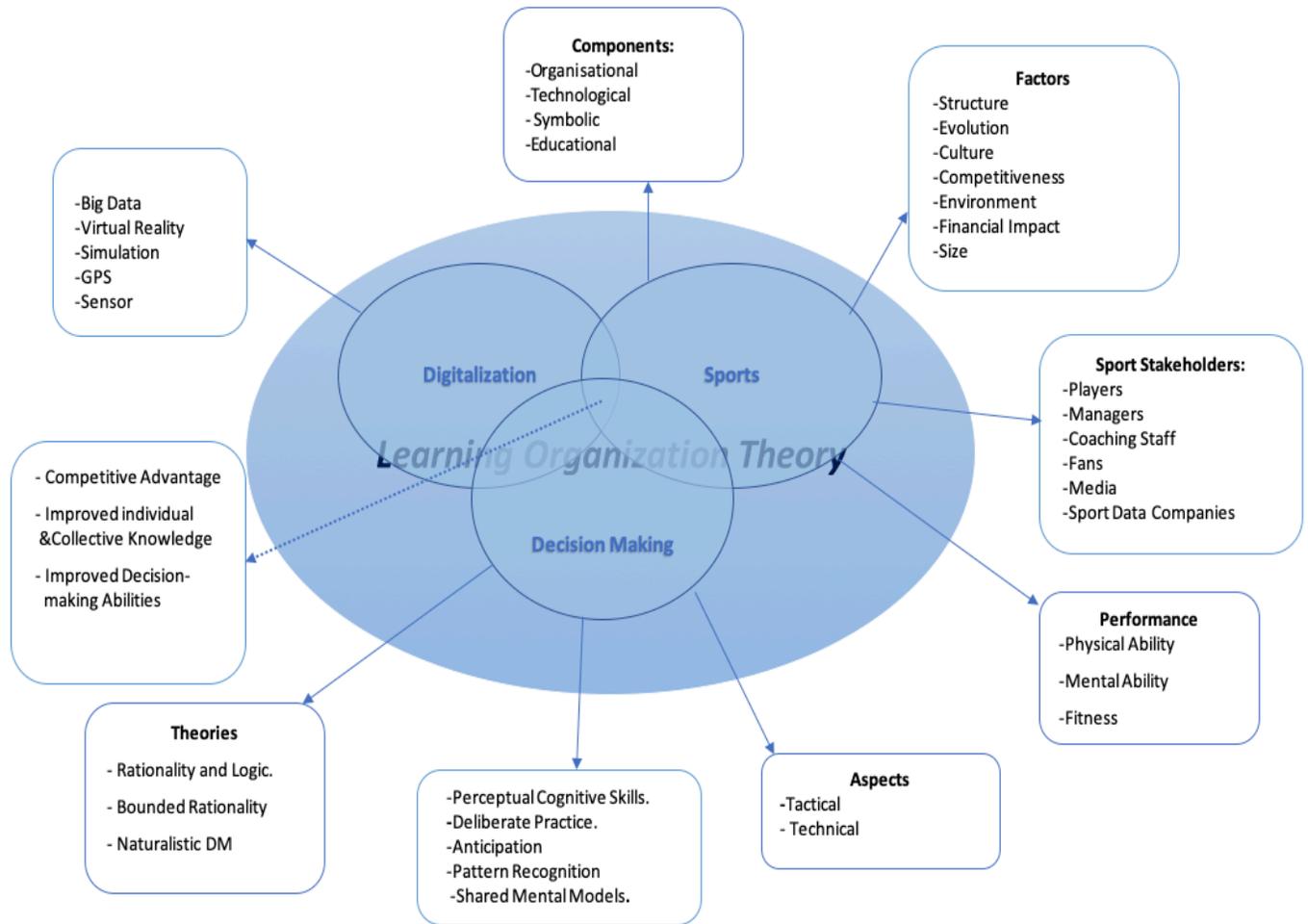


Figure 18 - Conceptual Framework of Study II

2.14 Chapter Summary

This chapter has discussed pertinent literature in congruence with the research aim, objectives and questions. As this thesis aims to investigate the evolution and possible future of digitalisation in the sports sector using a learning organisation theory, relevant theories and literature were discussed in an effort to help situate this study and justify the research questions. The literature focused on three main bodies of knowledge: digitalisation, sports and decision-making, with a fourth intersecting body of knowledge which is the learning organisation theory.

The first research objective of this study is to investigate how digitalisation has influenced the sports ecosystem, specifically within the on-pitch domain. Consequently, it was important to present literature on the past and current state of data and technology utilisation in sports in an

effort to not only identify past and current applications but to establish timelines, which will be key within the discussion chapter.

This chapter concludes with a conceptual framework of the study which showcases the four main bodies of knowledge, shown in Figure 17 and 18 respectively. In the subsequent chapter (**chapter 3**) the research methodology will be presented, and the corresponding paradigm will be explained and justified.

Chapter 3: Research Methodology

3.1 Introduction

The present study follows an interpretivist perspective on the philosophical level, utilising qualitative approach at the methodological level, with semi-structured interviews (33 interviews) as the method for data collection. Interpretivism naturally lends itself to qualitative approach and interpretivists believe that reality is multiple and relative (Hudson & Ozanne, 1988). Renowned researchers and scholars have postulated that these “*multiple realities*” are dependent on other systems for meanings, consequently making it that much more difficult to interpret (Lincoln & Guba, 1985). The knowledge that can be acquired within this is socially constructed. As this research focuses on sports, the unit of analysis is “*sports team*” – a group of individuals working together to achieve a common goal. Within sports structure, that is tantamount to a group of players and also the coach who sets out the plan for how that goal can be ultimately achieved. Participants have been carefully selected using stakeholder analysis while taking into cognisance the limitations of the study in terms of access and geographical issues. The data collection consisted of semi-structured interviews as well as secondary data such as online information and prior interviews. Access to the participants was not without problems due to the nature of the industry being investigated, but with careful and realistic planning, majority of the data was captured in a timely manner. 33 in-depth semi-structured face to face interviews were conducted with industry experts and sport stakeholders, which included: Sport Directors, Managers, Head Coaches, Players, Performance Analysts, Medical Staff and also Sport Data Companies. Additionally, semi-structured interviews were conducted with Academics and Researchers within the field of sports analytics and performance analysis. The primary inclusion criteria for participants was that each of them had some degree of knowledge and experience on the subject matter.

Each interview lasted at least 45 minutes and the longest 1 hour 30 minutes. The online transcription tool ‘<https://otranscribe.com/>’ and NVivo12 software proved to be very useful in the transcription and subsequent data analysis. Audio recorded interactions with participants were transcribed verbatim. Framework analysis was used in the management and analysis of the data.

3.2 Research Questions

RQ-1: How has digitalisation changed the sports ecosystem, (a past, current & future perspective) and what are the current technological practices and their level of utilisation?

The above research question was formulated in order to explicate the impact digitalisation has had on the evolution of sports, while illustrating through extant literature and interviews the past, current and future state of sports. The research question was formed with the assumption that digitalisation has played a major role in the development and structure of sports, with data and technology influencing the main component of sports.

RQ-2: How does digitalisation enable sports teams to develop learning capabilities and increase their knowledge base?

It is evident that organisations that continue to learn and facilitate the learning of its employees will always remain a cut above the competition. A learning organisation develops as a result of the complexities of modern organisations and allows them to continue to remain competitive in an ever-changing environment (Wang & Ahmed, 2003). The same circumstances operate within sports, due to its dynamic and unpredictable nature, it remains imperative for sports teams to not only win but to keep that momentum constant. In sports context and in this research, the players and coaches are regarded as the employees. With the aforementioned in mind, this research question is formulated to understand how digitalisation can enable sports teams to develop learning capabilities and increase their knowledge base, particularly how the players and coaches increase their individual and collective knowledge through digitalisation. A learning organisation theory is employed as a theoretical lens.

RQ-3: How does digitalisation influence on-pitch decision-making abilities of players and coaches?

The rhetoric of the field of decision-making within sports has produced some complex literature around how it can be developed effectively, however there has been limited research on how data and technology can potentially play a role. There is, however, a plethora of research on how digitalisation can be utilised in measuring performance, to an extent where it has been suggested that the sport industry is now reaching a plateau in terms of physical fitness. Hence, making it

necessary to investigate how digitalisation influences on-pitch decision-making of players and coaches, as it has been suggested that good decision-making equals better performance.

3.3 Research Philosophy: Interpretivism

Philosophical underpinnings are established at the very beginning of a research study and all other aspects of the study are formed around that. Choosing a philosophical stance is recommended in business and management studies. According to Holden & Lynch (2004), cited by Javed (2017, p. 117) “*philosophical assumptions are to know the nature of reality at an ontological level and to understand the nature of knowledge at an epistemological level*”. The idea that there exist different opinions on how people perceive the world and the processes that function within it is a portion of what is generally referred to as philosophy. The word “*philosophy*” can be viewed as a system of beliefs and assumptions regarding the growth of knowledge (Saunders, 2015). Research is usually based on some assumptions and researchers knowingly or unknowingly support or refute a particular assumption with the decisions they make as regards how to go about conducting research on a particular study (Burrell & Morgan, 1979). This is referred to as the paradigm of the study. A paradigm is made up of the following components: Epistemology, Ontology, Methods and Methodology and all of these components should be related to one another. According to Crotty (1998), ontology involves identifying the overall nature of existence of a certain phenomenon. Assumptions in ontology has to do with what makes up reality i.e., “what is”, we aim to find answers (reality) to the research questions. Epistemology, on the other hand, is concerned with how we uncover knowledge that exist and learn about this “*reality*”. It is imperative for researchers to choose a standpoint in terms of how they feel things are and how things actually work. Figure 19 shows the reflexive process involved in developing a research philosophy.

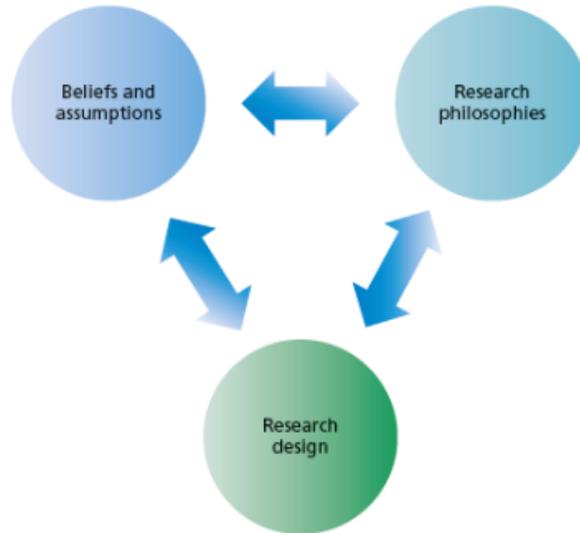


Figure 19 - Developing Research Philosophy (adapted from Saunders et al., 2007)

When thinking about philosophy, researchers naturally wonder about whether there is a “best” philosophical approach for their research. However, according to Saunders et al. (2007) that could pose a problem in terms of the “best” philosophy and your assumptions and beliefs clashing. Furthermore, in business and management, researchers are torn between choices regarding the best philosophy (Tsoukas & Knudsen, 2003). So, it is important to recognise that when choosing a philosophy and a research design, that differences are a natural part of research in business and management. Saunders et al. (2007) postulated that different philosophies and assumptions adds “something” unique and extremely important to business and management. Ultimately, the best approach to research will be dependent on the phenomena that is under investigation.

Generally, there are two main philosophical paradigms: *positivism* and *interpretivism* (Saunders et al., 2007). Positivists believe that the world is external and that any research phenomenon has a single objective reality irrespective of the viewpoint of the researcher. Ontologically, they believe that reality is not dependent on shared understandings or assumptions, and that there is a single external reality. Epistemologically, positivist believe knowledge as factual and obtainable. Conversely, according to Mutch (2005), interpretivists believe that reality is multiple and relative. Lincoln & Guba (1985) posit that the knowledge obtained within this school of thought is socially constructed rather than objectively determined. Interpretivist therefore believe reality is based on people’s assumptions and perceptions and seek to understand these assumptions and perceptions. Ontologically, there is no single external reality while epistemologically, reality is understood through perceived knowledge.

This research follows an interpretivist paradigm. This particular paradigm lends itself to the chosen research approach which is qualitative. As an interpretivist researcher, even though there is prior knowledge about the research context, due to the nature of sports the researcher posits that this is insufficient in formulating the research design because of the unpredictable “*nature of what is perceived as reality*” (sports) (Hudson & Ozanne, 1988). Therefore, the researcher remains open to emerging knowledge throughout the duration of the study and will let it evolve with the help of participants of this study. Ontologically, the researcher holds that there is no single external reality and the “*world*” being investigated is populated by different individuals who possess idiosyncratic thoughts and interpretations, and are also from different domains of sports such as football, cricket and rugby, which warrants the use of interpretivist design such as interviews. Since individuals perceive the world differently, their interpretation of reality can be different. Epistemologically, it can be said the knowledge will be created through interaction between the researcher and the participants, by way of discourse and reasoning as the principal method of investigation.

Accordingly, Wright (2015, P 113) stated that “*previously, research within the realm of performance analysis has largely used the positivistic paradigm, a core concept of which is reductionism*”. Consequently, a different research approach is necessary. Nelson et al., (2011) corroborates this point by postulating that “*more naturalistic and qualitative methods such as case studies, interviews and mixed method approaches may be beneficial in developing new knowledge and understanding*” (Wright, 2015, P 113). Furthermore, Mackenzie & Cushion (2013) postulated that employing qualitative approaches will enhance knowledge regarding the effective use of performance analysis. Therefore, this justifies the interpretive approach chosen in this research and also qualitative methodology discussed in the subsequent section.

3.4 Research Methodology: Qualitative

This study employs a qualitative research approach while using semi-structured interviews as a means of data collection. A qualitative approach predicated on interviews and observations generates a comprehensive understanding of a particular phenomenon. The manner in which the research paradigm, aim, objectives, questions and method of enquiry will be integrated so as to reach the desired outcome has been depicted in figure 20. Since little attention has been paid to the influence of digitalisation within on pitch decision-making and how it can be enhanced, this

highlights the need for a qualitative approach. Obtaining in-depth qualitative statements from participants will definitely help explain the phenomenon under question. Patton & Cochran (2002), stated that qualitative research “*is characterised by its aims, which relate to understanding some aspect of social life, and its method which generate words, rather than numbers as data for analysis*” (McCusker & Gunaydin, 2015, p. 537). Thus, it is imperative to engage with sport organisations in a way that generates detailed accounts of information which will no doubt add to the understanding of how digitalisation influences sports on the pitch, in terms of decision-making.

3.5 Research Framework

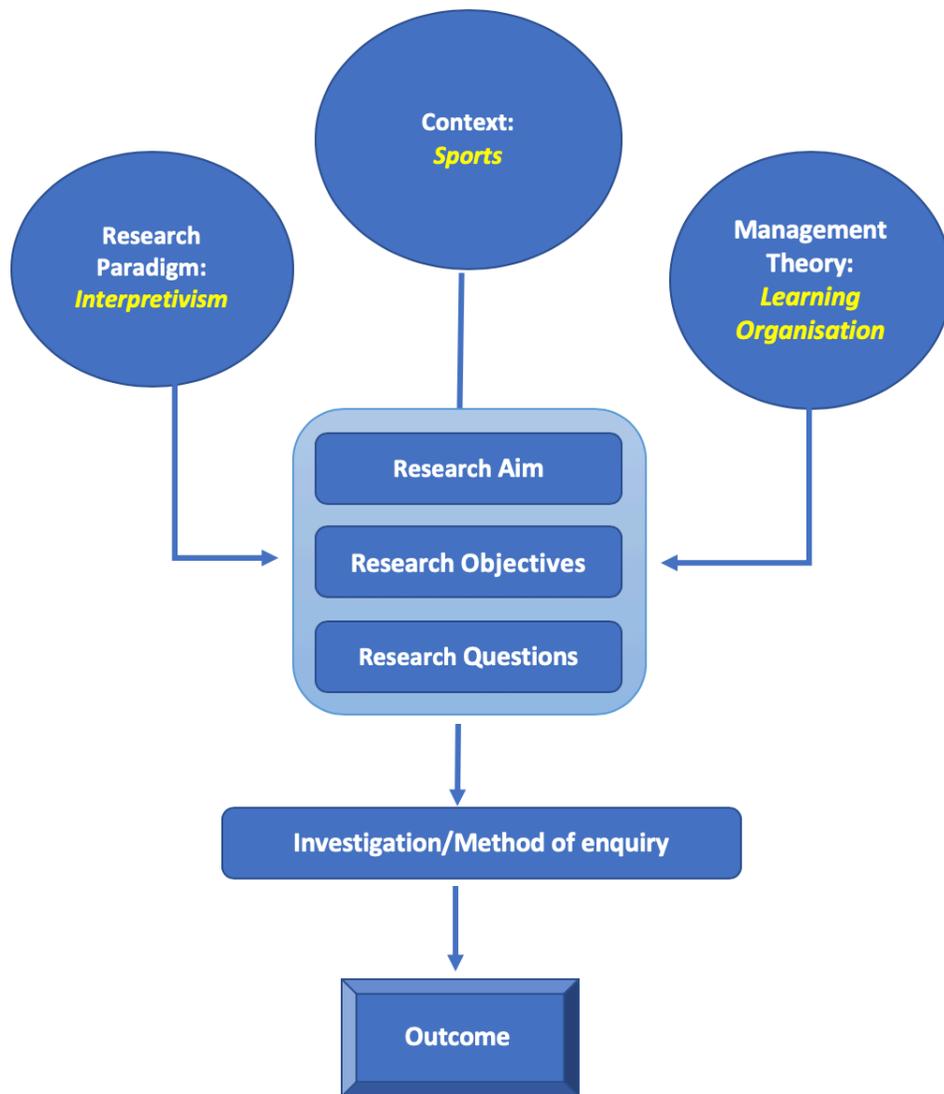


Figure 20 - Research Framework

The qualitative research methods used for this study are described below and included convenience sampling, semi-structured interviews, simultaneous data collection and data analysis practices.

3.6 Unit of Analysis: Teams

The unit of analysis of this study is “*sports teams*” as opposed to individuals. A team can be defined as a group of individuals working together to achieve a common goal. Within sports structure that is tantamount to a group of players working together to achieve a common goal (e.g. win a match/cup, get promoted). This team dynamic also includes the coach who sets out the plan for how that goal can be ultimately achieved. The reason for the chosen unit of analysis is because this particular context offers a more complex setting, offering a greater challenge with regard to decision-making. The team dynamics and interactions are much more unpredictable, and this provides a complicated if not interesting research area.

3.7 Population and Sample

This research is being undertaken within the United Kingdom with different sports teams from different leagues. The main sports which are being targeted are Football, Rugby and Cricket. The main reason for targeting the aforementioned sports is because they are the most popular and most followed sports within the United Kingdom and globally, and therefore offers more interesting investigations. Sawe (2018) and Miaschi (2018) identified football, rugby and cricket as the most notable sports in the world. This makes it crucial and worthwhile to investigate in the context of digitalisation and decision-making, as the findings from the study will have the potential for profound impact. Investigating different sports will help make the data collected richer and provide more in-depth explanation in terms of the phenomenon being investigated. The aforementioned sports are suitable to the research because they are team sports which provide a dynamic setting that offer a high degree of variability, where the decision-makers often experience unpredictability.

3.8 Sampling Technique

The convenience sampling approach was used for data collection, followed by the snowball approach. This is due to the nature of sports organisations, getting access is usually a difficult task. Therefore, these sampling techniques seemed to be appropriate and effective, by reaching out to

contacts already known, it was easy to use the snowball approach to develop a more robust list of participants.

3.9 Data Collection Process

The data collection process was initiated in an effort to not only provide answers to the research questions but also make a valuable contribution to this field. The process started with identification of stakeholders of this project using stakeholder analysis depicted in figure 21 below.

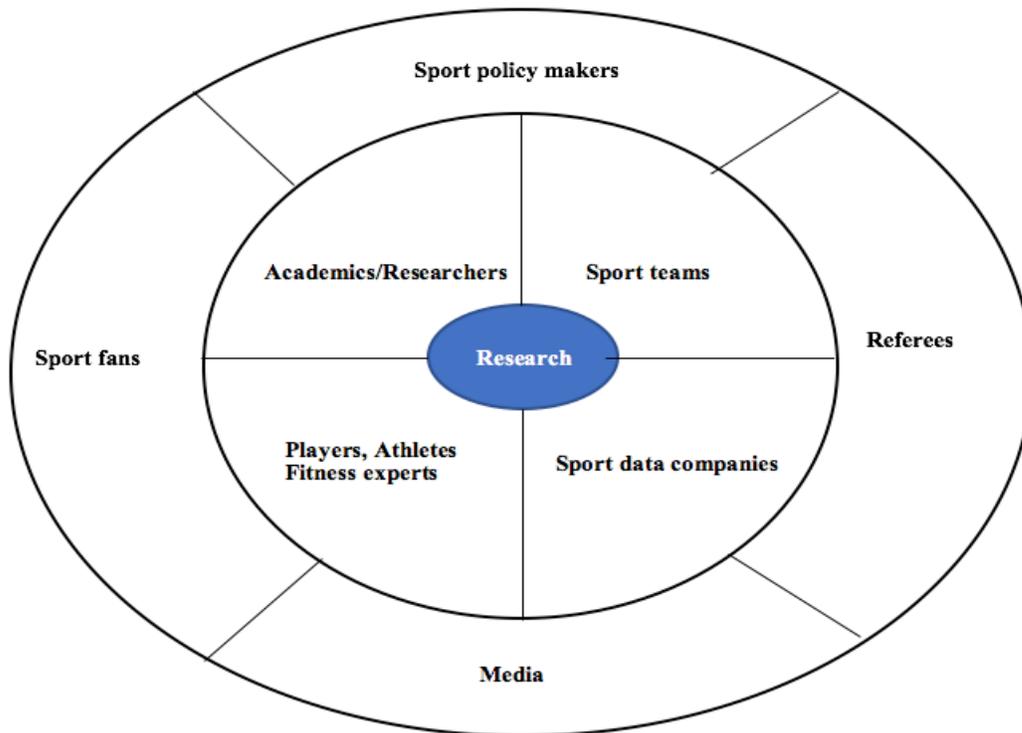


Figure 21 - Stakeholder Analysis (adapted from Steward & Benepe, 1960; Stakeholder Analysis & Management, 2011)

The stakeholder theory posits that the interest of all the stakeholders should be taken into cognisance (Stakeholder Analysis & Management, 2011). The key principle behind this theory is that it enables one to be able to acquire information about the individuals or groups of individuals that can potentially have an impact on the achievement of a project. Looking at figure 21 above, this concept has been applied to this study by way of identifying primary and secondary stakeholders within sports. This has allowed identification of the main stakeholders who are required for the success of this project (the primary stakeholders which can be seen in the

innermost part of the diagram). The secondary stakeholders will not be involved in this project (outermost). All participants/stakeholders were fully informed and willingly consented to participate in the study. Data was collected through face to face in-depth interviews, online interviews through skype and also through telephone calls.

The interview guide was created using a matrix table which was used to visualise how the interview questions relate to the formulated research questions of this study. This enabled the researcher to be able to ascertain that the interview questions were representative of the research questions. The researcher believes that this particular approach to developing qualitative instrument will help provide a rich data set and as a result address the research questions. Three columns were created, in the first column the research questions were listed, in the second column the key concepts and the last column the interview questions. The interview questions were open ended and segmented based on key concepts/topic identified from the literature.

3.9.1 Access to Participants

The unit of analysis in the study are sport teams and as such permission from the teams was required in order to conduct interviews. Emails were sent out to potential participants, introducing the research and also benefits of participating. These emails included a consent form for research participation. According to Vohra (2014), it is important to explicate the sample size so as to reduce the ambiguities of qualitative research. Furthermore, the quality of the interview will be dependent on richness of information rather than sample size.

Figure 22 shows the process of access to sport teams. Access to participants is never a straightforward process, especially since the context – sports – is a very competitive industry, which made it a bit difficult to gain access. The researcher attended sports conferences and went to sports team stadiums in order to identify suitable participants. This was followed by 100 emails sent to all identified participants. The process while tedious, proved effective, as 33 responded and agreed to participate in the study. Afterwards, appointment dates were agreed upon, and the researcher made efforts to make himself available so as to conduct the interviews. The interviews were conducted on the grounds of sport teams and also over the phone and skype when necessary for follow up interview sessions.

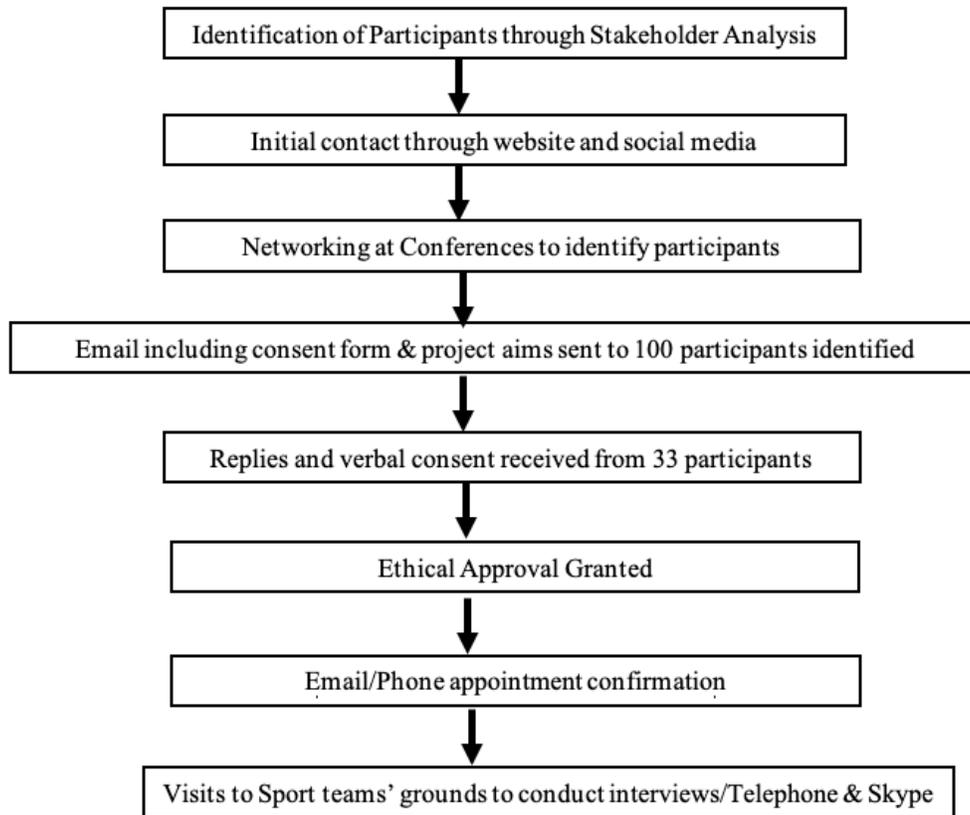


Figure 22 - The process of access to Sport teams

3.10 Research Methods

According to Britton (1983), research methods of social sciences and physical sciences vary considerably. The choice of method should be thorough and practical, rather than simply choosing an epistemological approach (Buchanan & Bryman, 2007). Qualitative methods bring research to the forefront of deeper knowledge as opposed to merely testing. The size of the organisation under investigation, location and nature, as well as the state of the research location equally play significant roles in the selection of the method. Moreover, Buchanan & Bryman (2007) postulate that the method choice needs to be suitable for the pertinent audience. The authors further debate the importance of the researcher's social and networking prowess, and how it influences the research. Additionally, the researcher's preferences, knowledge and comfort level equally play a part in choosing the method. The method chosen for this research proved effective in capturing and explicating the phenomena.

3.10.1 Multiple Data Sources

According to Groom (2012, p. 102), “*much of the research of performance analysis is located within the positivist paradigm and chiefly concerned with producing an accurate and reliable analysis of performance data*”. This statement highlights a need for a different approach(s) in understanding the phenomena under question and also because the research questions of the study is located within the interpretivist paradigm. Using several methods at the data collection phase can help mitigate the deep-rooted shortcomings of primary and secondary data (Johnson et al., 2007), and subsequently ensure validity (Von Maravic, 2012). The data collection approaches used for this research are depicted in figure 23 below and subsequently discussed.

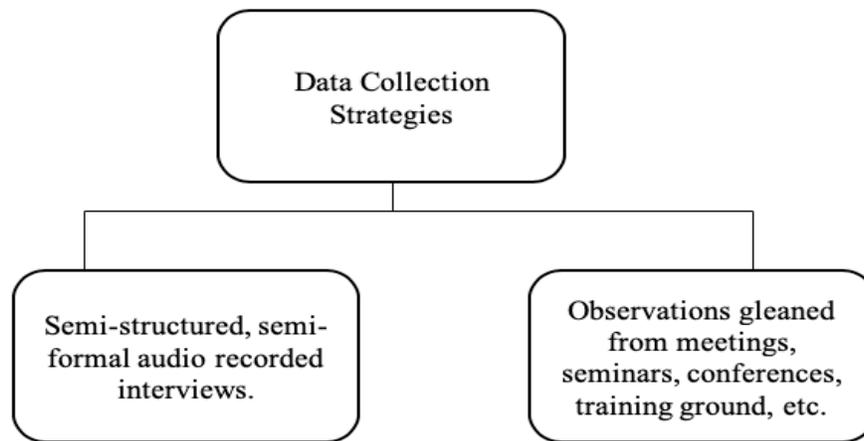


Figure 23 - Data Collection Strategies

3.10.2 In-depth Interviews

According to Braun & Clarke (2013. p. 2), “*interviews can be useful for exploring understanding and perception-construction-type research questions*”. Cohen & Manion (2001) also made note of the fact that interviews are intersubjective. As alluded to in the section above, a thesis on *understanding performance analysis within the coaching process* undertaken by Groom (2012) made light of the fact that methods such as interviews have rarely been used within this field. Semi-structured interviews were conducted for this research and this method was effective because it enabled the use of the snowballing participation approach. After each interview some of the participants suggested and facilitated the entry into other sports teams. An open-ended line of questioning was adopted in an effort to reduce the researcher’s sway on the interview sessions and

collect rich data (Vohra, 2014). Majority of the interviews were conducted face to face, with each interview lasting at least 45 minutes and the longest 1 hour 30 minutes. The interviews were recorded, and notes were made when necessary. An example of the interview protocol can be seen in table 3. The audio recordings, note taken, number of interviewees, duration of interviews and also the location offered rich insights.

3.10.2.1 Data Saturation

Scholars and academics alike have underscored the impact data saturation can have on the quality of research conducted and the content validity (Bowen, 2008; Kerr et al., 2010). Qualitative research design poses potential problems in terms of data saturation when interviewing participants for a study. Specifically, researchers must take into cognisance the question of “*how many interviews are enough to attain data saturation*”. While there is no “*one-size-fits all*” approach to attaining data saturation, there is a consensus among researchers regarding values and concepts such as: “*no new data, no new themes, no new coding and ability to replicate the study*”(Ness, 2015, p. 1408). The approach through which data saturation is reached will depend on the design of the particular study. Guest et al., (2006) put this into perspective by stating that data saturation can be reached with as little as six interviews depending on the sample size of the population. Nonetheless, it is crucial to think about the data with regards to its “*richness*” and “*thickness*” instead of the sample size. Ness (2015) defined richness in terms of quality and thickness in terms of quantity. Further to this point, it is important to have data that is rich and at the same time thick. Both elements present within data will ensure data saturation. Consequently, this research has followed meticulous methods to ensure the richness and thickness of the data. Firstly, a stakeholder analysis diagram was created in **section 3.9** to identify the most suitable participants for the study, taking into cognisance the research questions. Identification of suitable participants ensured that data was collected from people with the right knowledge and experience capable of answering the interview questions. This helped ensure the *richness* of the data. Subsequent methods such as sampling technique and data collection method (semi-structured interviews) also helped in improving the credibility (quality) of the data. Bernard (2013) postulated that interviews are one method by which data saturation can be reached, implying that qualitative methods lends itself to data saturation. However, the researcher should structure the interview questions in a way that allows the researcher to ask multiple participants the same questions. This study has followed this

approach in order to ensure not only the *richness* but also the *thickness* of the data. The interview protocol presented in **table 3** below was designed to allow the researcher to ask all the participants the same question while also probing further as at when necessary to obtain more rich and thick data. Moreover, triangulation is another method through which data saturation can be reached (Denzin, 2012, 2017). Triangulation has been confirmed as a way to ensure the reliability of results and attainment of data saturation. Denzin (2012) posits that there is a relationship between the data triangulation and data saturation, one in which data triangulation ensures data saturation. Accordingly, this study employed multiple methods to collect (**section 3.10**) and analyse the data.

Table 3 - Interview Protocol

<p>A. Background Questions.</p> <ul style="list-style-type: none">• Could you tell me about your roles and responsibilities at the club? <p>B. Questions on Sports Environment and Evolution with regard to data and technology use.</p> <ul style="list-style-type: none">• What major changes do you feel your particular sport industry has gone through over the last 10 years.<ul style="list-style-type: none">○ What are some of the factors that you think influenced the aforementioned changes?• The use of data and technology in sports has increased over the years, what has been the highlight for you? <p>C. Questions on Digitalisation</p> <ul style="list-style-type: none">• Do you have a definition for Sport analytics/Performance Analysis?<ul style="list-style-type: none">○ What do you feel it brings to the sports industry?○ What effect as data and analytics had on your sports over the last few years?○ How much impact is analytics having on athletes and coaches○ How far do you think we've come since then?• When was data analytics first implemented at the club? What was the reason behind that? What do you use it for?<ul style="list-style-type: none">○ So, what's the main the things you are working towards?
--

- Are the players involved in the data analytics process? When? how is feedback given? what actions are taken based on the feedback?
 - How do you feel that helps them prepare for the next match/game, do you feel they learn from the data?
- How do you get players to digest all the information being given to them, to the point where they are able to use it intuitively on the pitch?
 - Do you consider information overload a problem for players?
- Could you tell me some of the key challenges the you experience in terms of data analytics use?
- Do you feel you can fully rely on data? What are some of the factors that you feel should be taken into consideration first?
- How would do describe the coaching culture within your professional sport?
 - What do you say to people that believe there is a traditionally cautious application of analytics?

The interview protocol was composed of six sections and 25 total questions which also had some sub-questions. Each section placed emphasis on a specific area relating to the research questions of the study.

3.10.3 Pilot Interviews

According to Majid et al. (2017), piloting for interviews is important in order to test the questions, while also acquiring some interviewing skills. Although, pilot studies are usually linked with quantitative approach to test the research instrument, it has been made popular with the qualitative approaches as well. Pilot studies are valuable during the planning of any study, irrespective of the chosen paradigm. It can be utilised to address possible issues that might arise. Furthermore, a pilot study conducted by Castillo-Montoya (2016) established that final interview protocols can be consolidated by piloting the interviews. For this research the pilot interview consolidated the interview protocol and help mitigate any potential issues. 30 minutes of interview session helped the researcher become familiar with the practice of recording, organisation of audio files and skill of meticulous listening. The experience garnered from this process enhanced the overall research.

3.10.4 Audio Recording

The research consent form attached to each email sent to participants had clearly stated that audio recordings would be made during interviews, subject to signed consent. This was again reiterated before the start of each interview to gain their permission. The researcher asked the participants if they were still comfortable with being recorded and assured them that the interview can be stopped at any point should they feel the need to. Table 4 below presents the list of the interviews conducted, the unique code assigned to each participant, their role, the organisation and the sport. The table shows the wide range of people interviewed within the sports industry in an effort to get a rich dataset.

Table 4 - List of Interviews

#	Reference	Position	Organisation	Sports
1	SP - P1	Sports Trainer	Self Employed	-
2	SE - P2	Sports Executive	Leigh Rugby Club	Rugby
3	SAPCH - P3	Professor of Business and Sports Analytics and Coach	Leeds University and AZ Alkmaar FC	Football
4	PA - P6	Performance Analyst and Lecturer	Salford University	Football
5	PA – P23	Performance Analyst	Hull City	Football
6	CH – P11	Coach	Leicestershire CCC	Cricket
7	MG – P4	Manager	Rugby League European Fed	Rugby
8	PA – P12	Performance Analyst	Norwich Fc	Football
9	PA – P19	Performance Analyst	England and Wales Cricket Board (ECB)	Cricket
10	PA – P25	Performance Analyst	Wolverhampton Wanderers FC	Football
11	DAP – P17	Data Analyst, Director, Performance Analyst, Rugby Operations Executive	Premiership Rugby	Rugby
12	SD – P28	Sports Director	Hiepa	Football
13	MG – P10	National Talent ID Manager	Wales national football team	Football
14	PA – P15	Performance Analyst	Surrey Cricket Club	Cricket
15	PS – P18	Senior Physical Performance Coach	Nottinghamshire Cricket Club	Cricket

16	CH – P7	Coach	Blackpool	Football
17	CH – P8	Academy Coach	Barnsley Fc	Football
18	PA – P16	Performance Analyst	Everton Fc	Football
19	CH – P26	Coach	Hibernian Fc	Football
20	CH – P20	Junior Coach	Stellenbosch fc	Football
21	PD – P14	Performance Director	Bury Fc	Football
22	CH – P13	Former player & Youth Team Coach	Arsenal Fc	Football
23	HP – P5	Head of Football Projects	Liverpool Fc	Football
24	CH – P21	Head of Sport Science and Strength & Conditioning	Crystal Palace Fc	Football
25	TD – P24	Technical Director	We Soccer	Football
26	MC – P9	Coach	Lancashire County Cricket Club	Cricket
27	MD – P22	Medical Doctor	Queens Park Rangers Fc	Football
28	MD – P29	Managing Director	Sports Office	Football, Rugby & Cricket
29	CE - P30	Chief Executive	The Little Sports Group	Football
30	CH – 31	Head of coaching development	England and Wales Cricket Board (ECB)	Cricket
31	FP – P32	Player	Sunderland Ladies	Football
32	PE – P33	CEO	Perth Glory FC	Football
33	SR - P34	Sports Researcher	iAfrikan Digital	Football, Rugby & Cricket

3.10.5 Observations

According to Bamford (2008), substantiated observations and evidence consolidates and enhances social theories. The researcher observed that each of the participants were willing and engaged during the interview sessions. The observations discerned in social science are distinctive and it was the intention of the researcher to use these observations to corroborate and consolidate the interviews. For observations, tools used included notes and a mobile phone to record and take pictures when necessary.

Table 5 - Observational Objects Code

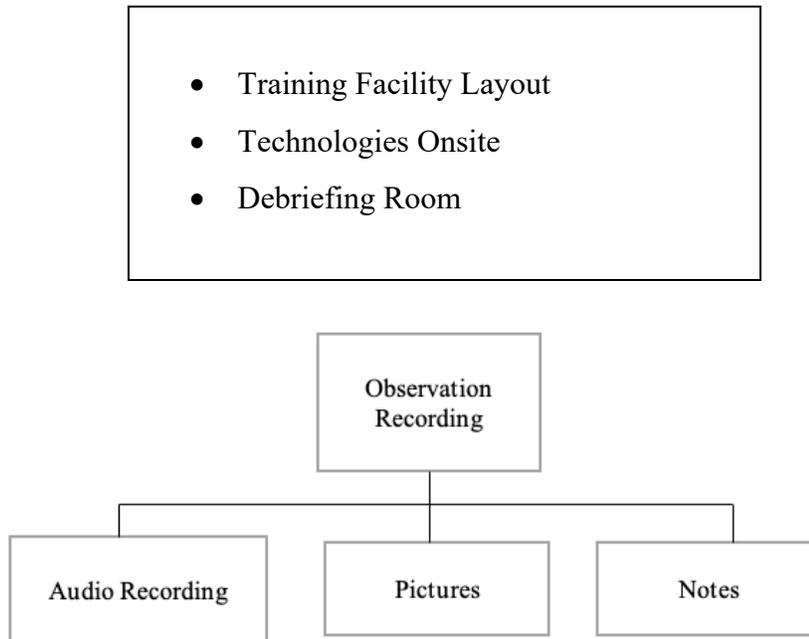


Figure 24 - Observation Recording Tools

3.10.6 Types of Data Collected

Three main types of data were collected for the purposes of this research from sports teams. They include audio data, handwritten notes and pictures, a description of each type will be explicated below.

3.10.7 Audio Data

Audio recordings were created for each of the interviews and all the audio data were transferred to the researcher's personal laptop and also the university's secure computers. A mobile phone was used to record all the audio during the interviews, and this made it easier to record and transfer the audio files without any problems.

3.10.8 Handwritten Notes & Images

According to Phillippi & Lauderdale (2018, p. 381), "*Field notes are widely recommended in qualitative research as a means of documenting needed contextual information*". Field notes were taken for each interview to document additional and contextual information that would have been

difficult to capture using the recorder alone. Eisenhardt (1989), postulates that field notes can be written in two ways: by observing the impressions and by giving serious consideration to it. One A4 writing pad was used to take notes, and information written down included the name of the participant, their role, the time and walkthrough of software being utilised by the sports team among other pertinent details. On the day of the scheduled visits, several images were taken using the researcher’s mobile phone. These images were of the trophy room, debriefing room, software and technologies being utilised.

3.10.9 Data Transcription

The data was transcribed in text from audio using online transcription tool ‘<https://otranscribe.com/>’ and NVivo12 software. Audio files were transcribed verbatim and compared with written notes to enhance validity (Halcomb & Davidson, 2006). The main transcription software used was NVivo12 and a snapshot of the transcription window can be seen in figure 25 below.

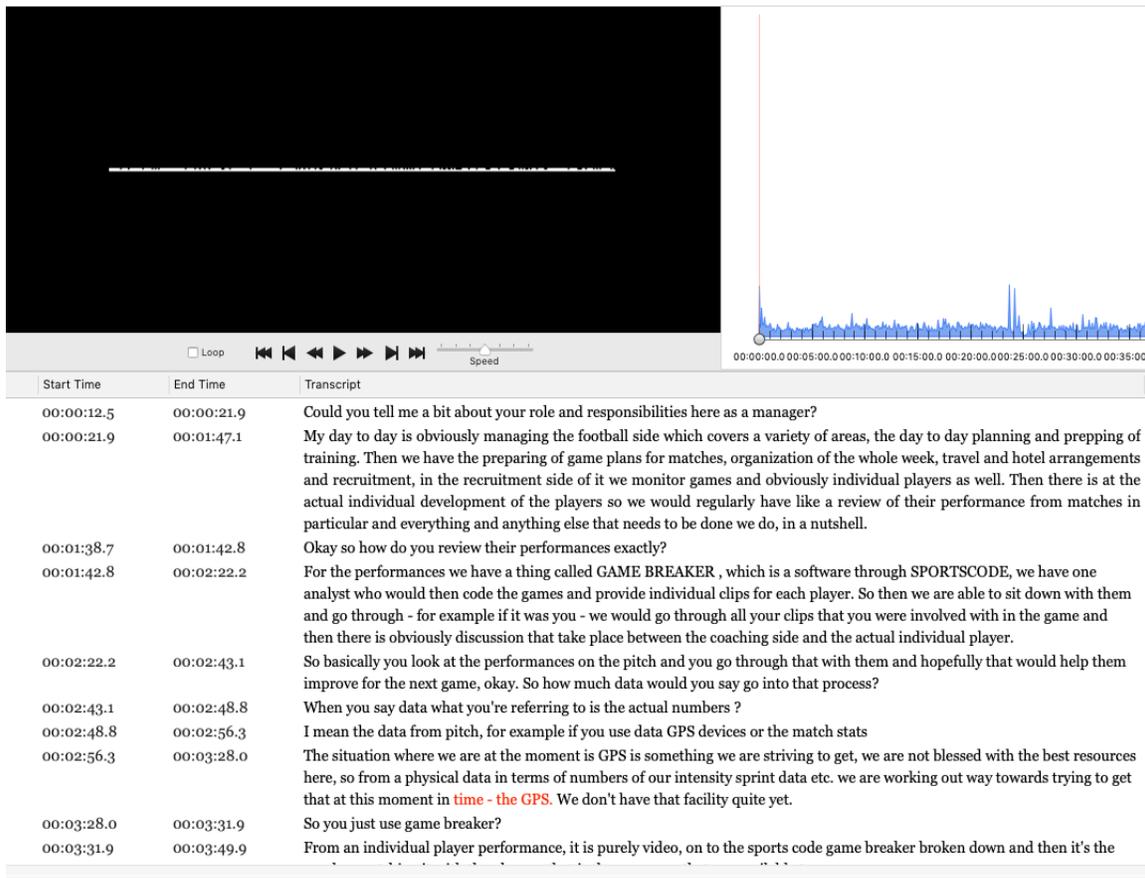


Figure 25 - Snapshot of Nvivo12 Transcription Platform

The NVivo12 transcription platform simplified the process of transcribing the audio files as the software included features that made it possible to listen and transcribe simultaneously. Shortcut buttons for playing, pausing, rewinding, fast-forwarding and stopping the audio also helped the transcription process immensely. Manual and self-transcription allowed the researcher to fully engage with the data and capture intricate parts of the interview. One of the main outcomes of the transcriptions was the familiarity with data, which helped speed up the data analysis phase. The transcription of the handwritten notes was fairly straightforward as it involved re-examining the notes taken down during the interview.

3.10.10 Data Storage and Management

All the data collected (audio files, written notes, pictures) were kept safe by the researcher. The audio files and pictures were stored safely on the researcher's personal laptop. The mobile phone used to record the audio was kept safe at all times and the laptop was never handed over to anyone, after which the audio files were transferred onto the laptop and transcribed. The transcripts were also stored on the researcher's personal laptop and the university's secure computer. Audio interview files and transcripts were assigned distinct code names which corresponded to each participant for easy reference, while also maintaining their anonymity. The researcher alone had access to all the data collected, and confidentiality was of the utmost priority.

3.10.11 Access to Sports Teams – Participant Incentive

The involvement of the participants in the study was voluntary throughout the duration of the data collection phase. Nevertheless, the research included a few incentives stated in the project brief sent to the participants when contact was initiated. Such incentive included an agreement to send an executive summary of the findings of the research at the end of the research.

3.11 Data Analysis

Vohra (2014) stated that in qualitative research, there are no distinct steps that separate the data collection phase from the data analysis phase, both should be done simultaneously and in congruence wherever possible. Bamford (2008) also stated that in order to have complete and holistic understanding of the data it is imperative to start intuitively analysing the data as soon as it is being collected. The analysis of the data started right from the point of data collection as this

provides synergy between the data collection and the analysis process. NVivo12 makes it easy to organise, analyse and retrieve insights in qualitative data such as open-ended interviews and it enabled the researcher to transcribe interviews while also developing the analysis. Adequately describing the data analysis phase posed a difficult challenge, in line with Thorne's (2000, p. 68) notion that the data analysis phase is the most complex and mysterious of all the phases of a qualitative project. Nevertheless, Miles & Huberman (1984), postulated that there are three main stages of data analysis – “*data reduction, displaying data and extrapolating conclusion*”. The aforementioned phase applies to this study as well, intensive reiteration and reflectiveness during the stages were naturally challenging. Furthermore, Bamford (2008) also made mention of the data analysis phases postulated by Easterby-Smith et al. (1991) which included: “*familiarisation, reflection, conceptualisation, cataloguing concepts, re-coding, linking and re-evaluation*”. It is important to note that there is no ‘one size fits all’ approach when it comes to data analysis (Eisenhardt, 1989).

In an effort to have a complete understanding of the subject under study, perusing written notes and listening to the audio recordings became daily activities. The researcher's written notes served as the first point of analysis (Tuckett, 2005). Welsh (2002) suggested that the analysis process commences by compiling the data, coding it and classifying it into manageable portions. The author further argued that the methodical organisation of data is of the utmost importance and necessary for thoroughness.

3.11.1 Use of Computer Software (Nvivo12) for Analysis

Over the recent years, qualitative data analysis software has enabled researchers to manage large amounts of data and played a crucial role in demonstrating audit trail. The researcher completed a training on NVivo to ensure familiarity and understanding of the software, so as to gain the possible benefits. This was done by downloading and installing the software onto a laptop and subsequently working with sample data. Nevertheless, while data analysis software can aid with the analytical process, it is important to note that qualitative software packages are more for organising and sorting data than actual interpretation. It is still necessary for researchers to engage in “*intellectual and conceptualising processes*” (Ward et al., 2013, p. 2).

3.11.2 Framework Analysis

Antaki (2002) debated that there is often a lack of clear and concise guidelines around thematic analysis. This particular issue has been highlighted by Attride-Sterling (2001), who stated that there is a drawback in the facilitation of methodological analysis. Nevertheless, Braun & Clark (2006), suggested that the utilisation of tools or guidelines that are inflexible can reduce the flexibility and restrict analysis. Qualitative data analysis has received several criticisms, one of which is its opacity (Murphy et al., 1998). It is essential for qualitative data analysis to be transparent, so the research reviewers and other individuals with vested interest in the study can see how the findings were derived (Furber, 2010). The subjectivity deep-rooted in interpretive qualitative research is also an issue that has been raised and criticised (Sword, 1999). That said, it is important to note that while no research or analysis technique is faultless or free of assumptions and biases, analysis needs to be transparent and auditable to improve the credibility of the findings.

According to Ward et al. (2013, p. 3) “*framework analysis is an explicit approach to analysis and sits in a thematic methodology. It is considered as straightforward, provides transparent results and offers conclusions that can be related back to original data*”. Framework analysis can be carried out during and after the data collection phase. It facilitates flexible and effortless retrieval of data explicating how decisions were derived (Swallow et al., 2011). Framework analysis is a data analysis technique that allows for data to be sifted through, charted and sorted in accordance with key themes using a step-by-step process (Gale et al., 2013). The framework analysis approach is apt, rigorous and systematic which helps give more credence to the findings (Ward et al., 2013). It addresses some of the drawbacks and criticisms of thematic analysis.

Framework analysis has five main stages: (1) familiarisation (2) developing a theoretical framework by identifying recurrent and important themes (3) indexing and pilot charting (4) summarising data in analytical framework and (5) synthesising data by mapping and interpreting. The framework approach analysis was applied to transcripts and it proved to be effective with its straightforward and transparent steps. This will be discussed in the subsequent sections, explicating how the five main stages were applied to the transcripts. Framework analysis was chosen because of its flexibility with regard to allowing data collection and data analysis to concur simultaneously.

3.11.2.1 Stage One - Familiarisation with the Transcripts

The overall aim of stage one is to fully immerse oneself in the details of each of the transcripts so as to get an idea of the interviews before separating them into different sections and categorising recurring themes (Rabiee, 2004). The researcher familiarised himself with all the transcripts, and because the interviews were conducted by him as well, this sped up the process of getting familiar with the data. The written notes taken during the interviews were read together with the transcripts in an effort to make sure that the context was taken into cognisance. Arthur & Nazroo (2003), emphasise that written notes during interview allows the researcher to document what is perceived and other issues that may be of relevance during the analysis. The researcher thoroughly and iteratively read through all of the transcripts generated from the audio files and also re-examined audio-recorded in an effort to become fully familiar with the data collected.

Qualitative research often generates huge amounts of data and as such not every piece of data may be examined at this stage (Srivastava & Thomson, 2009). Nevertheless, the researcher made sure at least all the transcripts were considered no matter the level of attention given to it, in an effort to make sure that no transcripts were overlooked. This process as expected was time consuming as several days were dedicated to understanding the data.

Coding

Initially, 3 transcripts were coded and since the data collected were from sports ranging from football, cricket and rugby, one of each was selected from each category of sport. While reading through the transcript, segments of the text that seemed interesting were highlighted and underlined and further used words to describe what the text meant. This ranged from using a few words to sentences. Notes and ideas that emerged while parsing the transcript were also written down, and this allowed for explanations of patterns in the data as the analysis continued. A demonstration of how this was done can be seen in table 6. The participant in the excerpt (table 6) talks about how technology has influenced the way sports teams now train and its role in providing a clearer picture of what performance is and subsequently using that to prepare players for the ever-changing demands of the game. The researcher used a few words to describe this account as shown in the table. In addition, based on what the participants said some notes were added as well. The underline was used to accentuate the segments of the text that were relevant and were worth coding.

Table 6 - Initial Coding Labels

Coding labels	Participant 3: Strength and Conditioning Coach	Notes and Ideas
<p>Impact of Digitalisation on Evolution of Sports</p> <p>Technology</p> <p>Role of GPS</p> <p>Impact on performance</p> <p>Gives Clear picture</p> <p>Helps inform practice</p>	<p>Interviewer: It seems like a lot is happening in sports right now in terms of digitisation. What major changes would say the sports industry has gone through say over the last 10 years.</p> <p>Interviewee: <u>For me the biggest thing - having worked previously in football - what GPS data has done in team sports like that is given us a better picture of what actually happens on the field and how that affects performance.</u> So in other sports, we know that certain numbers need to be or should be hit for performance elements, so if a team or an individual hasn't completed a certain amount of work within a week then they would look at that data and use it top players up to much that they are fit or they are in the best readiness state they can be to perform. Or if it's like a player who's like a substitute and not playing too much to make sure they are ready. <u>so the GPS data helps inform that has been a massive part in a lot of sports and getting that information across and what actually happens in the game</u> because it allows the staff to prepare the players effectively for the demand again whereas <u>before the use of the GPS technology we didn't learn how much distance, high-speed distance things like that the players are covering so it's a little bit more of a subjective element to how what you need to do to perform and then I think you could see that in a lot of training.</u> I think if you look back at the way teams trained 10-15 years ago in football, rugby, hockey there'll be a lot more variation in terms of how people prepare whereas <u>I think now if you look across the board people are training and preparing in very similar ways it will just be the odd bits here and there</u> that are different and I think that's because we know what a game looks like now, we know what sort of numbers need to be hit. So i think that as been a huge influence in the industry and then <u>I think there's been a lot more technology in term of testing, monitoring and reanalysis side of training.</u> So i think technology has had a huge influence over the last 10 - 20 years.</p>	<p>Technology making the way things are being done now a bit similar for every team. E.g. training?</p>

The annotation above was done in NVivo12 which made the process of coding easier and more effective than on paper. More importantly, this allowed for the development of the initial analytical framework, which was subsequently used as a codebook.

3.11.2.2 Stage Two - Developing a Theoretical Framework

The themes identified in the first stage can now be populated into NVivo12, which is the main data analysis software used for this research. Table 7 below shows sample of the initial themes and subthemes identified from the transcripts; this was the draft framework. The themes were created as a result of immersion in the data as alluded to above.

Table 7 - Initial Key Themes and Sub-themes from stage two

Key Themes	Sub-Themes
Best Practices	sport analytics program, communication, reliable data set, consistency, human element, player buy-in.
Challenges	implementation, utilisation, digital divide, drawbacks

Current Practices	Football	player feedback, data collection process, player management, utilisation of data, software and technology utilised
	Rugby	software and technology utilised, player feedback, utilisation of data.
	Cricket	level of advancement, data collection process, player management, software and technology utilised

3.11.2.3 Stage Three – Indexing and Pilot Charting

The initial draft framework generated from stage two was used to code the remaining transcripts. This enabled the researcher to become more immersed in the data, so that already generated themes and sub-themes could be polished. The main aim of this was to refine the themes and subtheme such that data fit into the right category and there was no repetition of themes. A resulting final framework (codebook generated from NVivo12) which was used to code all the transcript can be seen in table 8 below.

Table 8 - Code Book

Code	Description	Files	References
Best Practices	Best practices across sports. Crucial elements, relationships, etc	2	9
sports analytics program		1	1
Big Data	Utilisation of Big data.	2	4
Big data vs data analytics		1	1
Challenges	Resources, implementation, utilisation, data collection	0	0
Data collection		1	2
With Implementation of data and technology		0	0
Resources		1	2
With utilisation of data and technology		2	3
Current Practices and Utilisation of data	Current practices and levels of utilisation of data and technology across all sports. Sports vs sports	1	1
Contrast between Sports		0	0
Football vs Cricket		1	2
Cricket		1	9
Injury monitoring		1	2

Code	Description	Files	References
Level of advancement		1	1
New Technologies		1	1
Process of KPIs & Metrics		1	2
Software and technologies used		1	1
When Data and Tech was implemented		1	1
Football		2	11
Data collection process		1	1
KPIs		1	2
Rugby		1	4
Data and Technology Caveats	Drawbacks, gaps. Information overload, overuse, excessive reliance on data	2	10
Information Overload		2	2
Overused		1	1
Reliance on data		1	1
Defining Sports Analytics	How the participants would define the use of data and technology in sports	2	5
Effectiveness of Digitalisation on decision-making & Performance	How does digitalisation effect the development of decision-making.	1	1
Factors that influenced Digitalisation	Drivers that influenced digitalisation in sports. Better understanding, Finances, improving performance, societal changes	0	0
Better Understanding		1	2
Finances		1	1
Improving Performance		1	1
Societal Changes		1	1
Future of Sports	Impact, Plateau, predictability, ruining sport, VAR system.	1	1
Plateau		1	2
Predictability		1	2
Ruining Sports		1	1
VAR System		1	2
Impact of Digitalisation on the Evolution of Sports	Perception of impact of digitalisation on the evolution of sports. Football, Cricket and Rugby. Paradigm shift, GPS, recruitment, Training.	3	6
Cricket		1	1
Football		2	4
GPS		1	1
Recruitment		1	1
Training		1	3
Rugby		1	4

Code	Description	Files	References
Role of Digitalisation in Sports (Data and Technology)	The participants talking about what they feel data and tech brings to sports. Advantages, etc	3	14
Access to information on opponents		1	3
Role of Digitalisation on On-Pitch decision-making	Training, Education, information, explanation.	2	6
Educating Players		1	3
Sports Culture	Lack of knowledge, insecurity, resistance, progressiveness, younger coaches.	1	1
Cricket		1	3
Football		1	2
Rugby		1	1

3.11.2.4 Stage Four – Summarising Data in Analytical Framework

According to Gale et al. (2013, p. 5) “*qualitative data are voluminous (an hour of interview can generate 15–30 pages of text) and being able to manage and summarise (reduce) data is a vital aspect of the analysis process*”. Consequently, stage four allowed the researcher to reduce the data into comprehensible but succinct summaries of what participants said. Swallow et al. (2003), postulated that this process can be facilitated by using software packages that allows the summaries to be linked back to the full transcripts. This allow researchers to easily locate text whenever necessary. NVivo12 proved invaluable in this stage because it has a feature that allows the aforementioned to be done easily.

As shown in figure 26, NVivo12 allowed the researcher to summarise chunks of data and also include a reference of where to find it within the main transcripts (underlined in blue on the right side of the screen). On the left side, circled in red, the themes and sub-themes can be seen. When the text underlined in blue on the left of the screen is clicked the full transcript pops up and highlights the text and the interview question asked by the researcher. One of the benefits of framework analysis is that every stage is linked, so for instance the summaries can be related back to the quotes in the transcripts. Additionally, this demonstrates an explicit audit trail (Ward et al., 2013).

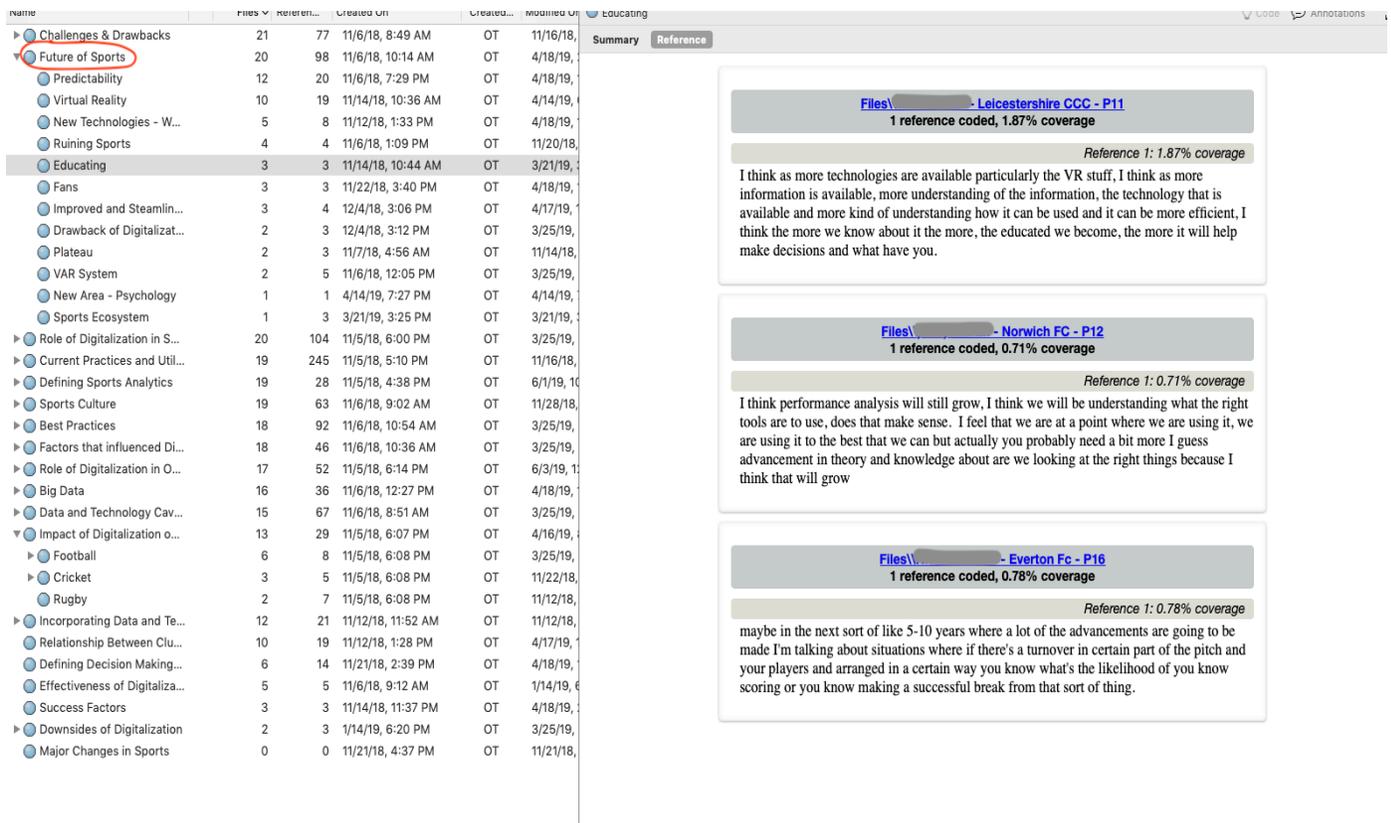


Figure 26 - Sample of data summaries

3.11.2.5 Stage Five – Synthesising Data by Mapping and Interpreting

Framework analysis is apt in facilitating the whole development of the conceptual framework by allowing the refinement of themes (Ward et al., 2013). This stage allows for and simplifies the process of comparing themes and subthemes and crosschecking against the transcripts to ensure apt context. In this phase the final themes and subthemes emerged after several iterations and refinements.

3.12 Ethical Considerations

Ethics are an integral and crucial part of social research. Ethics is a branch of philosophy that has to do with the conduct of individuals and guides the standards of behaviour of those individuals and relationship with one another (Akaranga & Makau, 2016, p. 1). It is imperative for researchers to meticulously contemplate potential ethical issues prior to conducting research, particularly in a study such as this, which involves collecting data from people through semi-structured interviews. The researcher obtained ethics approval from the university's business school ethics committee

before commencing with the data collection stage. An information sheet detailing the aims of study and other relevant information was presented to the participants. A consent form was presented to the participants and this was used to obtain confirmation as to whether or not they wish to be interviewed and also whether the interview can be recorded. The participants were assured that the data will be kept confidential and safe on the desktop at the university. The ethics code used for this research can be seen in table 9 below. Furthermore, a copy of the letter of invitation sent to participants, a sample of a signed consent form and the ethics approval confirmation can be found in the appendices section.

Table 9 - Code of Ethics

Principle of Ethical Research	Description of Practice
Informed consent	<p>Participants were given full information and explanations of the research which includes the research title, what the study is about, why they have been approached, etc. These details were contained in the participant information sheet which was given to each participant before the start of the interview.</p> <p>After reading through, they were given the participant informed consent form, to fill and sign. This will also be signed by the researcher. The form will have the title of the research study, the name of the researcher and the participant identifier number.</p> <p>The form explains the rights of the participants and by ticking the sections and signing, the participant agrees to take part in the study. This will also be duly explained to the participant.</p>
Confidentiality/ Privacy	<p>All information collected from participants during this research are kept very secured and any identifying information, such as names were removed and replaced with codes/numbers/pseudonyms.</p> <p>Data is stored on the researcher's university personal storage file and laptop and USB. The researcher has strong passwords on these</p>

	storage devices and data in these devices will be encrypted.
Anonymity	Participants involved in this research have all been anonymised.
Harm	<p>This research was considered from the standpoint of the participants so as to avoid potential risk to the psychological well-being of participants, stress, anxiety, harm or negative consequences.</p> <p>The research although involved human interaction where participants were interviewed one on one, there however, was no great harm aside from maybe a situation where participants were nervous and anxious in answering questions when being recorded. In this case, the researcher asked participants to speak on what worries them and assure the participant that all information passed during the interview will be strictly confidential and will only be accessed by the researcher and that no answer to questions are wrong.</p>
Affiliation	The researcher's affiliation with Huddersfield University was explicitly declared to the participants.

3.13 Methodology Limitations

The researcher encountered a few limitations while undertaking this study. Most notably, the number of participants and location, implying that care has to be taken in generalising the findings. When conducting research, it is beneficial to undertake it on a larger scale as this allows for more comprehensive analysis and gives more credibility to the overall research. This particular limitation, however, can be explained by the nature of the industry being investigated. Sports is a naturally competitive and secretive industry (Xiao et al., 2017) and rightfully so because it is all about marginal gains. Sport teams always want to ensure that critical information about players and tactics is not released or leaked, as a result, researchers investigating sports have a difficult time getting access to said sports teams. However, the utilisation of convenience sampling followed by snowball technique proved effective in conducting semi-structured interviews. A rich dataset of 33 interviews from elite sports teams yielded robust and pertinent qualitative data.

3.14 Thesis Contribution

Nicholson et al. (2018) conducted research to investigate the contribution strategies typically employed by researchers and scholars in positioning and highlighting the contribution of their research. The authors identified 5 main categories and 9 subcategories of contribution based on extensive analysis of the literature and postulated that all the contributions can be classified into these main categories. This particular paper is especially useful to researchers because it presents a conceptual framework (shown in figure 27 below) which offers a significant step in understanding the deliberate contribution strategies of scholars and can consequently help a researcher in positioning and underscoring their contribution.



Figure 27 - Contribution Strategy Conceptual Framework (adapted from Nicholson et al., 2018)

The framework presented in figure 27 above has been included in this thesis in an effort to explicitly state the potential contribution. Nicholson et al. (2018) postulated that researchers and scholars typically employ a combination of contribution strategies, since it is conceivable for a piece of research to make more than one contribution. Consequently, this thesis identifies

incremental (*neglect spotting*), revelatory (*using multiple lenses*) and consolidatory (*traditional literature reviews that advance knowledge*) contribution strategies as strategy applicable to this thesis. The following section will give a brief explanation of these terms and contextualise them within this thesis. Furthermore, these terms are used in **Chapter 1.6 and Chapter 6.6** to fully explicate the contribution of the thesis.

3.14.1 Incremental Contributions

According to Alvesson & Sandberg (2011) incremental contribution is a type of contribution based on the “*traditional gap spotting*” approach to reviewing literature. This is the most prevalent type of contribution strategy. Alvesson & Gabriel (2013, p. 248) stated that “*embedding your research within the existing literature is a must and allows editors, reviewers, and readers to orient themselves*”. Additionally, Sandberg & Alvesson (2011) further identify sub-strategies within the strategy of “*traditional gap-spotting*”: confusion spotting and neglect spotting. They stated that confusion exists “*where a collection of published papers within a theme fail to reach concord on a subject*” (Nicholson et al., 2018, P. 208). Therefore, an author’s approach in this situation would be to attempt to justify the previously published results. The second subcategory which is neglect spotting, is a strategy aimed at focusing on “*neglected or under-researched areas*”.

Consequently, this research follows the traditional gap spotting approach by way of reviewing pertinent literature to identify the gap and effectively embed the thesis within the existing literature. Specifically, the sub-category - neglect spotting - is applicable to this thesis. Horrocks et al. (2016) postulated that the sports industry is reaching a plateau in terms of physical fitness (measuring performance), and there is a pressing need to better understand the acquisition of decision-making abilities and a requirement for players capable of making swift appropriate decisions in time constrained and high-pressured environments. This implies that there is lack of research in terms of how data and technology influences decision-making. Moreover, James (2006) highlighted that there is very little research investigating how data and technology influences decision making abilities of coaches and how it impacts the players and ultimately performance in matches.

3.14.2 Revelatory Contributions

Nicholson et al. (2018) stated that revelatory contributions has two sub-categories; *assumption challenging and using multiple lenses*. The first sub-category, assumption challenging, is a strategy aimed at challenging the underlying assumptions of a body of work or challenging the consensus in a body of work (Grant & Pollock, 2011). The second sub-category, using multiple lenses, is a strategy aimed at developing multi-disciplinary research so as to explain complex research, and typically leads to the generation of significant findings.

Consequently, this research follows a revelatory contribution strategy, more specifically, it utilises multiple lenses in an effort to explicate the research questions. This research draws from the operations management body of knowledge, it borrows the learning organisation management theory. Additionally, the use of data and technology in sports necessitates tapping into different areas such as decision-making in order to fully provide the background to generate significant findings.

3.14.3 Consolidatory Contributions

Nicholson et al. (2018) define consolidatory contributions as contribution predicated on the dedicated literature review of scholarly work that aim to advance knowledge in some way. This type of contribution can be further divided into three sub-strategies; narrative, systematic review and meta-analysis. The first sub-strategy which is *narrative* is the most common and generally known as the traditional review, this involves the presentation of literature in a subjective manner. The second sub-strategy which is “*systematic-review*” necessitates greater objectivity and allows for the results to be generalised and replicated to a certain degree. The final sub-strategy, which is meta-analysis lends itself to quantitative approach, and is aimed at hypotheses testing and combining and juxtaposing the findings from various studies while also examining the sampling instrument utilised in each study (Geyskens, Steenkamp & Kumar, 1999)

Consequently, this research follows a contribution predicated on the dedicated literature review of scholarly work aimed at advancing knowledge. This research has put forward extensive literature review (**chapter 2**) presenting a body of work, albeit in a subjective manner. Specifically, the sub-category – narrative review - is applicable to this research.

3.15 Chapter Summary

Maylor and Blackmon (2005, p.156) stated that the “*research approach should always be consistent with the philosophical assumptions, methodology, method and the research questions*”. The present study follows an interpretivist perspective on the philosophical level, utilising qualitative approach at the methodological level, with semi-structured interviews as method for data collection. As this research focuses on sports, the unit of analysis is “sport teams” – a group of individuals working together to achieve a common goal. Within sports structure, that is tantamount to a group of players and also the coach who sets out the plan for how that goal can be ultimately achieved. Participants were carefully selected using stakeholder analysis while taking into cognisance the limitations of the study in terms of access and geographical issues. The data collection process was initiated on May 10th, 2017 and lasted through January 29th, 2019. All sports teams are located in the United Kingdom. The researcher’s interview protocol was meticulously designed and subsequently used to collect data while also incorporating triangulation for data validation. Prior to field work being conducted, ethical approval was obtained, with anonymity and confidentiality a main priority throughout the study. Data collected were secured and stored in appropriate storage devices, with data subsequently transcribed verbatim and framework analysis used to generate themes. This chapter concludes with a section on contributions, highlighting the potential contributions of this thesis.

Chapter 4: Findings

4.1 Introduction

This chapter sets the scene and boundaries for the research findings and the subsequent discussions in **chapter 5**. It presents the set of findings in relation to the research questions, and this is achieved by way of analysing the semi-structured interviews as explicated in **chapter 3**. As alluded to in the previous section, a framework was used to analyse the first 6 transcripts, which comprised of interviews done with participants from different sports such as football, cricket and rugby. A final framework was produced after no new codes emerged from the initial transcripts; the final framework was then used to code the remaining transcripts. The resulting findings have been categorised into nine themes starting from the impact of digitalisation on sport's evolution to the future of sports with regard to digitalisation. Table 10 below presents the key themes from the research and corresponding details explicating the information presented in each category.

Table 10 - Key Themes

Key Themes	Details
1. Impact of digitalisation on sport's evolution	This theme presents findings on the impact data and technology has had on the growth of sports and the factors that influenced the acceleration of digitalisation in sports.
2. Defining sports analytics/performance analysis	This theme presents and compares the definition of sports analytics/performance analysis from different participants and sports.
3. Role of digitalisation in sports	The role of digitalisation in sports is identified from the perspective of the participants.
4. Influence of digitalisation on decision-making abilities of players and coaches	Following on from the previous theme, this theme presents more specific information on the influence of digitalisation on decision-making, while demonstrating this with key excerpts from participants.
5. Challenges, drawbacks and the digital divide	This theme presents findings on challenges in relation to the implementation and utilisation of data and technology.
6. Data & technology caveats	This theme presents findings on the caveats that must be taken into considerations during the process of utilising data to inform practice.

7. Current practices and utilisation of data	This theme highlights and presents findings on the current practices of data and technology utilisation in football, rugby and cricket.
8. Best practices	Following on from the previous themes, this theme highlights and presents findings on the best practices of data and technology utilisation from the aforementioned sports.
9. Future of sports	This final theme concludes the presentation of the findings by presenting information on the future of sports given the evident and continuous impact of digitalisation on its ecosystem.

The themes were presented in a meticulous way ensuring coherent flow in terms of the evolution and future of sports. This chapter concludes with a critical summary of the findings and sets the scene for the ensuing discussion in **chapter 5**.

4.2 Qualitative Data Analysis

All the transcripts were compared with the notes taken during the interview to ensure both were consistent, Halcomb & Davidson (2006) suggests that this authenticates the analysis process. Consequently, the findings emerged from the interviews conducted during the data collection phase described in **chapter 3**. Figure 28 summarises the process of the analysis and how the findings were reached.

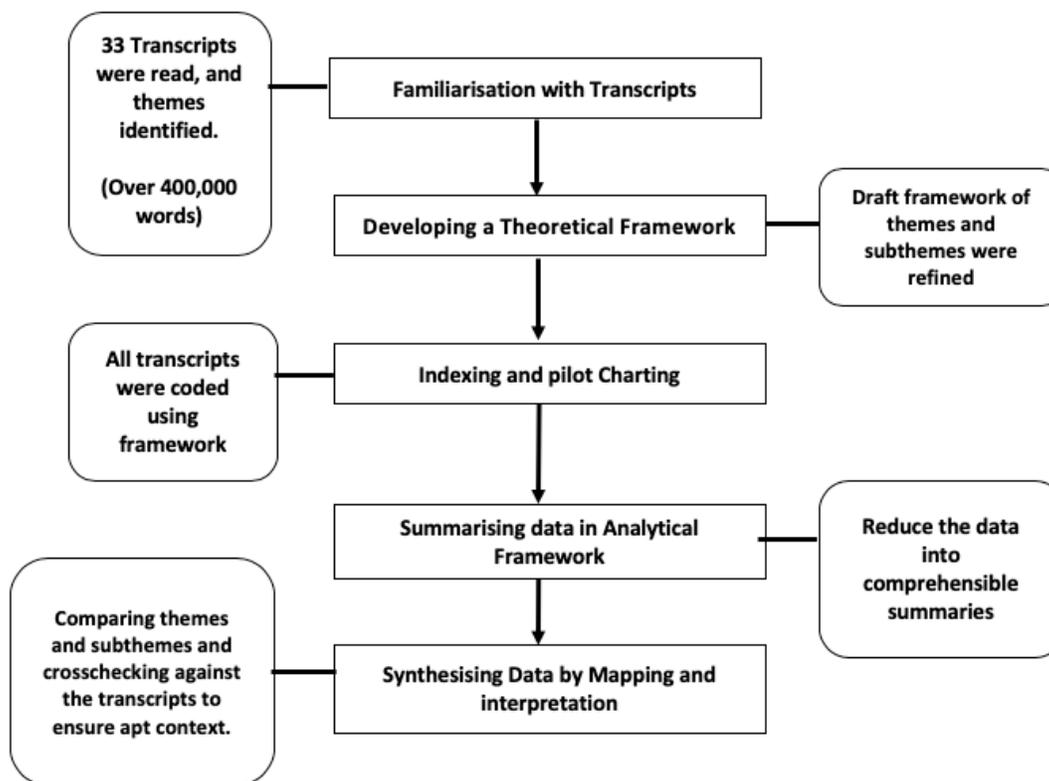


Figure 28 - Data Analysis Process

4.3 Impact of Digitalisation on Sport's Evolution

In this section the participants discuss the impact data and technology has had on the growth of sports and the factors that influenced the acceleration of digitalisation. The subthemes used to organise the discussion include culture, recruitment, access to data, new entrants, training, precise information and GPS.

Digitalisation has had a massive impact on the development of sports both on the field and off the field. The sports industry has come a long way over the last 10 years, with new technologies and new ways of analysing data being introduced. It has enhanced sports in a plethora of ways from improving physical fitness of players to bringing fans closer to the game. Participants acknowledge that certainly 10 years ago it was unheard of to use data and technology in sports:

“the first thing I would say is that 10 years ago it was very rare that we would have video analysis and stats analysis. We would sit down and have a chat about the opposition or sit down and have a bit of a guess or estimate of past score or average score on that ground, whereas now all the information is on hand so you can get much more precise. The video analysis that we do

is obviously quite common now, every coach has to know how to work a laptop or an iPad and go through some video analysis” – P11 Q1

The statement above gives credence to the fact that digitalisation has changed sports for the better, with sports stakeholders having easy access to data and technology. To the extent that it has become the norm and stakeholders are expected to be versed in working with such technologies. This has obviously impacted the culture of sports as well. Certain sports for many years have garnered reputation for being traditional in approach, as it appears that some sports are more progressive than other sports.

“Yes I think they have, a lot of that comes from lack of knowledge, a lot of that comes from insecurity but I think the game over this last ten years has really change in that area and there are lots of bright coaches out there now that embrace all the new technology, that embrace the data as long as they recognise that it has an impact on performance” – P7 Q1

Nevertheless, the statement above seems to imply that this “*traditional approach*” is changing as participants acknowledged the fact that even though there has been a culture of people in sports reluctant to embrace technology, that is changing gradually with managers and coaches now seeing the benefit of using it to inform practice. Similarly, other participants agreed with this and highlighted that the culture in sports in now that of technology being used more frequently.

“Yeah I think the coaching culture now is there's a lot of sports analysis now, prior to and post games, whereas before ten years ago managers that have played the game win lose or draw and they'll have their own opinions from sat on the side of the pitch whereas now there's cameras everywhere so there's a more detailed view and detailed perspective of what went well and what didn't go so well in a game” – P14 Q1

Comparing the use of data and technology in sports now to a few decades ago participant P25 stated that:

“I think people would have looked at sports science twenty five/thirty years ago as this luxury and this thing that wasn't set, with money coming into football it was just something that people were just starting to get into in terms of nutrition, high intensity running and things like this. Now that seems a commodity, where you can look at recovery, you can look at how they are sleeping, how players are eating you can look at the speed at which they are running with and without the ball, there are different thresholds you look and that would have been seen as a luxury back then” – P25 Q1

This account given by participant P25 stresses how much sports has changed and how data and technology has become essential. The participant went on to state that it is becoming a key part of everyday life in sports, where newly appointed coaches now bring in their own sport scientist and

fitness coach. Similarly, participant P21 who also happens to be a former player corroborated the above statement by putting forward that:

“Certainly from my end, from when I was playing no one wore GPS it was just a case of going out there and training, but I think obviously now you know like I say when I was playing I wasn't anywhere near the athlete that I deal with on a day to day basis so I think it is important when you invest so much money on these players it is important that you know they are being monitored correctly” – P21 Q1

The digitalisation of sports was further stimulated by the new entrants coming into the sports ecosystem, these are sport data companies and technology companies that made it easy for sports teams to not only have access to data but also provided an avenue for analysis and interpretation. This was a particularly big revolution in sports as well, considering the fact that sport is known to have a structure built around the players and the coaches. Companies such as Prozone and OPTA have been at the forefront of this phenomenon for many years and still continue to push the envelope. Their presence has been further ingrained in sports with notable sports leagues such as the English Premier League, Spanish La Liga and US Soccer signing agreements with technology giants in an effort to bring football to the forefront of sports through the development of world class players and coaches. Participants stressed the importance of sport data companies coming into the sport ecosystem because it allowed them to be able to compare software programs and choose the most effective one. At a point in time, Prozone was the only data company providing data to clubs but now there are a plethora of companies which creates more competition and adds more value to the sports ecosystem:

“Since then that particular area expanded and the number of companies that are offering us those products. So the first big thing that we've had was - we had GPS and we had Prozone and for the first time ever we could put GPS on the players (at that stage only like friendly matches because they weren't allowed to wear it in the Premier League) but we could actually run Prozone alongside GPS which allowed us to compare the two bits of software.” – P16 Q1

Additionally, with the premier league also supporting use of data and technology by providing game statistics on every team, it makes it easier for teams to now have access to information about their opponents, whereas before it was just a case of Prozone providing anonymised information on a team's stats:

“it's become much more so the Premier League getting a hold on it, so before it was prozone who would give you detailed information on your team's work but it gave you anonymised information about what the other teams were doing and in the Premier League

whereas now with how the Premier League is setting up you can see much more of what the other teams are doing so you know it's become much more open” – P16 Q2

Digitalisation has improved the standard of the game and it has improved the standard of a lot of sports, this is because sport teams now know more about the game and can train smarter and specific to the needs and demands of the sports. The introduction of technology such as GPS has played a massive role in sports such as football, cricket and rugby in terms of acquiring information that enables coaches and players to prepare effectively. Participant P18 comparing “*new look*” sports to a few decades ago stated that:

“before the use of the GPS technology we didn't learn how much distance, high-speed distance things like that the players are covering” – P18 Q1

Digitalisation has also had a massive impact in the terms of recruitment and scouting departments. It has made it possible for scouting departments to be able to watch games from all over world from the comfort of their own offices. Prior to that, scouts would have to fly out of the country to watch a potential player play before agreement can be made to buy him. Digitalisation has made it possible for massive amounts of data to be collected on a potential player and subsequently analysed to ascertain if that player would suit the philosophy and playing style of the interested team. One participant stated that:

“So it would cost me a lot of money to get a plane over to Bulgaria or America to go and watch a player on the basis that I've heard is a good player, so in order to substantiate that cost to your board say "look it's going to cost us two and a half thousand pounds to go and watch this player" they're going to ask why? so you know I would say that the statistical information, the data gathering to identify these players is a cost-effective tool initially to identify suitable players for your first team” - P14 Q2

The use of data and technology for scouting has become the norm within sports with some teams stating that they recruit solely based on statistics. This accentuates the impact that it has had on sports since its inception. Furthermore, sports data companies like Wyscout allow teams to be able to download games from all over the world on their platform which can then be viewed easily on a computer, mobile or tablet device.

“Statistics and data I've come into football huge over the last 10 years you know from a recruitment perspective football clubs now certainly in the championship we are recruiting purely down to statistics so you know they are identifying how fast a player can run, the distances a player can run and the data are of how successful they are in games over the period of 10, 20, 30, 40 games and they're looking at that has hard evidence when they're you know discussing recruitment opportunities into their first team.” – P14 Q3

“I think from our industry there are several products out there they enable you to scout games that you can't attend, so for example "Wyscout", we can download games, we can watch games from all over the world and again so that is something that has taken recruitment to another level.” – P7 Q2

4.3.1 Factors that influenced Digitalisation

The subthemes used to organise this discussion include competitive edge, finances, societal changes and better understanding. Although the utilisation of data in sports dates back 50 years, it can be said the data revolution came after what is referred to as the “*Moneyball Era*”. This solidified the use of data and statistics to inform practice and led to a wave of sports organisations embracing it. Sports has changed enormously over the last couple of years and while “*Moneyball*” set some of these changes in motion, certain factors have also played huge roles and continue to influence digitalisation in sports industry today. Sports has gone from being played for fun and grown into a billion-dollar industry. Participants have shed light on some of the factors that influenced digitalisation in sports, with the first one being finances. An enormous amount of money has been pumped into the sports industry over the years through TV media rights, ticketing and merchandising. Some of the participants were of the opinion that the monies available in sports now has allowed teams to be able to invest in technology.

“I think, one of the key influences has obviously been, the finances that are available to the sporting industry, I think we take our industry for example, the premier league, the TV money that is available is just staggering” – P7 Q3

The investment and scale of money involved in sports now has allowed a lot of sports teams to go down the route of utilising technology to a greater extent. In addition to this, participants also stated that data and technology enables one to be able to back-up decisions that they have made in terms of recruitment. Investing in a player can always be a tricky matter, because one cannot say with absolute certainty whether or not the player will be able to transfer the previous success to the new club. However, utilisation of data and technology can help alleviate certain doubts by way of providing an objective decision-making approach.

“Money, finance, the amount of money now in the game compared to 10 years ago has catapulted with all of the money that's coming through TV subscription rights and you know all of the money that's in the Premier League nowadays I think people look at statistics and data as a way of protecting themselves on decision-making, so they can say well this is why we've recruited this player as opposed to well we thought it was a good player based on our observation when we're going to watch him” – P14 Q4

While the monies flowing in sports is definitely an unshakable factor, other participants had a different opinion on the matter. Some stated that a “*better understanding*” and “*competitive edge*” are the drivers behind digitalisation. A good amount of the participants stated that teams have always sought out more ways to be competitive and get an edge over opponents, and this no doubt influenced some of the influx of data and technological innovations in sports today.

“In terms of drivers I think a lot of sports teams think it gives them an advantage, an edge. Sometimes you need technology all the time, you can actually just see it - the visual element - but I think that it’s about the edge” – P6 Q1

The sports industry is undeniably one of the most competitive industries in the world, with one of their main symbolic components being “*secretive*”, and rightfully so. Each and every sports organisation is built around the philosophy of winning games and staying competitive in an otherwise unpredictable and volatile environment. Therefore, it would make perfect sense to exhaust every avenue in their pursuit of greatness, and of course data and technology has become a big part of that. So much so that some clubs invest in technology when they see their rivals do it, in an effort to appear competitive, even though the technology might not be required, and they have little understanding about how it can be utilised effectively.

*“if Manchester city have something Manchester united will probably buy it because they want to be seen as competing, so there is an element of perhaps clubs buying into things without a real understanding of how they can benefit from it, it’s more about I want it because they have it”
- P6 Q2*

There is no denying that in the world today, digital technology has changed the way organisations operate and it has obviously trickled down to other industries such as sports. Human beings tend to follow the current trend of what is happening around them and in conjunction with the above statement, other participants have noted that societal changes are responsible for digitalisation in sports. The world today is driven by technology to a large extent, and the sports industry is no different. Sports now incorporate the use of mobile phone and tablets devices in training sessions because they believe the players will be able to relate to it better because of them being brought up in this age of technological revolution. From displaying some statistics about players on iPads during sessions to sending daily fitness goals to player’s mobile phones, the society has definitely played a big impact in the digitalisation of sports:

“I think the general changes in society in terms of how the power of the mobile phone now, I think it is something that we as coaches have embraced. People will say “they are always on the

phone" so understand that that is there generation, so we put a lot out stuff that we want them to see - information, data, videos- we will put on an app that is easier accessible to them and it's also their world" – P7 Q4

4.4 Defining Sports Analytics/Performance Analysis

In this section the participants discuss and compare the definition of sports analytics/performance analysis from different perspectives and sports, giving an insight into specific definitions depending on usage.

The definition of sport analytics is one that appears to be unclear and not completely stated within extant literature, as there appears to be no definite definition of sports analytics. This has no doubt raised some perplexity in terms of how it should be defined. Some of the participants also shared this confusion in terms of the definition. Without a proper definition it becomes hard to really pinpoint not only benefits of using it but also a starting point of how to implement it:

"I'm not sure to be honest it hasn't established enough to have it like a definite name in the organisations that I've worked in, it's always sort of like a field of performance analysis or you know the stats or something like that" – P16 Q3

It seems that sports teams are not particularly concerned about defining what sports analytics is, the above statement reinforces the fact that this definition is still not known and is defined based on how it is used currently at a particular club. Furthermore, some participants suggested that different clubs or sports might have different ways of defining it, based on how they use it, which seems to make it all the more confusing. Granted, perhaps no two clubs will use data and technology the same way, because in order to succeed it will be utilised in innovative ways. But at the basic level, there should definitely be a set of constant building blocks within the definition that offers a starting point in terms of implementation:

"You tend to find that different organisations refer to different aspects in slightly different ways, so like a performance analysis at one club might only incorporate one particular area but another Club it may incorporate a wider set of areas so that makes things quite confusing" – P16 Q4

Nevertheless, majority of the definitions suggested by the participants seemed to imply that the end result is to improve performance. Table 11 shows three definitions from sports ranging from football to cricket.

Table 11 - Defining Sports Analytics

Football	Rugby	Cricket
<p><i>“is utilising a tool to try and help improve someone's performance or a team performance”</i></p> <p>– P8 Q1</p>	<p><i>“taking whatever data you collect from players, because now a lot of players are monitored by data collection sort of systems. looking at that data then is analysed by the coaches to look at how they can improve a players performance” –</i></p> <p>P2 Q1</p>	<p><i>“I think for me everything we do is about improving performance so for me performance analysis the definition of it or it's meaning in sport is the use of information to improve team or individual performance” –</i></p> <p>P18 Q2</p>

While the above definitions were given by different participants from three different sports, and have slightly different variations, the one thing they all have in common is the fact that the ultimate goal is to improve performance. This is no surprise as performance is a very important element within sports, but the absence of other equally important elements does make the definitions vaguely incomplete.

4.5 Role of Digitalisation in Sports

This category identified the role of digitalisation in sports from the perspective of the participants. The following subthemes are used to organise the discussion: clarity, access to information, more informed decisions, competitiveness, reduced cost, and next level understanding.

The role digitalisation plays on and off the field within sports is an important one that cannot be disregarded. Coaches and players alike are certainly starting to recognise the benefits of this phenomenon and this has been exhibited in the findings. Digitalisation is unquestionably a growing necessity for all teams and over the past decade the sports industry has shown strong reliance on it, almost making it impossible to separate digitalisation and the sports industry. It is an enabler, certainly within sports and some sports thrive on using it. Comparing the sports industry now to what it was 10 years ago, one participant stated that:

“10 years ago or more it was just a case of you believe what you saw, so if you're a manager of a football club you used to think well he's working hard or he's not working hard or he's having a good game and he's not having a good game whereas nowadays they may still have that opinion in the outset but they will go and back that up” – P14 Q5

The statement above solidifies the importance and role of data and technology in sports. It brings an element of clarity not only for the players but also the managers and coaches as well. Participants credited elements of clarity to digitalisation:

“it is presented as evidence to support and underpin why coaches are suggesting a particular approach in a particular game. so the evidence is there with regard to the player to provide support justification for the argument of why are we suggesting that we play in next game this particular way, adopt these particular tactics, why are we changing how we're doing things to the extent that's more persuasive” – P3 Q1

The participant above stated that data and technology aids and reinforce the coach’s decision about a particular approach. There will always be arguments between players and coaches regarding performance in terms of the coach stating the player hasn’t had a great game and the player disagreeing. Data and technology can aid in clarifying and backing up decisions being made and difference of opinion. Although this can come across as a way for coaches to pick on players, this is not the case. Rather it is a way to identify strengths and weaknesses of the player thereby creating an opportunity for constructive discussions on how to improve:

“if they are sat in front of a player now they're not just saying to him " i think you've had a bad game and the player says "well I think I've had a good game" and they have a difference of opinion now it's a case of I think you had a bad game for this reason and they would put it on the screen, the statistics in the game and the video to support it "this particular instance I felt you should do this better so the online resources and the statistics have helped people identify strengths and weaknesses.” – P14 Q6

Constructive discussions between players and managers can definitely help players prepare for the subsequent games ahead and because it is impossible for the human eye to pick up everything that happens on pitch, sometimes having data can provide some next level understanding for the managers and coaches. One participant stated that:

“The coach generally sees pretty much most of what happens on the pitch but what data gives us is it can give us things that the human eye just can't pick up because it can pick up much more complicated patterns that if you're watching one part of the game that you made the human brain might not be able to absorb everything that's going on” -P16 Q5

Participant P13 substantiated other participants claim by confirming that:

“It brings clarity, like I said before in a game situation depending on the state of the game, the mental state at the time, it brings clarity because the pictures don’t lie, it tells you some of the story but again for instance sometimes I would say in a game situation if you are in a big stadium away from home you can’t anticipate the crowd and the emotions they are going

through but it does give clarity to what actually happened on the pitch. It gives clarity to positioning, it gives clarity to decision-making” – P13 Q1

Participant P5 further underlined benefits of data and technology by stating that it brings an element of accountability:

“I think it bring a level of accountability because now players don’t accept necessarily criticism from a coach or the manager or performance analyst as easily as they might have done when the video wasn’t available or the data wasn’t available. Now they can cross check it themselves you know and it actually stimulates more interesting discussion around the performance and what the right thing to do was” – P5 Q1

There was a general consensus around the role digitalisation plays with regard to clarity and accountability. Sports is a game of many opinions, structured around players, coaches, managers, medical staff, nutritionist, among others. Consequently, all the individuals involved will have an opinion about how a particular player performed or should be performing, including the player himself. Digitalisation lay bare all information and ensures clarity. Furthermore, digitalisation has made it possible for sport teams to now have access to vast amount of data and information which can be analysed and interpreted for the purpose of informing practice. Sports has always been structured in a way that data and statistics about a team is kept within the confines of that team alone, but digitalisation has made it so that even the fans have access to data about their teams. Not to speak of the level of access teams themselves now have to opponent’s data. Participants noted that years ago it used to be that a team would go to an opponent stadium without knowing much about the other team’s strategies or tactics but there is so much information now at hand and that helps the manager prepare the players appropriately.

“ten years ago you would go and play against opponent and you would probably not know much about the opponent, now certainly under 18 level we can now get videos from the last two or three games of our opponents and our analysts then utilise the software to carve up clips of the opposition so the coaching staff can identify strengths and weaknesses and then that helps them shape their tactical plan” – P8 Q2

From point of the view of the players, this certainly helps them be prepared because the manager can harness the data and use that to educate the players on what to expect and where the opponents are weak. Participant P8 further buttressed this point by stating that:

“what data might do is inform us of things that our opposition do and we’ll then educate the players that this is what the opponents might try and do, or this is where the opponents are weak but it wouldn’t change their tactical setup, how we set up to play” – P8 Q3

In congruence with the aforementioned statement, participant P11 shed light on how data and technology now aid in preparation of an upcoming match. He explained that:

“you get a lot more insight into going into a different ground, going into an away ground. You have a much clearer idea of what an average score is and you can base your game around it. You can get much more evidence on the opposition, you can do a lot more kinda of research into the opposition, planning and tactical analysis becomes a lot more evident as well” – P11 Q2

Furthermore, data is now whittled down to small chunks of information for each player, making it seamless for the team to have quick access to opposition player’s data. This account given by participant P18 emphasises the role data and technology now play within sports in comparison to before its introduction:

“So before they go into the fixture they know so much about that player that their ability to bowl at them is a lot better so if they perform their skill effectively they will be able to be successful against them, whereas before we had this technology and the power to look at a player's previous matches and previous modes of this dismissal you're almost kind of go into the battle with the player and work that out as you go” – P18 Q3

Players now have massive amount of information on their opponents and vice versa which creates more a more competitive and interesting sporting environment. From a team perspective, the influx of data has enabled and fostered an even more competitive environment within sports. The days when only the top-level teams dominated the leagues are long gone, now all teams have the capability of playing on a levelled playing ground. Teams that lack the financial clout to invest in top players can now use data and technology to their advantage. Leicester FC is a great example of this, winning the Premier League having made data and technology an integral part of their practice:

“for teams that don't have as much funding, they will look at how they can utilise analysis in a cheaper but still efficient way. Everything is becoming portable now, so you've got things like iPad and thing like that. and you can buy apps for quite cheap and you can just do some video type feedback and you can do that with the players and get them to interact with it as well – P6 Q3

Participant P3 put this into perspective by putting forward the following statement:

“in Dutch football if AZ Alkmaar and the smaller clubs can compete with the AJAX, PSV, and Feyenoord it makes Dutch football more competitive, more unpredictable and so the teams that tend to embrace analytics tend to be the smaller teams who don't have the money to spend to compete with their financially richer rivals and if analytics can help them it makes the sports even more unpredictable” - P3 Q2

Consequently, it can be said that data and technology bring additional competitiveness, thereby allowing the lesser clubs to compete with the top clubs. This phenomenon now spreads down into the lower leagues and levels the playing field.

As mentioned above, players are now more aware and have more information at hand going into a game or even training sessions. Ultimately, data and technology bring a chance to assess and evaluate in a slightly objective way than done previously, and while you have to take it with a pinch of salt, it does give the opportunity to compare between vast amount of data. Data available now makes it easy for players to know what they are going up against and they know what is expected of them. In addition to being well-informed about opponents, data and technology also aids in aspect of injury return. Participant P15 stated that:

“making sure that a bowler is prepared especially when coming back from injury, they're prepared enough to sort of prevent themselves from having injury” – P15 Q1

4.5.1 More Informed Decisions

Many of the participants emphasised the role that data and technology plays in terms of informing decisions. The introduction of data and technology inform coaches and players about performance, consequently utilising information to then put in place development activities to help improve future performance. Participant P8 put forward the following statement:

“I think it brings information and it makes people more informed, normally when you're more informed I think you make better decisions so ultimately it's aiding decision-making, I don't think it's overriding a coach's decision-making but I think it's aiding the decision-making” – P8 Q4

While noting that data and technology makes individuals within sports more informed, participant P8 was also quick to affirm that technology doesn't necessarily overrides the coach's decisions but rather aids it. There has been the opinion that technology might be replacing or undermining the decision of sports agents, but this statement above appears to dislodge this. Data and technology give evidence on performance, it gives information to make more calculated decision: from selecting a player for a game to signing another one that fits the team's philosophy. Participant P12 put forward the following analogy:

“it backs you up if that makes sense, it is like doing a research paper and going - ‘great my hypothesis is correct’” – P12 Q1

Participant P12 put a different perspective on it by stating that it supports decisions made by the coaches and also confirms their theories regarding what works and doesn't on the pitch. So rather than just relying on gut feeling it gives a cleaner, clearer picture of assessment on the team and players. Data and technology bring next level understanding and details. Typically, the coach can see what transpires on the pitch and the interaction between the players, but what data offers is the ability to identify events during the game that wouldn't be possible with the human eye. Data and technology can be used to identify complicated patterns, one participant emphasised this by stating that:

“as human what we struggle to do is if you take like a hundred Premier League games and look for patterns that are similar between them there's no way any human could ever do that whereas - if we get the data and you know treat it in the right way and use it in the right way and ask the right questions of it we can now start asking questions like that where it can just look at a huge number of situations to try and get similarities in that” - P16 Q6

Similarly, another participant shared this viewpoint by putting forward the following statement:

“I mean for a coach to watch a whole game of cricket is a difficult thing to do, so even though T20 game may be three hours long, a one-day game is you know six hours of cricket” - P19 Q1

Additionally, the participant went on to highlight the issue of bias as a result of watching the videos from a game. This seems to imply that biases are a naturally by-product of relying on gut instincts, therefore, technology can aid in eliminating unintentional biases:

“for a coach to be able to watch that and not formulate bias, I'm not saying that they're deliberately doing it. But this is the way you know the ability for us to be able to I guess take a step away from it and to have hard numbers and data that stop biases and hopefully through that create better decisions” – P19 Q2

Data and technology provide an all-encompassing view of performance and makes the coaches and players smarter. Participant P23 made emphasis of the fact that sport teams are sometimes rather reactive than proactive within their practice. The participant put forward the following statement:

“sometimes we are a bit reactive rather than proactive within our sports, so data actually allow us to be more proactive, so becoming smarter about the trends and patterns within football” – P23 Q1

The participant went further to state that within their training programs they have a good idea of what physical training output should look like from day to day. This allows them to know how the players are doing physically and what they need to achieve on a given training day, so if the

physical output from a training session is lower than expected they would know the reason behind it. Ultimately, data and technology allow sport teams to be smarter, they have crucial information on opponents, how to stop them and they have a good idea of the percentage of success at a particular stadium.

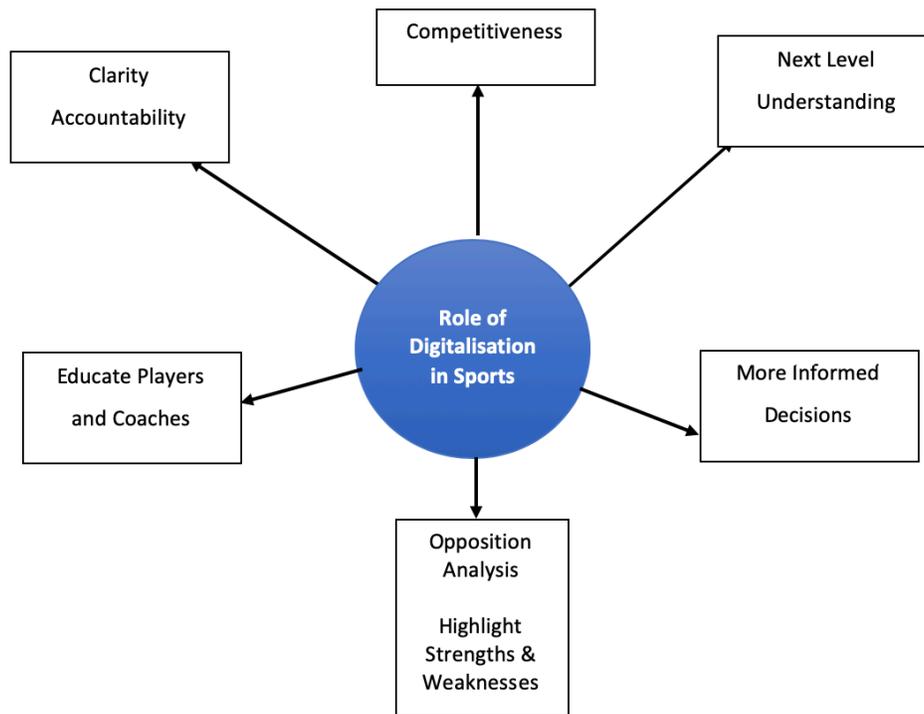


Figure 29 - Role of Digitalisation in Sports

Figure 29 above illustrates and summarises the role that digitalisation plays in sports, by highlighting the ways in which it helps the coaching practice. The elements identified above are the main elements in terms of what data and technology brings to the sports industry. Key elements such as clarity, accountability, competitiveness, next-level understanding, more-informed decisions, opposition analysis and education are key within sports in terms of digitalisation.

4.6 Influence of Digitalisation on Decision-making Abilities of Players and Coaches

Following on from the previous theme, this section presents more specific discussion on the influence of digitalisation on decision-making, while demonstrating this with key excerpts from participants. The subthemes used to organise the discussion includes: Educating Players & Coaches, Developing Players.

Decision-making is one of the crucial elements of any sport endeavour. The sport industry has come a long way in terms of the various ways in which technology is been utilised to monitor performance. However, participants stated that decision-making is still an untapped area in sports that needs more attention, particularly in cricket:

“I think decision-making is something particularly in cricket that is untapped, that is an area that we would want to learn more about and get better at, this is why I think the virtual reality stuff would really help the decision-making” – P11 Q3

Another participant corroborated the above statement by putting forward that:

“at the moment that's an area that hasn't really been looked at too much but I think it once we understand the data well enough it will really enhance the players sort of like understanding of why certain decisions are made and a lot of things that the coaches coach” – P16 Q7

Nevertheless, sports teams are beginning to recognise its importance and have innovative strategies in place to not only help improve players and coaches but also support their long-term development. Video technologies, Wearables, and GPS systems among other technologies are facilitating this process. Participants stated that the main role of data and technology within on-pitch decision-making is to help educate players and coaches. The convenience brought on by the introduction of these technologies has had a massive impact on player-coach relationship and diffusion of information. Participant P25 stated that:

“Technologies we are using at the moment, we are using things like online platforms, we are using huddle, so that enables us to send video and data out to players if need be and individual passes and things like this” – P25 Q2

Participant P14 also stated that:

“there's a new software called CoachPaint at the moment which is used on Monday Night Football where you'd have seen Gary Neville on Monday Night Football actually moving players around circling - a lot of clubs have that now so that helps when you having your individual meetings with your players one to one basis and you can actually get them up and say - 'look show me where you actually was meant to be in that instance and look what happened'- so the analysis then of that individual performance is there to see” – P14 Q7

In addition to the aforementioned technologies, virtual reality appears to be another cutting-edge technology teams are using to influence decision-making. While still in its infancy, virtual reality holds many benefits as suggested by participants.

“Yes, Virtual Reality is probably the biggest one at the moment and everyone is talking about it, so within that there is probably two or three points of interest for us. One is the analytical side so for example to be able to recreate a scenario for a game, look at decisions made in that more accurately, looking at what would have happened if a player had made this decision instead of this, looking at it from their perspective on the pitch. So if it is a defender their movement to get into position and a clearer cross but they don't quite get there, you can look at what were they seeing at that time, what would they have done now on reflection”. – P25 Q3

The above statement implies that virtual reality could potentially be the technology that provides the all-important edge in terms of decision-making. This account below provided by a participant illustrates the extent to which virtual reality is and will change the learning process of coaches and players:

“put a pair of goggles or pair of glasses and I'll be a able to sit there and watch it on mine and actually be in your position on your pitch, now that is staggering because that gives you a better perception of the decision-making process of the player” – P7 Q5

The above statement was put forward by a coach explicating how the technology can bridge the gap and enable coaches to better understand the thought process of players. The participant further stated that:

“Virtual reality will just do that, I think you will be able to look at it in real time and then actually as a coach be able to go into the player decision-making and the player himself go into the decision-making there, see what he has done, so what he actually saw in that moment. For me I think that is just brilliant” – P7 Q6

The virtual reality technology is regarded by participants has a potential game changer in terms of understanding and improving decision-making processes. The ability to be able to recreate a scenario where previous games can be relived and certain events that transpired during the game can be dissected and understood is unparalleled. Decision-making is evidently one of the most intricate and difficult aspect of sports to understand and exploit, due to its abstract nature. Furthermore, it can be influenced by many other factors such as instincts as pointed out by a participant:

“it gives them more information to make a more educated decision, but I do think cricket is such a game that is done on instincts” – P11 Q4

Participant P11 put forward the above statement to reinforce the influence of data and technology has on player's decision-making abilities, stating that it gives them information to make more educated decisions. The participant, however, went ahead to state that cricket is a sport played on instincts, which also highlights the fact that technology and human element need to co-exist to have holistic decision-making. That said, the influence of digitalisation on decision-making cannot be neglected, as it serves as a foundation for the effective development of this complex element. Participants pointed out that the data available now makes players more aware and as a result more likely to anticipate situations during the game:

“I think there is better knowledge now; the players are more aware, more knowledgeable, more intelligent around the game. They are more conscious of what they are doing; they are more conscious of where they can improve and where it makes a difference and I think that is a real positive. I think it makes a real impact on a lot of players” - P25 Q4

Another participant echoed the above statement by explicating that:

“Data can make players clever and more aware of situations, it brings precision, enhancement and development. The use of big data and technology can help create more knowledge, which can be used toward decision-making and ultimately improve performance” – P1 Q1

The way in which technology can influence decision-making abilities has been a grey area for some time now within extant literature. This could be because it is difficult to establish a cause and effect relationship between introduction of technology and improved decision-making abilities and then subsequently performance. But perhaps there are ways in which technology can aid decision-making. One participant put forward the following statement:

“Yes, the thought process so you can make the player aware that if this happened again then what would they do and they could start to learn more, they can look at their actions, how they affect the game and see consequences of what they do and maybe help them make a better decision, because I think in football you probably talk about decision-making effectively, every piece of data, it is to help make decisions better. And if players make better decisions normally the outcomes can be better” - P25 Q5

The aforementioned statement seems to imply that every piece of data can potentially have a positive effect on decision-making abilities of players, which then influences performance in the long run. A key element, however, is the ability to reflect on one's own performance and be able to make deductions based on past events and patterns that emerge through pieces of data. Furthermore, the participant illustrated the importance of the technology within the coaching

process and how it can aid players in developing knowledge by putting forward the following statement:

“it is coaching put on a screen instead of the grass whether it’s data or video you are getting more contact time with the players because in terms of the coach being able to educate them it is an educational tool and previously because of technology improving you get more access to the players so even if you are not with a coach, or assistant manager an analyst can upload something, the player gets a notification of their phone to say this has been uploaded have a look at it and the player” – P25 Q6

The coaching process particularly within football has come a long way since the inception of data and technology in sports. The above statement not only illustrates how much technology has infiltrated the coaching process but also how much impact it is having on the players and how the coaches can help the players learn better through streamlined approaches. Technology helps speed up the learning process of players and as a result can influence how much knowledge players are able to absorb at a particular point in time. Players can become more knowledgeable through this process of coaches and assistant managers sending “player specific” updates to each player’s mobile phones.

It is imperative to get the players involved, and according to participants the benefits of that have become apparent with players now being conversant of the importance of data in improving their decision-making abilities and subsequently their performance. This awareness is prompting players to be more inquisitive and interested in how they have performed and how they can improve. They recognise it can give them an objective assessment and score of how they performed during training or on the pitch and this allows them to be able to evaluate themselves in a different viewpoint to how they might have felt during the game. Participant P8 put forward the following statement:

“Player wise, I think they really like it they want to know what the stats are, what the sprint stats, how many passes have been successful, I think if a manager uses it or a coach uses it appropriately then maybe set a player goals - so for example if you're trying to develop a players passing and let's say a player regularly is scoring below 70% pass accuracy if you undertake additional work with that player and after training on his passing and perhaps in the weeks thereafter you maybe hope to see these statistics are better” – P8 Q5

This can potentially make them clever and aware of situations, thereby enabling improvement and development. As the focal point of analysis is usually the players, they are routinely tasked with initiating certain conversations regarding the data, this way they are able to reflect on certain

decisions that they have made and understand how it could have been executed better. Another participant stated that:

“The players, I think they analyse, they look at footage, they look at stat based evidence” – P11 Q5

Consequently, it is fair to assume that players are now becoming students of the game and presumably have a deeper understanding of their own performance through the availability of data. Another participant emphasised the importance of players learning independently and how they actually do it by putting forward the following statement:

“So, on Saturday, again I am just relating to the most recent stuff. On Saturday we beat Southampton 1-0, alright not that the result is the be all and end all, but the fine details of the set piece that we identified could be there strength because they used zonal marking and we end up scoring from that, and that is down to the players looking into it and practicing the day before then going out and executing it, and that is just at youth team level” – P13 Q2

The participant gave an instance of a Saturday game when the team scored a goal as a result of what the players learnt from the data. They were able to identify the weaknesses of their opponent and exploited it. The use of video technology certainly plays a major role in terms of showing and explicating what transpired during a game, it allows for reflection and discussion. Video footage of events such as crucial passes made, goals and positioning are all essential data points that players now have access to. One participant highlighting the role of data and technology stated that:

“I think that is a massive sort of learning tool because you're not going to be with them on the pitch so you have to sort of learn how they can sort of reflect and then improve on that whilst they are actually in performance”. – P6 Q4

Participants, however, were quick to point out that, while all the data is available at the disposal of the players, they are only given player specific information, as alluded to above. This approach ensures that they are not overloaded with irrelevant information:

“now in most sports they are given individual videos aren't they. So, they can look at the data” – P2 Q2

Providing individual-specific data or player-specific data is imperative to the development of players, as this allows the coach to focus on how each player can improve based on their previous performance. Participants stated that the video clips from the previous games can be utilised to

show players what a typical player in that position should be achieving and how they can potentially reach that level:

“The coach may just pull them aside and say look the analyst has got these clips ready, I just want to show you that in my opinion you could improve your performance by doing this, this or this, here is a video example, or here are examples of in the data this is how many times the top players deliver when they are in this wide area. You get in this wide area, you don’t deliver as much therefore what strategies can we adopt to make sure that when you do get into the good areas that you do get into, that you produce something”. - P5 Q2

Furthermore, data and technology has created a coach-player learning mechanism that makes it seamless for both parties to learn effectively. So, the data “teaches” the coaches everything they need to know, and the coaches subsequently impacts that knowledge onto the players, the players then go out onto the pitch to execute the plan. Participant P12 illustrated this by stating that:

“So for example if you want to talk about me as a defender, okay I have got four people that I need to be aware of right now that are a danger, I can use data to be taught which one of them is probably the one with the most threat if that makes sense” – P12 Q2

The statement above illustrates how coaches and players can learn from data. The data can help show which players from the opponent’s team are the most prolific and come up with possible plans to stop them. Additionally, the participant talked about how data can influence decision-making abilities of players in real-time:

“if you are standing on the corner of their penalty box and you have got three options of people to pass it too and one is slightly covered, one is closer to the goal I think you can use data to try and inform ‘okay, I can then make a gut feeling based on what I have been taught from the data about making that decision’. So you have done the analysis before and you know that okay I can ideally get to the guy who is closer to the goal....” – P12 Q3

While the example above may seem very specific and basic, it highlights an important way in which data can influence the development of decision-making abilities of players. Instincts are an innate and inherent part of every player, so it would be impossible to separate that from what goes on in the game. However, the statement above from participant P12 seems to imply that perhaps gut feeling or instincts can be altered and developed through data thereby influencing decision-making abilities. Participant P14 put forward the following statement by including another element that should be considered when considering decision-making abilities. The participant highlighted emotion as another factor that seems to be often neglected:

“emotion is a huge factor that people try to take out of the equation when making decisions, statistics help that because to analyse statistics you have to take the time but still in football there's a lot of emotion involved in the decision-making process” – P14 Q8

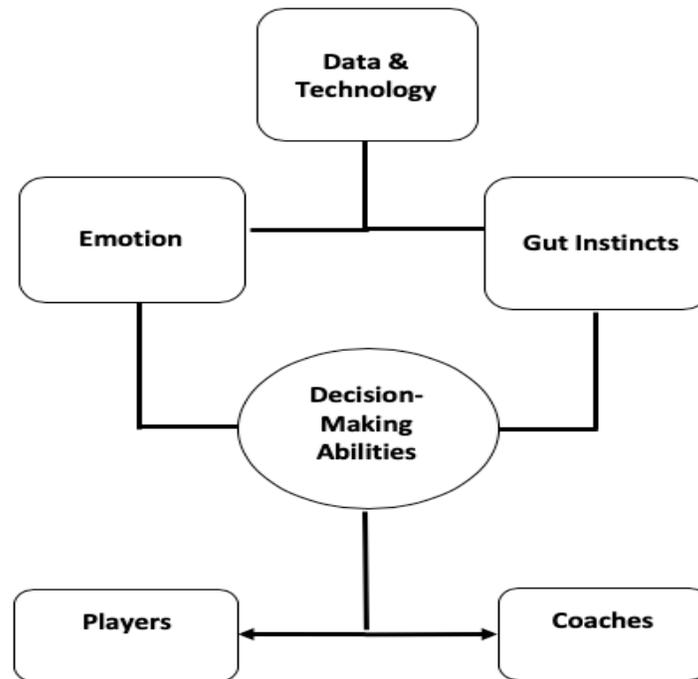


Figure 30 - Developing Decision-Making Abilities

Figure 30 shows the relationship and interaction between data and technology, emotion, gut instinct and decision making. Decision-making process includes elements such as emotion and gut instincts, and it is perhaps conceivable to think that if data and technology can alter these elements then it can ultimately increase decision-making in the long run. As stated above, the process is that which involves both the coaches and the players themselves. The coaches learn from the data and subsequently impact their knowledge onto the players. However as stated by participant P13 Q2, it is imperative to involve the players as much as possible and get them to interact with the data. The players are the first point of analysis, participant P13 talked extensively about how they get the players to interact with the data by getting them to do their own analysis and create a plan on how to win subsequent games. The players would normally break into groups of five, for instance one group could look at different elements of the data, such as possession, set plays and goals, while other groups look at fouls committed, passes and runs, and make their own inference from

that. After the players conclude their analysis, they would then be required to present some information back to the coaches and that would stimulate further discussion. This particular system puts the players at the forefront of everything that happens with regards to data and technology utilisation. This way the players are empowered, and it makes it easier for them to understand why the coach is asking them to perform a particular task. When asked about the type of information the players are required to present back to the coaches, participant P13 stated that:

“So they would present back in transitions, they may say ‘well midfielders are slow to recover, they don’t get back behind the ball quickly so they leave gaps in wide areas’ for instance. Again, that would then become part of our strategy for the game, so we would then look at that on a Thursday or Friday and use that in the game.” – P13 Q3

Information like such illustrated above is presented by the players to the coaches, the coaches then take into cognisance the information and incorporate it into their game plan. The final game plan based on the players and coach’s information is implemented during the training session and subsequently during the live match against the opponents. Figure 31 below illustrates this process.

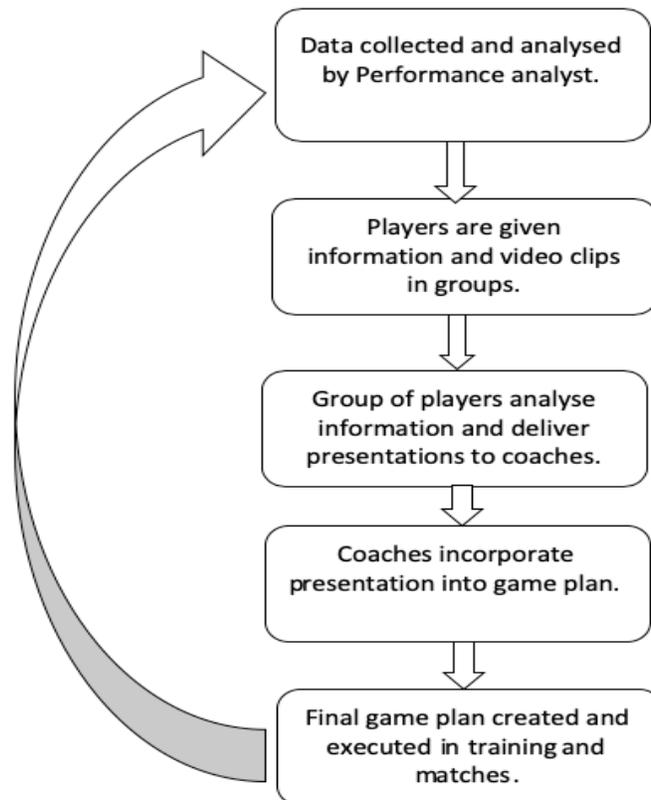


Figure 31 - Learning Process - Decision-making

This process of course is a continuous one and is restarted immediately after the final game plan has been created and executed. Participant P16 further corroborated this player-centric process and suggested that there are many benefits to giving the players access to the data, with a caveat.

“So because they're playing football week in week out it allows them to get this familiarity with the numbers that we're giving them but I'd say that at the level that we work at we're not giving them sort of a hugely complicated or complex numbers so intuitively they understand most of the numbers that would give them straight away” - P16 Q8

The participant stated that exposing the players to the numbers (data) weekly will get them more familiar with it, thereby helping them improve. However, the participant was quick to give a caveat about showing the players over complicated and complex information.

4.6.1 Decision-making Cycle

Decision-making is a crucial element within sports that is often neglected in the pursuit of optimising performance. This has been demonstrated by some of the participant stating that decision-making hasn't received ample attention. Further to this discussion, participant P19 emphasised the importance of focusing on decision-making processes rather than performance.

“I think good coaches work more on their processes and the decision-making in order to have better performance rather than focusing on the performance itself” – P19 Q3

The participant went on to suggest that performance is a result of decision-making, implying that in order for sport teams to win and stay competitive, decision-making should be optimised first and that will automatically influence performance. The information gleaned from data is transformed into knowledge, while knowledge is used to enhance decision-making and that subsequently influences performance. Figure 32 below illustrate this process.

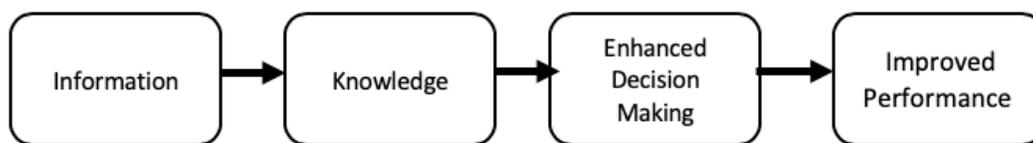


Figure 32 - Decision-making - Performance Improvement

Participant P12 also corroborated this by stating that decision-making is an aspect of performance, but decision-making should be a prime focus:

“decision-making is an aspect of performance. I would argue about performance it has to have good decision-making as part of it, you know, have you been in the right position at the right time? have you made the right passes at the right times?” P12 Q4

The decision-making cycle within all sports teams interviewed follow this process which is presented in figure 33.

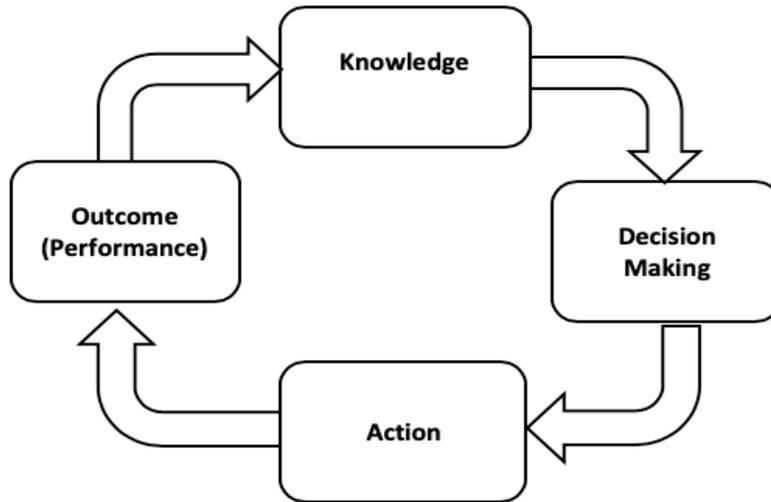


Figure 33 - Decision-making Cycle

Participant P25 expatiated on this model by putting forward the statement below:

“ in relation to decision-making I would say, so going from analysis to decision-making to the output it is probably the pathway and if you were to build a flow chart you would say the information is the start point, the analysis, decision-making and the outcome and that is the cycle, you would say that is how you learn because once you get to the outcome you won't know it that is right or wrong” – P25 Q7

This is the typical decision-making process utilised by sport teams in relation to data and technology. This whole process is initiated after collection and analysis of data, this is then transformed into knowledge and used to make more informed decisions.

4.7 Challenges, Drawbacks and the Digital Divide

This section presents participant's perception of the challenges being experienced within the sports industry with regards to digitalisation and has been grouped into 2 categories: challenges with implementation and challenges with utilisation.

4.7.1 Implementation Challenges

Challenges with implementation has to do with teams that want to incorporate data and technology within their practice and can't do it properly because of certain factors. Most of the participants pointed out that the implementation of data and technology within sports comes with a cost, as with acquiring any technology. However, within sports it is thought to be a bit more expensive to acquire certain technologies and then find the right personnel to utilise that technology effectively, particularly for the smaller teams. Participants stated that resources are scarce for the lower teams and they can't afford to get the data they need to enhance their program sometimes:

"The only challenges that we have with the data is not probably having the resources available to us that we would like to enhance our program" – P7 Q7

Similarly, another participant stated that:

"Challenges are the information at hand due to technology, funds, resource - lack of it" - P11 Q6

Sport data companies such as OPTA and PROZONE are tasked with collecting and providing data to teams and while this data is available upon request, it comes with a somewhat hefty price tag. This puts the lower level teams at a disadvantage as they often have to rely on their own in-house data:

"we don't have the financial clout to be able to go to big companies - they'll come here and say 'oh yeah we can provide you with a solution' - but at a ridiculous amount of money – P19 Q4

Similarly, a participant at one of the top clubs in the premier league put this into perspective by stating that:

"the limitations will be at a club that doesn't have this technology, we are lucky enough here at Arsenal to have all this technology. At Crystal Palace when I worked there, they wouldn't have recorded training sessions because they wouldn't have the capability to do so, and therefore they wouldn't have the staff and therefore they can't give the player the immediate feedback, so I think that is one negative is that the same technology isn't available to everybody – it is available to those that can afford to have the technology" – P13 Q4

The participant gave an account of when he was coaching at a previous club and stated that not all clubs will have the capability to do what his current club can afford to do. The same technology isn't available to every team, it is only available to those that can afford to invest in it. This begs a question of whether there is some sort of digital divide in sports. Digital inequalities have long been an issue within the business sector for some time now. The concept of digital inequality also known as "*digital divide*" transcends the business sector and is also being experienced in the sports industry. Participants have stated that only the top clubs are able to acquire technology, and this obviously causes some form of unfair imbalance between sport teams:

"at top-level sport where the clubs have got a lot of financial resources then everything possible is being utilised" – P8 Q6

Another challenge identified by participant in relation to implementation was finding the right personnel to conduct the data analysis. Participant P21 put forward the following statement:

"Yes I think the, certainly in terms of the analytics you have to have someone who can use the data that we have got and explain it in a way that makes sense to people who aren't analyst or you know have a background in data to be honest" – P21 Q2

The role of the data analyst in the coaching process is an important one. Coaches and players typically don't have any background in data analytics, consequently it is the job of the analyst to present the data in a way that players and coaches can comprehend. It is an important skill to be able to present data in a way that caters to different learning styles. Furthermore, participant P12 corroborated this by stating that:

"We had a data scientist here; he has now left for Southampton so we are now looking to replace him but it is a very bespoke skill set" – P12 Q5

Data unavailability seems to be another challenge some sport teams face in their pursuit of implementing a data driven approach. As alluded to above, smaller teams are unable to pay for data services offered by sport data companies because of the cost associated with it. Participant P12 stated that:

"I think the other barrier for its use is the availability, so for example the data is really expensive to get if you want to pay OPTA for it, it is a lot of money. The tools you then need to manipulate it in it's especially in data form is very difficult" – P12 Q6

In addition to data being expensive, the lower teams don't have access to certain types of data provided by the sport data companies:

So where that data is readily available for your Chelseas, Manchester City's your top teams on other players and players around the world, in the lower leagues for us we can only really work off assist, goals, passes and really really MINUTIAE detail really. that's the hindrance from our perspective working at a lower league that's the problem. – P14 Q9

The challenges sport teams experience in terms of implementation seems to border on lack of resources, the cost associated with acquiring technology and also the expertise needed to interpret and present the data.

4.7.2 Utilisation Challenges

The top clubs are not without challenges, as it turns out having the technology is only half the battle. Possession of technology is definitely an important step towards achieving success, but the way in which it is utilised, and the interpretation phase of data are equally important. Challenges in terms of utilisation is also an issue that a lot of sports teams tend to have, because nowadays there is an influx of data which can be overwhelming for teams who don't know how to parse and interpret it. If data is over collected and under analysed, then that could potentially pose a greater issue. Noting the aforementioned, one participant stated that:

“I'd say that we've still got a long way to go and that's mainly in that we're now probably collecting most of the data that we need but it's interpreting and making use of that data, it's the big barrier to overcome” – P16 Q9

The participant also went on to say that:

“a lot of this data is still new, so we don't fully understand all of it you know the obvious things are really easy to deal with like if you're looking at passing success rate or something, that's easy to understand but now we're getting so many numbers and so many different sub output” – P16 Q10

These statements seem to reinforce the fact that a lot of data is now being collected in sports, through various mechanisms, however, there still remains the challenges of interpreting the data and ultimately using it to improve performance. Descriptive data is relatively easy to parse and understand because it gives basic information about data but the inclusion of diagnostic, prescriptive and predictive data makes it even more complicated. The amount of time available to analyse data is quite short seeing as how the turnaround time for sports competitions is so short. The data collected from a match can be rendered useless within a short space of time because it hasn't been used to inform decisions when it should have been.

“so we spend probably kind of 90 percent of our time doing the boring bit and only a small bit of percentage of our time actually dealing with the analysis of the information and that's a problem with 'data'”- P19 Q5

Participant P12 corroborated this, he affirmed by stating that:

“data collection is so labour intensive and time consuming, for you to sit there and code matches, you know I used to do some manual data entry and stuff like that, it just takes so long that actually by the time you have done the analysis, it has gone, it is out of date” – P12 Q7

Data collection, analysis and interpretation are still aspect of utilisation that sports team struggle with, and due to the nature of sports, data collected today can be rendered unreliable or out of date the next day. Similarly, because sports teams now have different departments that look at data in different ways, it leaves room for people to see different things within that data. The medical staff, coaching staff, sporting director might see the data in a different way, which of course can cause some dilemma.

The challenges sport teams experience in terms of utilisation seems to border on too much data, the time it takes to analyse it and ultimately using the data to inform decision-making and performance at the right time.

4.8 Data and Technology Caveats

This theme presents findings on the caveats that must be taken into considerations during the process of utilising data to inform practice. The following subthemes have been used to organise the discussion: reliance on data, information overload, overused, and overcautious.

Data and technology are obviously here to stay in sports and a number of sports teams have shown heavy reliance on it. However, in the process of using and seeing other teams use it, participants have been able to identify some of the caveats that must be taken into consideration during the process of using data to inform practice. According to some of the participants, there seems to be quite a heavy reliance on data, which they say is “*more than it needs to be.*” In a sport like cricket, where there are so many variables to account for, going solely by the data can sometimes be a waste of time and effort. One participant noted that:

“so you can have all the stats in the world for the last 10 years or 10 games or whatever, at that certain ground but it is very dependent on the weather. So sometimes the stats kind of don't mean much. You know what I mean, it is a little bit of a grey area, because of the weather conditions and because of the underfoot conditions can differ so much” – P11 Q7

This is a statement from a participant within cricket, who stated that sometimes the data doesn't mean much because there are so many variables to account for, from the weather to the condition of the pitch which can sometimes affect the movement of the ball. Another participant from within cricket also stated something similar:

“In a sport like cricket there is a lot of external factors that can affect the performance, like atmospheric conditions of the weather, can affect how the ball moves through the air, the pitch can determine how the ball is moved off the pitch” – P18 Q4

Both statements seem to reinforce the fact that data should be neglected in certain circumstances or better still, used within certain limitations. It is important to take other factors into considerations as data can only paint a picture and doesn't tell the full story, there's only so much reliance you can have on data. While it does serve as a good foundation for making decisions, decisions reliant solely on data can be wrong sometimes.

A participant from football put forward a different perspective by saying that solely going by the data can somewhat limit the ability of the players:

“So, we have to be mindful that were not always solely going by the data and perhaps making players training sessions too easy or too low intensity that they're never going to get the physical attributes needed to be a first team footballer” - P8 Q7

The participant implied that solely going by data can potentially stunt the development of a player, because the data can make coaches a bit too cautious regarding player health and as a result the player not be able to keep up with the demands of the game. The participant went on to say that sports is becoming overcautious with some physical data and players don't play a lot of games in comparison to a few years ago. Apparently, it is important not to follow the data to the letter, up to the point of being overcautious. The demands of sports in terms of physicality has changed, and as such the players have to adapt to that but sometimes the data might indicate that a player should not play a particular game because his performance levels are low, even though that doesn't correspond to how the player actually feels. So, there is a potential issue of data making coaches too cautious thereby creating players who can't meet up with the pace and demand of the game:

“so I sometimes feel that you know it can be a case of sports scientists that is saying to the coaching staff – ‘oh this individual might need a light training session today, the levels are quite high from yesterday’ - we have to take that on board and consider it but we also have to think that if a player is going to play in top-flight football certainly in League One or English Championship they're going to have to be equipped to play 46 league games a season which is a lot of league games” - P8 Q8

While it is important for the coaching staff to take into cognisance all available information, if the players want to be equipped enough to be playing in topflight football, sometimes the data has to be neglected.

All sports share some elements of unpredictability and this is arguably what makes it so special, interesting and long-lasting. None more so than football though, as we see lower level teams rise through the ranks unexpectedly and top-level teams fall due to poor management or leadership problems. Football is a very player-coach led type of system, and that is what sports - at its core – is all about. While technology might play a huge role, humans are still at the centre of everything that happens, trying to remove that key element can be disastrous. Participant P22 noted that:

“while it has changed - technology has seeped in - in a huge way into sports performance. I think ultimately humans are still at the centre of that and how data is used” - P22 Q1

Technology is only going to advance and ultimately get better with time, but at the end of the day humans play a bigger role in this revolution. It can never replace emotional intelligence or communication, having a good balance between technology and human intervention will always make a huge difference to teams seeking that extra edge.

Another caveat noted by participants is that there can be information overload problems sometimes in terms of the players. There has to be a balance of information diffusion and information absorption, because if the players are being bombarded with too much information it can sometimes confuse them. It is imperative to ensure that the data being given to the player is kept simple as possible. One participant likened information overload to situations where players start overthinking on the pitch because of the information that has been passed on to them:

“you got to watch for young players that you are not asking them to go in the pitch and achieve XYZ technically, XYZ tactically and XYZ Physically or you're going to end up having someone that's overthinking the game and not going to deliver their optimum performance.” – P8 Q9

Further to this point, participant P21 warned against collecting too much information and instead one should focus on making the information as simple as possible for the players.

4.9 Current Practices and Utilisation of Data

This theme highlights and presents findings on the current practices of data and technology utilisation in sports. It is organised around the three sports considered for this research: football, rugby and cricket.

The data collected has highlighted some of the ways in which sports now utilise data and technology to help inform their practice. Typically, within all the sports that have been interviewed, they all have some sort of video cameras installed at the training ground or at the main stadium. The cameras are used to collect data, GPS systems are also used during both training and live matches to collect physical data. Additionally, data is also provided by sport data companies. Teams will typically use all three modes in collecting data or use a combination of the modes. The smaller sport teams who can't afford to invest in GPS or liaise with sport data companies will only use in-house methods such as video technology. Notwithstanding, as the preceding findings have shown, sports teams in general utilise high levels of technology in the areas of performance evaluation, player development, education, feedback and injury prevention and rehabilitation. The subsequent section will further highlight how football, cricket and rugby teams all utilise data and technology.

4.9.1 Football

The participants have indicated that football teams use more data and technology than cricket and rugby teams, which is quite surprising due to the fact that football has been known to be conservative in this regard. However, it seems that this is changing as more and more football teams are realising the benefits of using it to inform practice. They now use a host of software programs and technologies which has been highlighted in **section 4.9.3**. In addition to having the highest level of utilisation, they also have the most innovations and initiatives.

4.9.1.1 Data Collection Process

For most football teams, data collection starts from training session or during a game. Typically sport scientists/ performance analysts at the teams are tasked with producing statistics after each games and training session, that data is then fed to the coaching staff for them to analyse, in order to have a good understanding of how the players are performing from day to day. A large amount of the data amassed by teams is collected inhouse and analysed by the sport scientists or performance analyst: Participant P25 stated that:

“we have specific analysts working with the pre and post-match for the first team, we then have another for the under-twenty-three’s academy analyst, we have an under 18s and under 16s analyst that work with the rest of the groups” – P25 Q8

Sport teams now have analysts working at every level from the first team to the under 18s, making sure the massive amounts of data collected is dealt with accordingly. In terms of technology, it is typical for all teams to use video recording technology to capture and code intricate events during live games:

“In terms of the cameras, on a match day we have a wide angle camera that films which we live code – we have got a code written relative to how the data that we want to take and we want to use, if we want a video clip related to it but also that we want to built into an output to go on iPads if we want to map where people can look at things interactively, look at data interactively” – P25 Q9

Participants also spoke of external data collected from sports data companies such as OPTA:

“So OPTA provide the clubs with the statistics so they do all the actual sort of like counting and then they provide the numbers to the club's but we also do some of our own sort of like statistical stuff as well where we decide that we're looking at particular things that aren't offered to us” – P16 Q11

As stated above even though OPTA provides data to clubs within the premier league, clubs tend to do their own in-house data analysis, based on data collected from training and live matches. Often that data will be used to plan future training sessions and games. This gives them a good indication of what players should be achieving tactically, physically and technically. This helps the coaches manage the performance of the players, participant P8 stated that:

“We now know roughly what players in certain positions should be achieving per match in terms of distance covered, sprints covered and so we utilise it for that”. - P8 Q11

So essentially data is used as a benchmark based on the position of the player and what a player in that position should be achieving. This way coaches can look at certain statistics and see how to better help players individually. Another participant corroborated the aforementioned statement by asserting that:

“We are using, for example in training we use GPS data - catapult - Opta are providing us with technical data on match days of all games, that takes quite an amount of data that we are getting and we can get it immediately post-match and we can also get that for the games within hours after the game if not immediately and we also take trackapp physical data and technical data on every match day that is again available to us right after the game” – P25 Q10

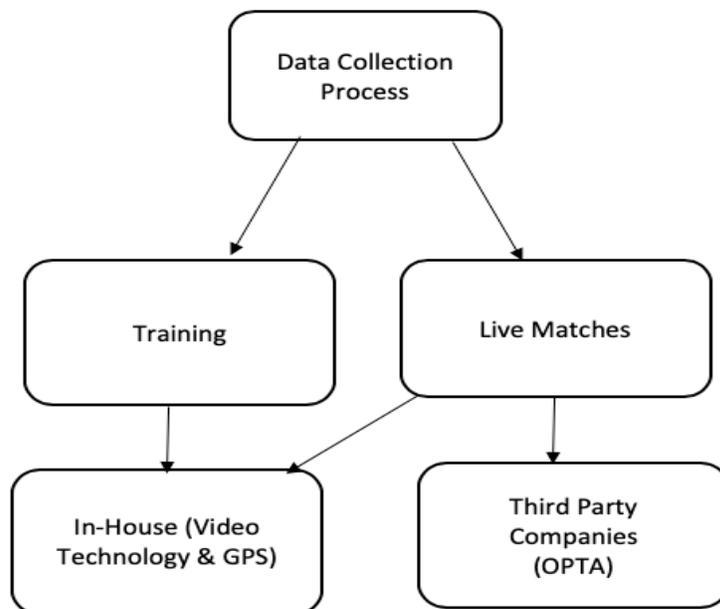


Figure 34 - Data Collection Process

The statement above highlights how much the sports industry has evolved in terms of the utilisation of data and technology. Physical data and technical data are now available immediately after matches through companies like OPTA and TrackApp. Furthermore, in-house analysis

departments are tasked with producing reports, clips of key moments during the game and delivering presentations to the coaches. Participants also spoke about how streamlined and effective their data collection process is, data from training is quickly turned into information by the analyst and presented to the team, which then becomes knowledge to be absorbed by the coaches and the players:

“it streamlined very quickly so the GPS reports are done and we get results so we give a training session, typically we train at 10.45 if we finish that training session by 12.15 by the time we have had lunch we would have a report on our desk and the same with video footage” – P13 Q5

4.9.1.2 Player Management and Identification

Data and technology serve as the basis for most sport teams as they typically utilise it within their recruitment process. Participant P14 cited example of a team that relies on data to formulate opinions on the right player to buy:

“Bristol City who will identify players solely through statistics and then obviously go and watch players and formulating an opinion on them” - P14 Q10

Conversely, Participant P6 emphasised the importance of player management and stated that data massively helps in this regard. The participant further likened it to having a database of all available players:

“I suppose it's like a database and seeing how players are getting on and tracking etc” – P6 Q5

Participants spoke about the difficulties of player management especially in football where teams usually have a large squad consisting of over 20 players. The management of regular substitutes or players not in the current squad due to injury or ineligible to play becomes a challenge. Participant P21 highlighted the issue of manipulating training such that all players are receiving the same level of exposure and stimulus. This is a particular area where technology is helping in management of players:

“how do you manipulate the training so that they are getting that exposure to the types of metrics that players are getting in games. So that is probably the one area for me where I think you know the data just does help us massively” – P21 Q3

The participant went on to say that technology such as the GPS is really helping to make sure that the players that aren't selected regularly are fit and ready for action as at when required.

4.9.1.3 Player Feedback

Feedback plays a crucial role in facilitating the learning and development of players and even coaches. Participant P6 spoke about the importance of getting the players to interact with the data instead of the coaches just giving instructions, they get the players to think about certain decisions that they may have made during training or live games. This allows the players to reflect and be cognisant of how they can improve their performance. Participants P25 spoke at length about how players are very receptive towards data and technology:

“I think players are more open to coming to staff and asking for information, they are more open to analysing their own performance and they are more open to different learning styles and different methods whether it is animation, text, audio. I think players are a lot more intuitive with the coaches and members of staff and I think they want to do more” – P25 Q11

The learning culture within sports teams is now very much influenced by data and technology, there is a real culture of improving knowledge of the players, the teams, improving the knowledge of coaches and improving the knowledge of the overall coaching staff. Furthermore, there is a culture of making sure the information received by players and coaches is applicable and specific. Participant P15 stressed the importance of ensuring that players only receive specific data as opposed to giving them everything they request for, as this might create problems and make them over think. Participant P21 corroborated the aforementioned statement by stating that:

“The players don’t necessarily have a say in what they are doing but I like them to see the data, they are exposed to it absolutely and so is the manager and so are the coaching staff” – P21 Q4

This seems to imply that even though the players are exposed to the data they don’t necessarily have a say in the final decisions. This is contrary to the opinions expressed by participant P13 who stated that players are at the forefront of the data analysis and feedback process. He stated that:

“our players are in analysing the game themselves. So the game is being broken up into different bits, different elements of the game, in possession, out of possession, transitions, set plays and these guys they look at that data and they normally present back to us but we are training later today so there is a hell of a lot of data that we look into” - P13 Q6

Participant P13 suggested that players are very much involved in the analysis of data, to the extent that they are required to deliver information back to the coaches. The players review data on opposition strengths and weakness and create plans on how to exploit it. This particular player-led approach allows the coach to get buy-in from the players, and as such they understand the game

much better. Nevertheless, participants were all in agreement that players respond to feedback differently and learning styles of players is of crucial importance. Certain players might respond better to video than actual statistics or certain players might prefer a one-to-one talk with the coach about their performances. Participant P5 put this into perspective by stating that:

“So I might respond better to someone showing it to me on video, you might be someone who needs it walked through on the training pitch to actually feel the motor skill of what they actually should be doing for that to resonate with them or you might be someone who can just be told, they understand the concept and then the performance improves off the back of that” - P5 Q3

Learning styles seems to be an important factor in providing feedback to players. Participant P5 further highlighted that the next step to change professional high-level sport is as you understand your athletes better mentally in terms of how they learn and how that influences the feedback process based on data and technology.

Ultimately feedback is given in two main ways, from a team perspective and from an individual perspective. The team will sit down as a group and the coach will review clips from the game on a big interactive screen, where the coach will go through key event. From an individual perspective, players receive specific information on their mobile devices relative to their positions and strategy created from the group meetings. Essentially, players position sometimes determine the amount and type of information they receive going forward.

4.9.1.4 KPIs & Metrics

The use of key performance indicators is a very prevalent practice within the sports industry, especially within football. The process of creating KPIs starts with understanding the coach's objectives in terms of team performance and the style of play and also the tactical approach. The analyst and the coach will typically have discussions regarding the key performance indicators to be considered. Participant P3 talked about how identifying key performance indicators allows the coach to track the extent to which the team and individual players are effectively implementing the tactical approach devised. He went on to say that creating effective KPIs is an interactive and iterative process. Participant P5 was in agreement with this and stated that:

“Well that is a constant discussion actually to be honest because I think in enquiring and challenging the model is what has improved it for us. So I think if you just create a model and say ‘this is a good way of judging a player’, then you don’t critically evaluate why it is saying that ‘that’s a good player’ and it will never work, so we have meetings all the time to talk about the players that are highly valued in the model and why they are highly valued in the model and

*then there is a discussion around the matrix that are looked at to make these assumptions” – P5
Q4*

Participant P5 referred to the model the club uses in identifying players to add to their squad. They have a set of KPIs which they think is indicative of a good player and use that model to identify potential players. Similarly, participant P16 stated:

“We watch first, so we will never make a KPI off like a snap decision, we like to use a good amount of data” – P16 Q12

Participant P16 adds that it is important to study the data closely and recognise trends, because the KPIs need to be well thought out, otherwise it can lead the team down the wrong route. The KPIs allows for comparison of performances and output of players in training and also during the live games, this enable coaches to effectively make better decisions.

4.9.1.5 Utilisation of data & Technology

Sports now collect enormous amounts of data to inform their practice and monitor players. The participants talked about the different ways in which data and technology is used to inform practice, these will be explicated below. Applications like Prozone are now fairly standard programs that all teams use to monitor fitness data of players. These applications provide information on player heartrate and workloads and allows the coaching staff to correlate all the data and to understand the teams work rate before and after a goal was scored by them or the opposition. Participant P6 stated that this approach enabled the coaching staff to understand why performance improved or declined. The Prozone application has a built-in algorithm that ranked players based on performance, this way the coaches know *“who is working hard and who is not”*. Participant P21 put this into perspective by stating that:

*“We can compare position to position in training, so we can see what our fullbacks are doing and in training we compare it to their normative values, so now what player x does usually on a Tuesday we can compare that to what he did this Tuesday, we can then obviously although the players don’t wear GPS in games we have other monitoring companies that do that for us” -
P21 Q5*

The statistics produced from the application is analysed by the coaches to make sure that the training objective is achieve and that players in certain positions are attaining their targets. Participant P13 also gave an account on the software being used:

“We also get analysis from Stat DNA and so for instance we get a report that is emailed to us that gives us loads of data, so expected goals scored, expected state of the game, press and efficiency so we have got a lot of reports, individual pass to completion, entry’s in the final third so we have got a hell of a lot of data” – P13 Q7

Stat DNA is another sport data company tasked with providing data to teams in the premier league. Participant P13’s account above highlights the different types of statistics now received by teams. These stats are used in congruence with the inhouse data as well, implying that it is very thorough and holistic. Participant P16 corroborated this by stating that:

We have data stored in all areas so excel is obviously one of them but we use all the different bits of software as well depending on what the data is and then we use software in the middle to then streamline that data and condense the data and join the data to other data sources that we need and then we push that up onto tableau server so then we use tableau server to them produce the reports – P16 Q13

Based on the narratives of the participants it is fair to assume that most teams now have a variety of data sources and technologies at their disposal. Participant P16 stated that:

“We look at anything from sort of like player status in terms of you know the work they've done recently, ‘have they done alot work?’ have they not done a lot of work, all the way through to how they're feeling that day, for us in the academy growth is a hugely and important thing so it's very important for us to know you know where that player is, have they grown quickly, we know that the human body struggles when it's fatigued quite quickly recently so that's important for us to know” – P16 Q14

Participant P16 working within the academy level of the club emphasised the importance of data in the development of young players in the academy system. They use data to manage and monitor the growth of players and to determine when they are ready to be transferred to the first team.

Drones are now being used during training sessions as well to collect more data on the players. The drones provide a Birdseye view of the game, thereby allowing the coach to see player interactions, tactical plan executions and defensive formation setup. While the use of this particular technology is limited to training grounds and is not currently being used by all teams, it holds great advantages, as highlighted by participant P20:

“the drone records the session, so your training session that you have set up, the drone will follow the whole drill and you can control the drone to follow who you wanted” – P20 Q1

The drone follows any player you want to monitor, this allows for more individualised monitoring and feedback.

Furthermore, simulation is another very popular and innovative way sport teams are using data to inform their practices. In order to be able to run this simulation, teams collect data from sport data companies who have data on all teams. This data is then filtered so as to identify and select only the relevant data points from millions of data point (e.g. number of shots in the final third, number of passes, tackles, goals, fouls, set pieces and a host of other data points). After the relevant data points have been selected it is then run through what one participant referred to as a “*Monte Carlo Simulation*”:

“how many passes in the final third and what research has indicated to being somewhat predictive of a good team and then you can run it through what I call a Monte Carlo simulation. So essentially you simulate every match” – P12 Q8

A Monte Carlo simulation is essentially a probability simulation technique used to understand impact of risk by building models of possible results by substituting a range of values. So, the simulation runs through various probabilities such as chances created, and goals scored to determine if a team can potentially win a match. This simulation is then run on 38 games and produces an end of season league table as an output. The simulation can then be run multiple times for a particular season to generate several league tables. When asked about the benefits the participant stated that:

“I guess it is a good gauge for us in terms of you know is our philosophy working, is this what we want to do, is this not what we want to do, I mean I speak to the finance department a lot and a lot of it is basically helping us track whether or not we are going to have to pay out bonuses to players and things like that”. – P12 Q9

After the simulation program has simulated a whole season several times, that gives them a good idea of how they could potentially perform in real life and they are able to have a clearer picture of what they need to do to achieve the result they want. For instance, if in 10% of the simulations they finish 1st and in another 15% of the simulation they finish 3rd, that seems to imply that they have 25% chance of finishing in the top 3. As a result, they can start working towards that. A graphical representation of how this simulation process works is shown in figure 35.

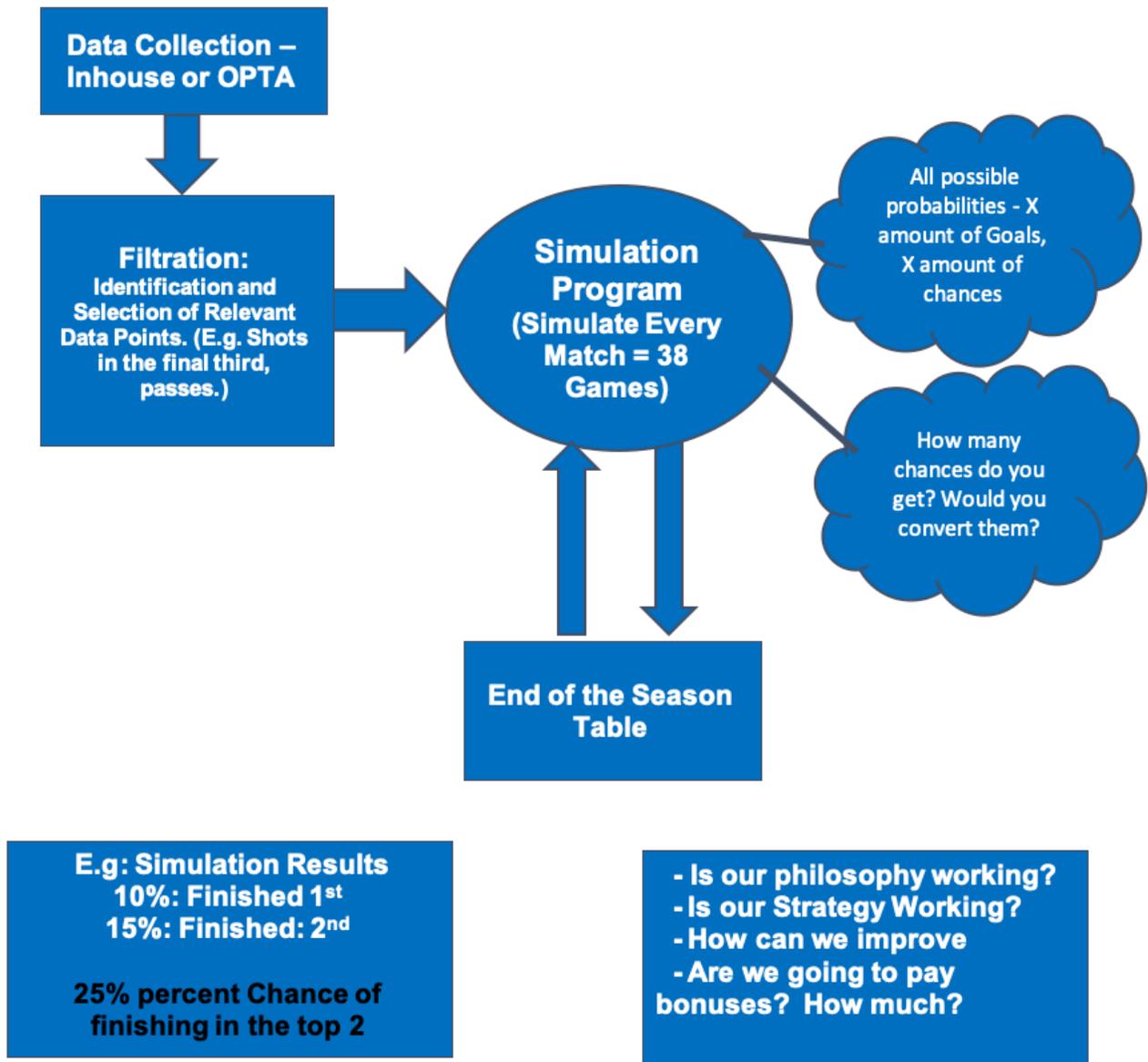


Figure 35 - Simulation Process

4.9.2 Cricket

4.9.2.1 Data Collection Process

The data collection process used in cricket is similar to that which is used in football (explicated in **section 4.9.1.1**). The data collection process in cricket is usually initiated by the coaching staff, the captain or the team as a whole, and the data requested for can vary from game to game. Participant P18 expatiated on this by stating that:

“So the captain might say for this season or for this game for this month I would like you to collect this information on top of what you already collecting or a bowler might say this is what I want to look out for my game so can you collect this and can you feed this back to me”. – P18
Q5

Participant P18 who is a performance analyst for a cricket club is tasked with collecting the data and based on the preferences of the coaching staff and the players, also feeding back information. The players have an input into the data that they want and the data that gets fed back to them. Cricket is such a sport where the captain of the team is the one that makes the on-pitch decisions depending on how he sees fit. Consequently, the account given above by the participant highlights the importance of the captain in a cricket team in terms of making decisions. Similar to football, there are two main sources from which data is collected in cricket, the first of course is inhouse data collection which is done by the team’s analyst:

“a lot of videoing stuff is done ourselves so we’ll do that at training, so my role as an analyst will include a lot of video work, so I’ll have a video camera video in training as much as possible. so we’ll all have you know video cameras we’ll all be recording that so there’s that side of it which is much you know driven by us. We will also obviously do the basic stuff which is just you know collecting notes and you know a bit of paper and adding things up and collecting information from training situations” – P19 Q5

The second source of data is through sport data companies such as OPTA and cricket’s official ball tracking technology, Hawk-Eye. Both sources offer an enormous amount of data for cricket teams and these data sources are combined and stored onto one system, which is then used to inform practice.

4.9.2.2 Injury Monitoring and Prevention

Injury prevention is one of the main areas teams are concerned about and as such the data they collect is used to try and monitor players workload among other things.

“so the bowlers in cricket are the ones who are most at risk of injury, so we monitor bowling workloads and we make sure that we push them at the right time and pull at the right time to make sure the injuries don't happen” – P18 Q6

Participant P18 highlighted that bowlers tend to get injured the most, so the data is used to monitor their workload and to make sure that they are not overworked. This process sometimes involves the development of KPIs, which require collection of normative values from players, these values are then used as a baseline. Data is used to ensure that the players are in peak condition by monitoring physical markers throughout the season.

4.9.2.3 Identifying Strengths and Weaknesses

Participants also stated that data is used to identify strengths and weaknesses of their oppositions. The data gives them information about how their oppositions are performing and then that helps inform their tactical plans. Below is a quote from a participant which paints a picture of data utilisation within cricket:

“if a certain player is really doing well at a certain time, in a certain game on the opposition then we will know that that is their main threat, we know to just try and nullify that threat a little bit and then we can attack in other areas, we can tackle the bowlers who are not as good as the people who are performing. So I think it helps in those regards.” – P11 Q8

4.9.2.4 Instant Feedback

Participants highlighted that data gives instant feedback and on-going feedback on how the players are performing and it also provides feedback on how the opposition is performing which then informs the tactical planning. Participant P11 put this into perspective by stating that:

“So we can analyse how we have performed, how we have bowled whether or not we have stuck to our plan or whether we have bowled to their strengths. We get instant feedback and we can kind of assess” - P11 Q9

Instant feedback is an important part of cricket, this enables the coach to know if the players are following the game plan or if the current game plan is not appropriate for the opposition being played. Coaches now receive almost instant information regarding players and the opposition. Another participant stated:

“we have access to everything and with that we can use that vision and that data to create plans on the opposition, so we can use that in our planning, we can use that in our post-game review, we can use that in our post-season reviews” – P15 Q2

Participant P15 went on to emphasise that any information on opposition is made available instantaneously and compared to the previously created key performance indicators (KPIs) being utilised.

4.9.2.5 Player Feedback

Feedback plays a crucial role in facilitating the learning and development of players and even coaches. Feedback is given to players in different ways depending on the needs and learning style of the player. Participant P19 highlighted that:

“Each player is very different in terms of the way that they want to receive information but also the information they're looking for as well so it becomes quite you know sometimes it becomes quite a scattergun in terms of the approach that you take and I guess the really good analyst or the skill of the analyst is being able to focus in and being able to really say - ‘right okay I know what you're saying what you're asking me for’” – P19 Q6

Consequently, this implies that feedback is given to different players in different forms. The analyst highlighted the importance of building relationships with the players, as this enables the interaction and usually serves as a way of understanding the type of information the players require:

*“the most important thing about us is the relationships that we have, the data is obviously the foundation of everything that we do but the relationships that we have with players and coaches and captain is important in terms of the way that we're able to deliver that information”
- P19 Q7*

The participant went on to state that building relationships with the players and even the coaches is of the utmost importance because this makes it easier to know what they want out of the data.

4.9.2 Rugby

4.9.2.1 Player Development

In rugby, data is used to establish individual improvement goals for players. If a manager notices that a player is not doing so well on the pitch, data can be utilised in an effort to try and help identify how that player can improve, by setting goals and monitoring the progression of those goals and how they are achieved:

“we have got a very good young player who is about 23 years and he has got huge potential but his tackling techniques are not as good and he often produces fouls and he'd get sin bid and it gets to the discipline committee and the coaches are taking that data which is coming from the

field on that player and from the video analysis and they try and look at how his tackling techniques can be improved” - P2 Q3

Furthermore, the players are now placed at the forefront of everything that happens with regard to data and technology. The coaching staff ensure the players are kept in the loop at all times, this is done through an application installed on a tablet device given to each and every one of the players:

“In Leigh this season they have bought the players Ipad” – P2 Q4

The statement above shows the dedication of the teams and the players to using data and technology to inform practice. The application on the tablet devices contains all statistics and information specific to each player and they can easily access it from wherever they are, whether they are at training sessions or at home. The application also contains individual goals set by the coach, for instance a player could have a goal of improving his pass success rate by 70% and he can monitor his progress as well.

4.9.3 Software Programs and Technologies Currently Utilised in Sports

There are a plethora of technologies and software programs being utilised in sports now. An account for each sport considered is summarised in table 12 below. It is important to note that this is not an exhaustive account.

Table 12 - Software Programs & Technologies Utilised

Sports		
Football:	Cricket:	Rugby
<ul style="list-style-type: none"> • GPS - Catapult 	<ul style="list-style-type: none"> • GPS - Catapult 	<ul style="list-style-type: none"> • GPS
<ul style="list-style-type: none"> • Prozone 	<ul style="list-style-type: none"> • WASP 	<ul style="list-style-type: none"> • CoachLogic
<ul style="list-style-type: none"> • OPTA 	<ul style="list-style-type: none"> • Hudl Technique 	<ul style="list-style-type: none"> • SportsCode
<ul style="list-style-type: none"> • SportsCode 	<ul style="list-style-type: none"> • Velocity Band 	<ul style="list-style-type: none"> • Microsoft Excel
<ul style="list-style-type: none"> • Tera Track 	<ul style="list-style-type: none"> • Cricket Scorer 	
<ul style="list-style-type: none"> • Coach Paint 	<ul style="list-style-type: none"> • Feedback-Cricket 	
<ul style="list-style-type: none"> • INSTAT 	<ul style="list-style-type: none"> • Fair Play 	
<ul style="list-style-type: none"> • STATSPORTS 	<ul style="list-style-type: none"> • TwoTechnology lanes (Simulator) 	

<ul style="list-style-type: none"> • Drones 	<ul style="list-style-type: none"> • Dartfish 	
<ul style="list-style-type: none"> • Simulator 	<ul style="list-style-type: none"> • Microsoft Excel 	

4.9.4 Big Data

With all the amount of data being collected in the world of sports today, one would think without a shred of doubt that big data is being collected and utilised but participants have indicated that the word “*big data*” seems to be thrown around a lot, and while some teams are utilising big data it is perhaps only the top level clubs that have the capacity to use it effectively:

“big data as a phrase is something that's banded around a lot”. – P19 Q8

Certain participants were of the opinion that majority of the data utilised in sports is small, and big data is used more in sports organisation on the commercial and marketing side. Participant P25 stated that:

“Looking at how fans interact with the clubs and it could be the decisions they make on a match day, considering what things they buy at a store – I think it is more a case of that” – P18 Q7

The participant stated that big data isn't being utilised on the performance side, although it is gradually coming into the performance element of it, with the growing number of metrics and measures. Big data is currently being used in American sports such as basketball and American football, but it's use seems to be a bit scarce within the United Kingdom. Big data will definitely vary from sports to sports, because some sports tend to generate a larger amount of data than other sports. Whilst a lot of data is being used within football, cricket and rugby as demonstrated within the findings, perhaps “big” is not the right term to use to quantify it. Comparing the sports industry to other industries, one participant stated that:

“well if you compare it to some of the industries out there it's small data” – P16 Q15

Similarly, participant P3 stated that;

“when we talk about Big Data in football and in professional team sports yes there's a lot of data but compared to some datasets it's fairly small. So I think the word big is actually overused and actually it's not really the quantity of the data that's important, it is the quality of the analysis and how that analysis is used and made relevant to the decision makers, the coaches for example” - P3 Q3

This statement put forward by the participant posed the issues of perhaps too much focus is being placed on the amount of data available instead of the quality of the data and the subsequent analysis. It seems that “*big data*” would only elicit more problems, and this is corroborated by another participant who stated that:

“big data can be available but I think you only use some of that data because also the coach himself he can't necessarily have the time and in between all these games when he's arranging training, when he's managing players you can't have the time to dissect all that big data” – P8 Q12

The participant further made mention of NSTATs, a sport data company that produces stats on every game and offer teams a report which is roughly 18 pages long. The participant put forward the statement below in response to this:

“now if that's considered big data to me that's far too vast, that doesn't inform best practice it doesn't inform necessarily measures against output that that club or that coach sees as important to either winning the game or to player development” - P8 Q13

Other participants suggested that it is being used but only by teams that can afford to do so:

“I think the top clubs, definitely, with the resources that are available I would say definitely. I think the top clubs would”. - P7 Q8

While another participant stated outrightly that big data is not being used in sports:

“I don't think that you know in terms of big data sets that are being used in professional team sports are particularly big” – P3 Q4

The mixed opinions from participants seems to imply that perhaps big data is still a grey area within sports as it is unclear as how to define it and the amount of data that qualifies to be referred to as “*big*”. There is obviously a lot of data in sports currently but there remains the question of how many data points make big data. Furthermore, participants expressed their opinion on whether big data should even be considered in terms of monitoring performance, as the coach would never have enough time to go through the huge amounts of data or even reports resulting from its analysis.

4.10 Best Practices

Following on from the previous themes, this section highlights and presents findings on the best practices of data and technology utilisation from football, cricket and rugby. The section has been structured around the following subthemes: culture, communication, context, player feedback and buy-in, and holistic practice. A desire to use the best practices in any industry is a desire to use the knowledge and technology available in an effort to secure success. With the amount of data and technology available in sports today, it has become important for teams to know essentially the “do’s and don’ts” (etiquette) in terms of implementation and utilisation. It can be stated without a doubt that every sport team is using some sort of data driven approach within their practice and obviously this has been demonstrated within the findings. Applying best practices often means working through trial and error and learning from experiences. Through careful and thorough questioning, the researcher has been able to identify some of what can be considered best practices in terms of utilisation of data and technology in sports.

4.10.1 Culture

First and foremost, organisational culture plays an important role, for data analytics to be effective within a team, that particular team has to have a solid cultural commitment towards evidence-based approach. Organisational culture not only defines the team’s internal and external identity, but it is important to the overall success of the team in terms of utilisation of data. Sports for many years, has been known to have the perspective of “*it works, so why change it*”, “*adhere to the status quo*”, so it is natural to have holdouts during the implementation phase. Key stakeholders within every team must be brought onboard before the data revolution can reach its apex. Buy-in from players and coaches is essential if the data analytics program is going to be successful. The players are the main source through which data is often collected and as such they have to understand the purpose of the data being collected, how it is being used and how it can ultimately help them improve. One of the participants cited a situation where they were able to use data to actually get buy-in from a player by just showing the player relevant data which was used to highlight when the player was less effective on the pitch and the reason for it.

“So, we were able to use data to as almost like a bargaining chip to say - you need to do a bit more work. It was a good buy-in”. P18 Q8

Initiatives like such described above are very necessary in getting players to conform to the culture of evidence-based approach. Furthermore, another participant emphasised the importance of a strong culture by putting forward the following statement:

“So, the absolute crucial thing I would say is that for data analytics to be effective within professional team sports it can only be effective in teams where there is a strong cultural commitment to an evidence-based approach” – P3 Q5

4.10.2 Communication

Another key component in any sports analytics program is communication. Sports is structured in such a way that coaches and managers have the final say in terms of decision-making and if the data is not communicated well enough it would be difficult for them to use it effectively or use it at all. Participants emphasised the importance of communication:

“Most important aspect, communication, getting everybody on board. So quite a lot of times the fall down is making use of the data, so where you either collect data and somebody will sit there and interpret it but then how do you communicate that to the coach or the players in a way that they can use” – P16 Q16

Communication is always going to be a barrier especially when it involves complex data like that generated from sports, but it is the responsibility of the data analyst to pinpoint objective specifics within the data and ask questions of the data regarding how it relates to performance and how it can be incorporated into the current training session. The information must also be communicated to the coaches and players as well during the session. Relationships and rapports with key stakeholders are also key elements. Participants have firmly stated that they use data as a foundation for everything they do and stressed the importance of having correct data to base decisions on. Bad data is worse than no data, and that is especially true in the case of sports where every decision counts and can potentially lead to winning or losing a game:

“it's important for us that in our roles that information is built on good data, so it has to be correct” – P19 Q9

The participant went on to highlight the painstaking process of making sure the data is of the highest quality:

So, what we tend to do is we spend a lot of time cleaning the data and analysing it so that it's good data and we use that as our foundation – P19 Q10

4.10.3 Context – Data informing Practice

Participant have emphasised the importance of making sure that the data collected directly informs practice. Participant P4 highlighted this connection by stating that:

“How those statistics are used is very important because I know football clubs where data has been supplied, yet there is no connection between the supplied data and the analysis of that data. So there is an argument to say that if there is no connection between the analysis and the provision of data then - what’s the point?” – P4 Q1

Participant P4 implies that sport teams tend to collect data for the sake of it, without it necessarily informing performance or decision-making. Similarly, when asked about the most important aspect of any data analytics program, participant P8 stated:

“That it is measured in context with what the coaching staff are looking for, you know, there’s no point in me knowing that someone has made 42 runs at high-intensity during a game but what happens if those runs are all stupid and they’ve not affected the game in a positive sense” – P8 Q14

Consequently, it is important to collect relevant data that not only fits the overall philosophy of the teams but also inform practice in terms of decision-making and performance. This also seems to imply that data cannot be used in isolation.

4.10.4 Player Feedback and Buy-In

Player feedback is an important area participants have highlighted as one which requires delicate effort and focus. Ultimately, the players are at the receiving end of data and are tasked with putting in a good performance during a game. The way in which the feedback is relayed to each player is of great importance and could be the difference between the player learning from his mistakes or repeating the same mistake in the subsequent games. Participant P7 put forward the following statement:

“ I think if you just bring a player here and say look "you didn't do this well, you did that well, you did that well, you did that well" and then go out the room, I don't think that will have a long lasting effect but your questioning, where you ask them what they were doing there, what they were thinking, asking them to explain the process, and asking them what they did well and how that felt, has an impact on them. From my experience that's only helped developed the players as well” - P7 Q9

This account by Participant P7, who is a coach demonstrates how players can learn and develop more effectively through data by asking them the right questions as opposed to always criticising

and showing them what they did wrong. Getting buy-in from the players is an important piece of the puzzle that can't be neglected. Participant P13 corroborated this by putting forward the following statement:

“It's like any organisation if you are constantly told what to do without any input into how you are going to do it. You get a lot more buy-in I think if you have been a part of the process” – P13 Q8

Moreover, it is equally important that data is delivered in a way that the players relate to, can easily understand, and is not too convoluted:

“ if they need it, its not thrown on them, it is not bombarded, we don't bombard them with it, we try and make it as simple as possible, so if there is any kind of outliers, any kind of real anomalies in the data that's gonna help us make a decision or pick a team or plan for a certain player in the opposition then we'll use it but if it is something not out of the ordinary we try not to confuse them” – P11 Q10

4.10.5 Holistic Practice

Data and technology now play a major role within the coaching practice of all sports teams, as demonstrated within the findings. However, the participants were quick to highlight the importance of having a holistic approach, rather than relying solely on data and technology. A holistic approach involves the inclusion of human element. When asked about the influence data and technology has had on team performance at the club, participant P7 stated that:

“My personal opinion is it is never just down to one thing. It is a lot of hard work that goes into that and that is both off the pitch and on the pitch” – P7 Q10

The participant went on to say that it is equally down to relationships and rapport with the staff and the players, it has to be a whole program. Another participant put this into perspective by stating that:

“for me the data guides your practice it doesn't own it, so don't let the data own what you do and rely solely on the data” - P18 Q9

Similarly, another participant stated that:

“I just think it has to include the human element; it is never something to replace what the human does” - P22 Q2

Solely relying on data without considering other equally important elements could lead to issues within the team. Some of the points highlighted above and in the previous sections has been used

to design a diagram which basically shows the necessary components that must be present for effective use of data and technology. This can be seen in figure 36 below.

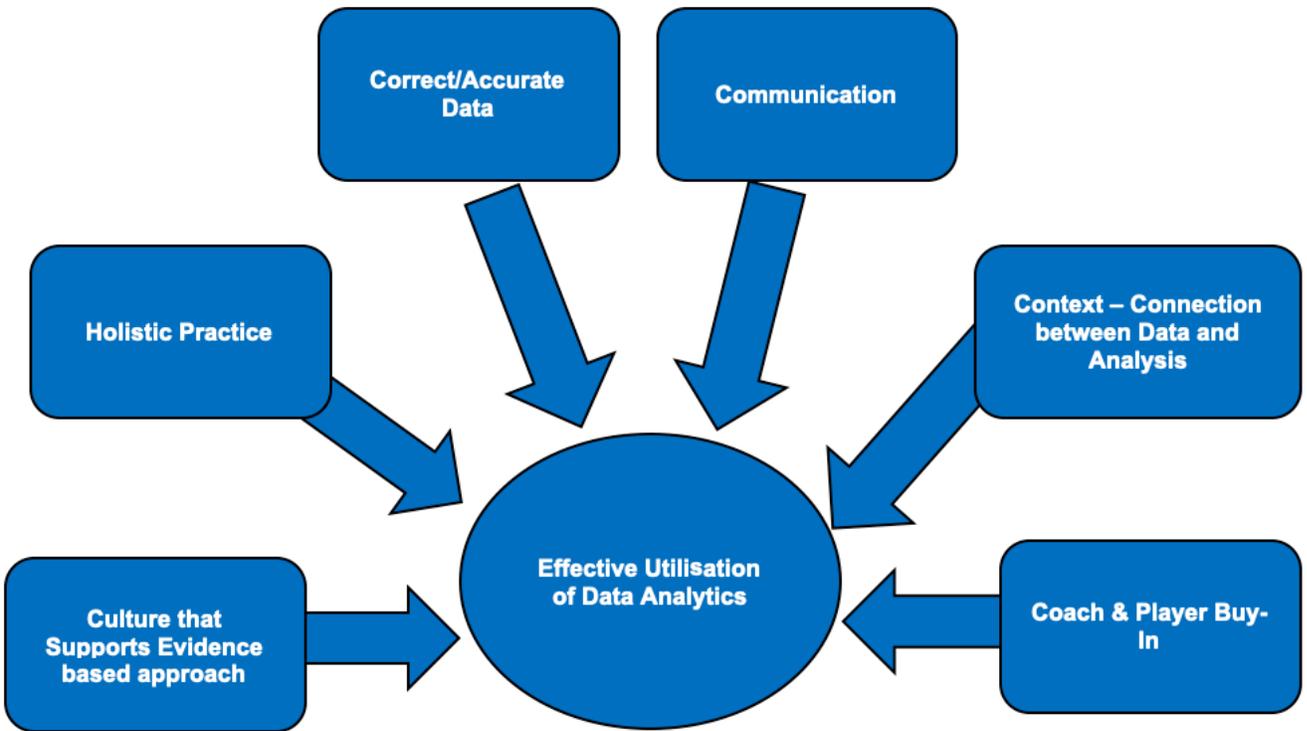


Figure 36 - Effective Utilisation of Data & Technology

The diagram in figure 36 above has been put forward based on information extracted from interviews in an effort to showcase all the key elements that must be present to ensure successful implementation and utilisation. Although this is not an exhaustive diagram, it surely provides a strong starting point.

4.11 Future of Sports

This final theme concludes the findings by presenting information on the future of sports given the evident and continuous impact of digitalisation on its ecosystem. This section has been organised around the following subthemes: predictability, educating, plateau, new technologies, VAR system and virtual reality.

The sport industry continues to push boundaries and continues to be one of the biggest and fast-growing industries in the world. This “*growth*” has no doubt been fast-tracked by and can be attributed to digitalisation in more ways than one. The amount of technology available in sport now is remarkable and participants think that there is nowhere to go but up for sports in terms of technological advancement:

“I think that sports will always improve, there's that much money now to be made in sports at the top end there's now much money in sports with a lot of foreign investors etc. that data and analytics will always be embraced” – P8 Q15

Technologies like virtual reality and augmented reality (while still at its infancy) are making their way into sports and once they become available, sports teams will have more understanding about how it can be used efficiently, particularly in the area of decision-making, which seems to be untapped at the moment. Decision-making seems to be an area where ample attention hasn't been placed over the years, and while it is fair to say that decision-making is an abstract and complex area, more attention needs to be placed on it. Consequently, it is important for sports to start paying more attention to this important element, and how it can be potentially improved. New technologies such as virtual reality show glimpses of being able to do this, one participant acknowledged:

“I think the virtual reality stuff would really help the decision-making” – P11 Q11

However, it seems we are a long way from seeing that come to fruition:

“virtual reality might be something that you know comes into play but you know that's a long way in the future” – P16 Q17

Similarly, another participant stated:

“I do think it will start to come into the game, and I do think 10 years from now, certainly 20 years from now” – P11 Q12

The above statement seems to reinforce the fact that enough attention isn't being placed on decision-making, in the sense that all focus is on performance and that draws back the development and

advancement of the technologies that could potentially aid in decision-making. While performance is no doubt an important element perhaps too much attention is being placed on it. One of the participants was of the opinion that technology in sports could reach a state of stagnation:

“my personal opinion is it's going to plateau a little bit because in terms of new technologies based on you know, the information is there to improve or to give us an understanding of a player or a team or the demands of the sport, and the amount of different ways of doing that are going to run out because that's the nature of sports” - P18 Q10

The statement above seems to place emphasis on the fact that the sports industry might experience a point where the technologies being introduced will reach a stage of stagnation, because there are only so many different ways you can analyse performance. This could mean that the sport industry could run out of ways of doing that, thereby resulting in bringing out technologies that are not relevant. Furthermore, with the multitude of technology companies entering the sports ecosystem every year, it can be difficult to know which one can provide the kind of system that suits a team's needs in terms of philosophy, training and also tactics among other things. One of the participants believes that data and technology in sports is a bit *“bigger than it needs to be”* at the moment but the future will bring a more streamlined, efficient and focused ecosystem for all involved:

“I think a lot of what we see now is superfluous to actually what it needs to be and I'm hoping that moving forward it will become a slightly smaller but more effective process” – P19 Q11

Regardless of what happens in the future, one thing that can be counted on is that more advanced technological innovations are going to come into sports. However, these technological innovations may perhaps come at a cost. One Participant stressed that there is a danger of sports becoming purely stats driven and hinted at things being a bit robotic in the future:

“I think there is a danger of becoming purely stats driven, I think there has to be an element of human error, conditions, dealing with emotions and all those kinds of things. I think there is only a certain point where everything becomes robotic.” – P11 Q13

While another participant agreed with the above statement in a certain light, the participant stated it was necessary for the growth of the industry:

“the advancement of technology can denature sports but the industry has to grow and does stand to benefit from its use” – P1 Q2

Although other participants were in complete disagreement. The inherent randomness within sports is always going to be present and as such there is no possibility of it being predictable. The only way it could be making sports predictable is in terms of the data available now to the public, it is making it harder for teams to remain secretive as they once were. Teams are now so well prepared because of information that is available, in that sense it might be making it easier to identify the strengths and weaknesses of your potential opponents.

4.11.1 Technologies that will revolutionise sports in the future:

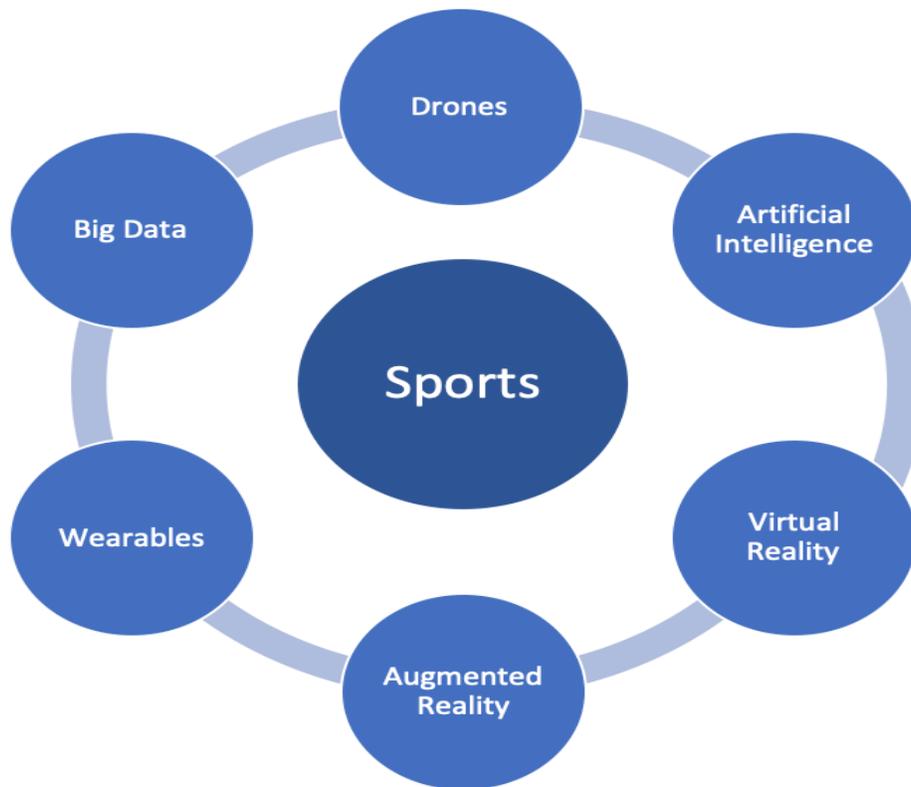


Figure 37 - Future Technologies

Figure 37 above highlights a number of technologies that the participants think will revolutionise sports in the future and take it to the next level. The findings have indicated that decision-making seems to be an untapped area in sports that needs more focus, which seems to imply that these technologies will be tailored towards improving performance as well as decision-making.

4.12 Chapter Conclusion

This chapter presented findings from 33 semi-structured interviews conducted with industry experts and sport stakeholders, which included: Sport Directors, Managers, Head Coaches, Players, Performance Analysts, Medical Staff and also Sport Data Companies. The findings were presented in nine sections that corresponded with the main themes that emerged from the analysis of the data. The findings have revealed the impact digitalisation has had on the evolution of sports and the factors that influenced these changes. It is clear that data and technology has seeped into sports in a massive way and now influences major decisions being made in football, rugby and cricket. This chapter presented findings on the impact of digitalisation on sport, its role, influence on decision-making and also the challenges and drawbacks. It also presented findings on the current practices in sports such as football, rugby and cricket, while underscoring the current best practices across sports. The chapter concludes with a section on the future of sports, highlighting technologies that will revolutionise sports in the coming years. The subsequent chapter will discuss the findings presented above in relation to the extant literature and the theoretical perspective.

Chapter 5: Discussion

5.1 Introduction

The current study aimed to investigate the evolution and future of digitalisation in sports, with a focus on how it influences on-pitch decision-making of players and coaches using a learning organisation theoretical perspective. Due to the nature of the research questions, the sector being investigated and the objectives, a qualitative approach was deemed appropriate and was one of the strengths that aided in fully exploring the phenomena in an effort to have a holistic understanding. Wright (2015, P 113) stated that “*research within the realm of performance analysis has largely used the positivistic paradigm, a core concept of which is reductionism*”. Consequently, a different research approach is necessary. Nelson et al. (2011) corroborates this point by postulating that “*more naturalistic and qualitative methods such as case studies, interviews and mixed method approaches may be beneficial in developing new knowledge and understanding*” (Wright, 2015, P 113). Therefore, employing interviews as a data collection approach allowed the researcher to obtain more detailed and pertinent answers. This chapter will discuss the findings of this study in relation to the extant literature and the theoretical perspective. The iterative synthesis of the extant literature and the findings led to a comprehensive discussion. Figure 38 below illustrates this process.

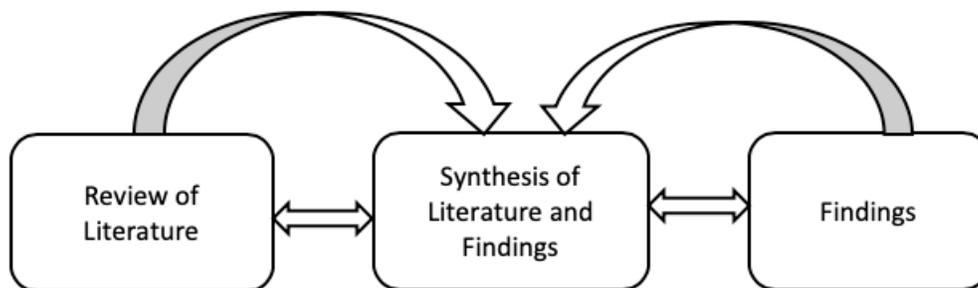


Figure 38 - Discussion Model

The discussion of the findings has been structured around the three research questions of this thesis, and the subsequent sections will explore these.

5.2 RQ1 - How has digitalisation changed the sports ecosystem, (a past, current & future perspective) and what are the current technological practices and their level of utilisation?

This section will address the research question RQ-1 and is concerned with the influence digitalisation has had on the landscape of sports, with emphasis on highlighting past, current and future state of sports with regard to digitalisation. Digitalisation refers to the acquisition or increase in use of digital or computer technology by an organisation, industry or country (Brennen & Kreiss (2014, p.1). It leverages technologies such as big data, sensors and cloud technologies to create and open unforeseen opportunities while offering the possibility of making radically new products and services (Rachinger et al., 2018). Literature has indicated that sports is made up of *organisational, technological, symbolic and educational* components (Loy, 1968), therefore the first part of the discussion will be structured around how digitalisation has changed and influenced these components. The aforementioned components are intertwined and will be discussed together.

5.2.1 Sports Components

Ryall (2013, p. 129) stated that “*sport is a human enterprise that represents a multitude of human compulsions, desires and needs: the urge to be competitive, to co-operate, to excel, to develop, to play, to love and be loved, and to find meaning in one’s existence*”. The urge to be *competitive*, to *excel* and to *develop* are key points that stand out within the aforementioned excerpt and somewhat provide certain motivations for the introduction of data and technology in sports. The sports industry has come a long way over the last 10 years, with new technologies and new methods of analysing data being introduced. For instance, Major League Baseball (MLB) implemented a camera and radar-based device in every MLB team stadium, allowing the monitoring of real-time baseball information such as ball velocity and trajectory, and the performance of each individual player in greater detail (Neyer, 2014). Similarly, National Basketball Association (NBA) stadiums have all been fitted with cameras that allow teams to monitor the movements of players, aggregate the data collected and analyse it in an attempt to produce state-of-the-art player performance statistics. The organisational component of sports which involves government, sponsorship and team structure has largely been influenced by digitalisation in numerous ways ranging from how sports are now structured to how they are being managed (Xiao et al.,2017). The findings of this study revealed that digitalisation has had a massive influence on sports ecosystem both on and off

the field. Participants corroborated the aforementioned statement, suggesting that digitalisation has enabled the easy access to data and information which is now utilised in the management of sports. Digitalisation goes beyond the typical network of sports organisations and this is because there are new entrants/stakeholders in sports, such as the sport data companies coming into the ecosystem. The study conducted by KPMG Report (2014) affirmed that the sports ecosystem “*comprise different dimensions or segments that go into establishing and developing a sport and there are various stakeholders in each segment*” (Da Silva et al., 2017, p. 414). These dimensions or segments have been identified as: *Sport Governance, Fans, Media, Sponsors, Leagues, Clubs and Players*. Taking into cognisance the above definitions, it can be surmised that the sports ecosystem is essentially made up of the important segments that make up sports and ensure its adequate operation and continuous advancement.

The introduction of data and technology has brought about a wave of new stakeholders, this is corroborated by previous research conducted by Xiao et al. (2017). These stakeholders - sport data companies - further perpetuated its implementation and cemented its utilisation, by way of facilitating access to data and also providing an avenue for analysis and interpretation. This was a particularly remarkable revolution in sports as well, considering the fact that sport is known to have a structure built around the players and the coaches alone. The organisation of sports is typically structured around - “*sport producers*” - players and coaching staff with particular roles who can be considered “*assets*” and are tasked with producing “*sport situations*”. However, the introduction of data and technology has seen the list of sport producers increase significantly, and it currently extends to data scientists, strength and conditioning coaches, physiotherapist, performance analysts and sport scientists. Participant P19 who is a performance analyst, put forward the following statement, “*well it’s given me a job and allowed people to be employed [..].It has certainly created an industry of performance analysts, and I read there more people at universities studying sport science or performance analysis than there are jobs in the whole industry*” (P19 Q12). Correspondingly, participant P13 added that “*when I was a youth team player at Luton Town when Luton Town were a premier league club so that was 1987-1990 and there was a youth team coach, a physio and a bus driver that was about it – whereas now there is myself and Kwame – two coaches, you have got a goal keeping coach, you have also got two analysis guys, doctor, masseuse, fitness guy so the amount of staff and the amount of people you have around you and the resources that you can tap into – you can add psychologists as well - is*

just vast” (P13 Q9). The aforementioned statement exemplifies the impact data and technology is having on the organisational component of sports. Certainly, there will be more sport producers as technology continues to improve and the sports ecosystem continues to evolve. The current advancement and success of data and technology in sports can somewhat be credited to sport data companies. Davenport (2014) highlighted that sports teams are relatively small organisations who can’t afford to invest in data and technology due to lack of resources, consequently the introduction of these sports data companies has been critical to the development and success of the new data-oriented sports ecosystem. Companies such as SAP, Prozone and OPTA Sports (Newcomb, 2013; Schroer, 2018) have been at the forefront of this phenomenon for many years and still continue to push the envelope. This statement put forward by Participant P14 exemplifies the current culture of sports with regard to data and technology utilisation, and demonstrates the impact third party stakeholders have had on its growth, *“the coaching culture now is that there's a lot of sports analysis now, prior to and post games, whereas ten years ago managers that have played the game win lose or draw, they'll have their own opinions from sat on the side of the pitch but now there's cameras everywhere so there's a more detailed view and detailed perspective of what went well and what didn't go so well in a game”* (P14 Q1). This demonstrates that the introduction of new stakeholders has had a profound effect on the development of sports. Their presence has been further ingrained in sports with notable sports leagues such as the English Premier League, Spanish La Liga and US Soccer signing agreements with technology giants in an effort to bring football to the forefront of sports through the development of world class players and coaches. This is in congruence with previous research emphasising that the introduction of new entrants will allow for further growth and complexity of sports ecosystem (Xiao et al., 2017). Further evident changes are that of the Premier League now having access to detailed information which is made available to teams. Participant P16 stated that *“it's become much more so the premier league getting a hold on it, before it was prozone who would give you detailed information on your teams work but it gave you anonymised information about what other teams were doing in the premier league, whereas now with how the premier league is setting up you can see much more of what the other team are doing, it's become much more open”* (P16 Q2). Initially, data provided by sports data companies to teams about their own performance and performance of their opposition used to be anonymised and basic, but since the endorsement by the Premier League, teams can now easily

see what their oppositions are doing, as data is now made public (Premier League, 2018). This provides a segue into the discussion of symbolic component of sports.

As previously mentioned in **section 5.2**, sports components are linked and intertwined which is the reasoning for discussing these components together. The organisational component is equally linked to the symbolic component of sports, which covers the features around secrecy, display, rituals and culture (Serazio, 2013). Sports being a sector with deep rooted traditions and culture has seen rapid change over the last ten years, majority of these changes were fully instigated by the introduction and utilisation of data and technology. According to Loy (1968) the sports sector like the business sector is known for its strict confidential conducts, secrets pertaining to game strategies and several other technical aspects that are handled with high priority. Secrets pertaining to game strategies and other technical information are now public knowledge, sport teams now have unfettered access to data regarding their performances and even other team's performances. Furthermore, even the fans now conduct their own analysis of the game because of the massive amounts of data available now, which they have easy access to. Xiao et al (2017, p. 9) put this into perspective by stating that "*hidden information on the technological component of sports (e.g. the level of physical skills of certain players, performance data of players and teams) has become increasingly accessible, traceable, and visible to the public*". Although, this particular impact on the symbolic component of sports may seem detrimental - since the secretive nature of sports is what most teams rely on for competitive advantage - Hughes & Bartlett (2008) postulated that the intricacies and ever-changing nature of sports necessitates the need to observe and measure performance before it can be fully understood. Consequently, implying the need for the change even though it seemingly threatens the fabric of sports with regards to its symbolic component.

Technological and educational component of sports are intertwined and somewhat rely on each other. Loy (1968, p. 8) defined technological component of sports as that which involves and underscores "*material equipment, physical skills, and body of knowledge which are necessary for the conduct of competition and technical improvements*". Conversely, the educational component involves the activities of obtaining skills and knowledge. These skills and knowledge are usually obtained through training. In essence, the technological component is a means by which the educational component can be improved. The technological component of sports encompasses the knowledge possessed by the players and the teams, the physical equipment, the physical skills and the skills and knowledge possessed by the manager, coaching staff in an effort to enhance the

“technological component”. The past decade has ushered in an evident development in the use of data and technology within sports such as football, cricket and rugby (Carling, 2009). These developments have predominantly had a massive impact on the technological component of sports, as this is arguably the most important component, in terms of sport’s longevity and overall competitiveness. Demonstrating this profound impact, participant P11 stated that *“the first thing I would say is that 10 years ago it was very rare that we would have video analysis and stats analysis. We would [...] have a chat about the opposition or have a bit of a guess or estimate of past score or average score on that ground, whereas now all the information is on hand so you can get much more precise. The video analysis that we do is obviously quite common now, every coach has to know how to work a laptop or an iPad and go through some video analysis”* (P11 Q1). This statement exemplifies the progression of data and technology over the last few years, and how much it has been ingrained into the fabric of sports, to the extent of it becoming the norm, and sports stakeholders such as the coaches and even the players are expected to be well versed in operating and working with such technologies. Similarly, participant P15 affirmed that *“...if you look at sport as a whole and you look at the science, medicine and analysis side of things they have grown ridiculously, particularly if you look at rugby and you look at football as well”* (P15 Q3). This is in line with previous research suggesting that coaches and players alike now recognise the role that extensive high-quality data plays in areas of training and performance (Davenport, 2014; Passfield & Hopker, 2017). A study conducted by Blaze et al. (2004) further corroborates this, they found out that nine out of ten Premier League Managers who answered questionnaires utilised *“computerised notational analysis”*. The analysis of data plays a key role within sporting practice and serves as a foundation for most training programmes (Thelwell, 2005). Certainly, the amount of data sports teams are now able to collect and the technology that goes behind that has changed immensely (Travassos et al., 2013). Davenport (2014) attributed some of these developments to the growing utilisation of Internet of Things (IOT) technologies which includes sensors, wearables and tools for analysis, thereby allowing massive amounts of data to be collected and analysed (Alamar, 2013; Agarwal & Mehrotra, 2016). Research conducted by Franks et al. (1983) first identified the role of performance analysis within the coaching process by using a framework to show how performance analysis is conducted. Although dated, the research highlights an important milestone in the pursuit of assessing performance in sports in an effort to develop an accurate understanding of actions that can inform decision-making. Franks et al. (1983) demonstrated how

performance analysis and feedback technology could be integrated into the coaching process. Their framework seemingly consisted of the use of coach's observation and video of recorded training sessions, implying that observational data and video recording made up the majority of the performance analysis conducted at the time. A subsequent research done by Hughes (2008) referenced by Groom (2012) updated this model to include the use of more modern technology, while also indicating how this has changed the coaching feedback process. The advances in technology and analytics has now created a coaching system that involves the use of numerous tracking hardware and software that enables more high-level data collection, storage and visualisation. The findings of this study corroborate the aforementioned statement, participant P23 stated that *"having new software like PowerBi, Tableau, AlterX [...] We are utilising PowerBI to help visualise and that's helping us inform our messages a bit clearer. So, I think it's using visualising tools such as that but also it is making it smarter as well"* (P23 Q2). Football teams now invest in devices that allow them to generate a range of different data types about their players, which necessitates the need for technologies such as PowerBI. Perhaps indicating the evolving role of data analysts as well. Previously, data analysts or performance analysts were required to record videos and do basic statistics, but the role has now evolved into where sport teams now need analytical experts to manage, generate and communicate insights from data. Data analyst and performance analyst are now key members of every coaching staff. The analysts are tasked with collecting the data about the players and presenting the information back to the coach and even the players in certain situations.

5.2.2 Current Practices

Data and technology are currently being utilised for training, performance management, injury prevention and for team and opposition strategy. Even though there is a dearth of evidence linking data analysis and improved performance (Wright, 2015), the ability of a team to incorporate data-driven practices within their coaching system will enable them to monitor team performance and also improve individual player performance and subsequent development. The findings have highlighted that invariably all sports teams now utilise some sort of data-driven approach, whether it be in-house, or third party sourced. Participant P19 stated that *"I think from our perspective we use data as our foundation, it's important for us that in our roles that information is built on good data, so it has to be correct, it has to be right the information that we make our decisions on"* (P19

Q9). The statement affirms that most sports team now utilise data and it serves as a basis for every decision made by the coaching staff and the players. This is contrary to the views expressed by Court (2004), the author suggested that performance analysis is used as a reactive tool ensuing from a poor performance or a loss. Participant P23 made emphasis of the fact that sport teams are sometimes reactive than proactive within their practice, but the data enables them to be more proactive. The participant put forward the following statement *“sometimes we are a bit reactive rather than proactive within our sports, so data actually allow us to be more proactive, so becoming smarter about the trends and patterns within football”* (P23 Q1).

The findings have indicated that most elite teams use sport data companies in the collection, analysis and interpretation of data. The report resulting from the interpretation is usually sent to that particular team’s performance analyst, who is then tasked with further analysis and subsequent presentation. Participant P16 affirmed that *“they will provide us the statistics, so typically - at first team level - quite common one to be used will be OPTA, [...] they provide the clubs with the statistics so they do all the actual sort of like counting and then they provide the numbers to the clubs”*(P16 Q18). Conversely, sports teams also conduct inhouse data collection and analysis, participant P16 further stated that *“we also do some of our own sort of like statistical stuff as well where we decide that we're looking at particular things that aren't offered to us”* (P16 Q19). However, the findings also indicated that some sports teams are unable to seek the services of sport data companies due to the high cost associated with it. Participant P19 stated that *“we don't have the financial clout to be able to go to big companies - they'll come here and say, ‘oh yeah we can provide you with a solution’ - but at a ridiculous amount of money”* (P19 Q4).

It has been noted by Carling et al. (2009) that there are fundamental advantages to using sport data companies, that is because they may provide more data on the team and opposition that would be impossible for the team to collect themselves, due to lack of resources or lack of access. Majority of the sport data companies within the English Premier league and other leagues are contracted to collect every piece of data from every game (both home and away), consequently they may have in their possession data that some sports teams don’t possess. This put the lower teams in a slight disadvantage, because while the top teams can afford to pay for the data, the lower cannot, and this creates some sort of data imbalance. From the study it was apparent that SportsCode and Catapult are the most commonly utilised software and technology. Nevertheless, the capability to fully utilise the data provided will be dependent on the ability of the performance

analyst at the club and the ability of the coach to provide feedback to the players (Hughes, 2004). **Section 4.9.3** has presented all the information regarding the sport data companies used the most in sports and the accompanying software programs and technologies. The table presented in **section 4.9.3** provides a comprehensive list of companies and software currently being utilised in sports today. Football, Cricket and Rugby teams now utilise bespoke applications tailored to the team's philosophy and overall strategy. However, one unexpected surprised was that the level of utilisation within football, rugby and cricket based on the software utilisation is very disproportionate, with football appearing to have higher utilisations and more initiatives. Football seemingly has always held a conservative approach towards the use of data analytics and technology (Valdes, 2019). The findings have indicated that perhaps this is not the case any longer. Moneyball and big data-oriented stories in sports are readily capturing the interest of sports teams as they are starting to appreciate the benefits of this phenomenon. Although there are still certain holdouts in terms of embracing technology, as suggested by a participant within football who stated that - *"I think some leagues have been more open to innovation, more prepared to embrace the technology. I think Association football has probably been the lag out in that respect and I think it's partly a culture that on the whole football has been less willing to embrace the analytics revolution and I think that runs through the football, I think that there's been issues with regard to the power of tradition"* (P3 Q6). Correspondingly another participant within cricket corroborated the aforementioned statement by putting forward that *"I think this is one of the issues that we have with cricket and data, is that at the moment data is being pushed as opposed to pulled. So, we have coaches that are technologically driven and that are interested in data but it's rare that we come across coaches that actually are looking for more and more information"* (P19 Q13). Davenport (2014) postulated that the traditional culture of many teams poses a massive barrier to the successful utilisation of data and technology. The author went further to assert that *"relatively few coaches and players pursued careers in sports because of their interest in analytics. Even when considerable data and analytics are available to support key decisions, they may not employ them over their intuition and experience. In short, demand from key decision-makers for sports analytics is considerably less than the supply of data and technology"* (Davenport, 2014, p. 2).

The findings of this study have demonstrated that there are significant signs of improvement and advancement within the sports industry as discussed above. Participants while noting this strong power of tradition of sports also stated that the tradition is changing rapidly, and

stakeholders are now fully embracing technology. Participant P21 put forward that *“at first it was a little bit difficult to get players use to wearing it, but now it is kind of second nature. The players know that every time they touch the grass, every time they go out that they are to be wearing the GPS unit, so from there we can gather so much data. Some players are really, really interested in it, they will be texting me first thing on a Sunday morning asking for their information, the game stats and that type of thing”* (P21 Q6). Congruently, participant P13 also stated that *“they are very progressive here, very open minded, looking at new ways to learn, very realistic approach, looking at improving all the time whether that be as a player or as a coach they want to learn, [..]* (P13 Q10). This substantiates and gives credence to the fact that sports (especially football which has been known to be traditional in approach) is now embracing and incorporating technological approaches within their practice.

5.2.2.1 Coach - Player Feedback

Extant literature has indicated that feedback plays a crucial role in facilitating player development in relation to skill learning (Carling et al., 2005; Thelwell, 2005; Kuper, 2011). Consequently, it has been postulated that one of the main benefits of accruing data in professional sports is that it can underline areas of strengths and weaknesses in the game and provide a full picture of what is to be expected in forthcoming matches (Carling et al., 2005). The findings of this study corroborate this, participants firmly stated that feedback plays a crucial role in facilitating the learning and development of players and even coaches. This allows the players and coaches to be well prepared, develop a strategy to counteract the opposition in an effort to neutralise any potential threat, while also exploiting weaknesses identified. It is important to understand, however, that the philosophy of team and plans created by the coaching staff needs to be understood by all in order for the feedback to be effective and transferable to training and subsequently live game (Wright, 2015). This seems to imply that if the feedback process is not clearly understood by all and articulated effectively, there could be a potential disconnect between what should be done and how to carry it out. Data and technology play an important role within the coaching process itself, however it is even more equally important to get the players to interact with the data as opposed to the coaches being authoritative in their coaching style. Participants emphasised the importance of this approach and underscored the player’s receptiveness to said approach. *“I think players are more open to coming to staff and asking for information, they are more open to analysing their own performance*

and they are more open to different learning styles and different methods [...] I think players are a lot more intuitive with the coaches and members of staff and I think they want to do more” (P25 Q11).

5.2.2.2 Challenges

Sport teams still encounter challenges in areas of implementation and utilisation of data analytics. This corroborates previous research conducted by Davenport (2014) and Martin et al. (2018), in which the authors highlights that teams are not adequately exploiting this phenomenon either because they deem it unnecessary or simply cannot afford to invest due to lack of resources. The latter seem to be even more true as shown in the findings. Most of the participants stated that the main reason behind challenges still being experience is the fact that lower teams find it harder to acquire the data and subsequently perform analysis due to cost required to obtain it. Furthermore, the aforementioned point suggests a digital divide between teams as a result of imbalanced finances and clout. Digital inequalities have long been an issue within the business sector for some time now. The concept of digital inequality also known as “*digital divide*” transcends the business sector and is also being experienced in the sports industry. Maxcy & Drayer (2014) accentuates this point in their study by stating that teams differ in terms of their use of analytics and also their interest towards it. Despite the clear indication of the activity and growth of this phenomena, there are still ever-present obstacles and barriers. The findings of this study corroborate the aforementioned statement and goes further to categorise these challenges into; implementation and utilisation challenges. With implementation challenges tantamount to teams that want to incorporate data and technology within their practice and can’t do it properly because of certain factors (such as lack of resources) and utilisation challenges tantamount to teams that already have technological capability but struggle to parse and interpret the massive amount of data being generated in sports today.

The findings of this study identified cost and personnel issues as two of the main barriers facing sport teams in their quest for competitive advantage through the route of data and technology. The cost associated with acquiring software and technology fundamental to the implementation of a sport analytics programme is quite high and leaves some teams in a clear disadvantage in comparison to other more advance opposition/teams. A point made by participant P15 who is a performance analyst epitomises this evident issue, “*in terms of cricket, funds and*

resources are issues - so I'm in a really lucky position that I'm a full-time analyst and whereas some counties don't have that option they'll have someone at the basic form, they'll just have someone coming in and coding and that's it, [...] and that can be because of funding [...]" (P15 Q4). In addition to cost required to acquire the technology, personnel issue is another significant problem being experienced.

The study conducted by Martin et al. (2018) with coaches within sports such as football and cricket corroborated this by stating that the principal barrier for the coaches using or trying to use performance analysis software were cost of software, hardware and personnel. Moreover, a more significant barrier they identified was the time taken to complete analysis and *"the lack of time available to interpret and analyse information"*. These problems seem to be one in the same, the turnaround time in sports is quite short. Previous research by Carling et al. (2005) put this into perspective by affirming that a single game of sports generates massive amount of data and video footage of pertinent events that transpired during the game. This necessitates that quite a lot of time be dedicated to the analysis of data collected and subsequently analysis, interpretation and dissemination of results to the key stakeholders. Participant P19 corroborated this by stating that *"we spend probably kind of 90 percent of our time doing the boring bit and only a small bit of percentage of our time actually dealing with the analysis of the information and that's a problem with 'data'"* (P19 Q5). Participants were of the opinion that due to the massive amounts of data being generated in sports, it is a natural consequence to have problems regarding the collection of the data. The need to collect all available data is also a by-product and an issue that has been underscored within literature. There are clear indications that the sports industry is reaching a stage where the capability to collect data is growing exponentially than the capability to utilise it. Due to the nature of sports and the short turnaround time for games, it is crucial to have the analysis completed before the next game so the team can debrief and look forward to the next game. However, lack of funding to secure skilled personnel and an imbalance between capability to collect data and capability to fully utilise it makes this a seemingly impossible task.

5.2.3 Future of Sports

The sports analytics market size, estimated to be at \$125 million in 2014 is expected to reach \$4.7 billion by 2021 (ReportsnReports, 2015). The professional sports industry continues to push boundaries and continues to be one of the biggest and rapidly growing industries in the world. This “*growth*” has no doubt been fast-tracked by and can be attributed to digitalisation in more ways than one. The amount of technology available in sport now is remarkable and participants of this study think that there is nowhere to go but up for sports in terms of technological advancement. Turner (2013) postulated that initially sports and technology seemed like an odd mix due to its nature, symbolic component, the protruding clunky devices worn during training and live games. However, advancement in technology have seen these “clunky devices” reduce considerably in size and increase in functionality. Participants have chronicled initial difficulty of getting players use to wearing these devices but more recently wearing these devices have become second nature to players. Arguably, this is because the size of the devices has reduced which allows the possibility of collecting data on every aspect of the game. These advancements have led to considerable improvement in human performance, the players are fitter, stronger and quicker, it is fair to say that digitalisation has raised the standard of the game.

Figure 39 shows a timeline of technology introduction in sports and also the possible technologies that will be introduced based on current trends. The red line in the graph shows that technologies will continue to come into sports and improve the overall ecosystem. Virtual and augmented reality (VR/AR), predictive analytics, internet of things (IOT), artificial intelligence (AI), machine learning (ML), blockchain, player tracking, and big data analytics are technologies set to further revolutionise the sports industry in the nearest future. These technologies are already being introduced and implemented in other sectors such as business and banking (Gandomi & Haider, 2015). Although we are starting to see some of these technologies implemented in sports, it is currently in the early stages according to participants. Participant P16 while acknowledging the potential benefits virtual reality can bring to the sports industry especially in area of decision-making stated that “*virtual reality might be something that you know comes into play, but you know that's a long way in the future*” (P16 Q17).

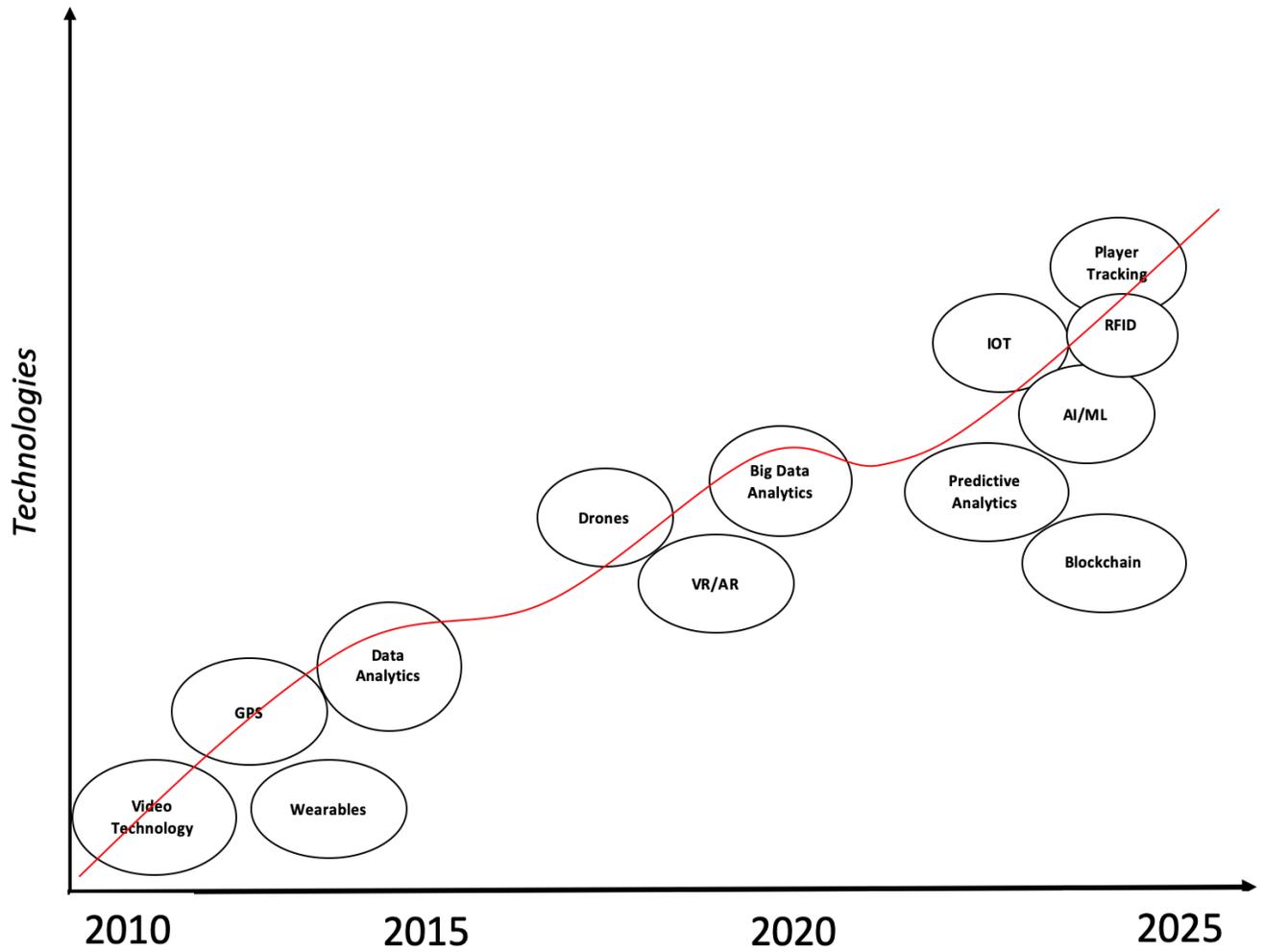


Figure 39 - Technology in Sports - Future State

5.3 RQ-2: How does digitalisation enable sports teams to develop learning capabilities and increase their knowledge base?

This section will address research question two (RQ-2) and is regarding how digitalisation enables sports teams to develop learning capabilities and increase their knowledge base. Organisational learning capability is the ability of an organisation to process knowledge, in essence, the skill to generate, acquire, transfer and incorporate knowledge, while also altering their behaviour to adapt to new situations with the goal of improving performance (Gomes et al., 2017). Farrukh & Waheed (2015) postulate that organisations that continue to learn and facilitate the learning of its employees will always remain a cut above the competition. A learning organisation develops as a result of the complexities of modern organisations and enable them to continue to remain competitive in an ever-changing environment (Wang & Ahmed, 2003). Similar circumstances operate within sports, as a result of its dynamic and unpredictable nature, it remains imperative for sport teams to not only win but to keep a constant momentum. Consequently, in sports context and in this research, the players and coaches are regarded as the employees/stakeholders. **Chapter 2** proffered background to important concepts such as leadership, innovation, change, learning organisation and knowledge management. Learning organisation and knowledge management, particularly, are concepts that have been underlined within literature to be crucial in the development of the collective knowledge of an organisation (Senge, 1990). Leadership and innovation are also equally important concepts that will be discussed subsequently in relation to the findings.

Alavi & Leidner (1999) stated that knowledge management is a methodical and structurally specified process for obtaining, organising, and conveying tacit and explicit knowledge of individuals within an organisation in order for others to utilise it, in an effort to be more effective and productive. Knowledge management has become increasingly important for sport organisations, it is a way of sharing ideas among the coaches, players and the team as a whole in an effort to generate adequate knowledge to respond to the unpredictable nature of sports (Argyris and Schon, 1997). Digitalisation, organisational culture and organisational structure have been identified in literature as knowledge enablers that lead to organisational effectiveness in organisations (Zack et al, 2009). Although, this has been investigated within the business sector, it is unclear how digitalisation enables sports teams to develop learning capabilities and increase their knowledge base (Coleman, 2012). Consequently, it is important to discuss the findings and the literature in terms of the aforementioned research question (RQ-2). Erhardt & Martin-Rios

(2016, p. 5) stated that “*team sports are not only based on physical and emotional factors, but are also very much a mental exercise, which makes it a context suitable to explore how knowledge is managed*”. At the core of every organisation is knowledge management and organisational learning, and what these two concepts have in common is data as a foundation of learning. It has been postulated that learning leads to creation of new knowledge (Chiva et al., 2014). Accordingly, the amount of data generated and collected by most sports teams serves as a good starting point for learning and the creation of knowledge.

The findings have indicated that a fundamental element is the ability of players to reflect on their performance and to make deductions based on past events that emerge through data, indicating a relationship to learning organisation constructs such as empowerment and self-development. Correspondingly, this is in line with previous research on learning organisation that suggests that the first step in understanding the learning process of an organisation is to understand the learning process of individuals within that organisation. The role of individual learning is crucial in organisational learning (Wang & Ahmed, 2003). Learning is initiated at the individual level (the player level) and predicated on this level for overall success. Although, within sports the coach is responsible for initiating the process of learning and also facilitation, since the coach will naturally have his vision and philosophy in mind. Therefore, there is also a strong indication that effective leadership plays an important role in the creation, sharing and accumulation of knowledge (Singh, 2008). Similarly, Gardner (1993) postulated that leadership is considered to be an extremely important factor that often determines the success or failure of an organisation; thus, leaders must be cognisant of their influence on employees and ultimately the organisation as a whole. In order for learning to take place, the coach must ensure that the team has the same mental models, while also helping them understand the benefits and importance of such vision and philosophy. Participant P13 spoke extensively about how the players are the first point of analysis and the benefits of getting them to interact with the data, by giving them the opportunity to conduct the initial analysis and then create a plan on how to win subsequent games. This plan forms the foundation of the overall strategy which will be created by the coaching staff in several iterations. This particular process not only empowers individual players but also helps create a shared mental model between the team. This is further corroborated by Chiva et al. (2014, p. 689) who stated that organisation learning is “*the process through which organisations change or modify their mental models [..]*”. Argyris & Schon (1996) put this into perspective by stating that the concept of mental

models is one that doesn't have any specific boundaries and encompasses continuous alteration. This is because situations will often require different levels of attention and detail and as a result, the construction of previous mental model might change due to new circumstances. This is the case, especially in sports where a team typically plays more than 50 games a season, coupled with the fact that their opponents will often have different and varying philosophies, which creates a need for changeability. Richards et al. (2012) postulated that the development of a shared mental model facilitates the improvement of player knowledge and also ensures that there is consistent information between the coaching staff and the players. However, research conducted by Bampouras et al. (2012) suggest a contrary point, their study found that although the players/athletes are object and receiver of performance analysis, they are not involved in the process itself, therefore implying a more authoritative coaching practice where they are not given the opportunities to conduct their own analysis. This can possibly limit their learning and potential development, but perhaps coaches perceive this "coach-centric" approach as beneficial in terms of controlling the amount of information the players have access to. This is in congruence with research conducted by Wright (2015), which found out that coaches will naturally have different methods in terms of how the feedback sessions are conducted; some coaches employ a player-centric approach while others are more coach-centric regarding how information is delivered to the players. Nevertheless, the former approach appears to be more impactful and beneficial with majority of the players suggesting that they feel the player-centric approach supports their learning and development (Wright, 2015). The aforementioned discussion underscores the importance of the coach-player relationship, in terms of ensuring that the players receive appropriately measured information depending on their needs for development and level of information absorption. Wright (2015, p. 134) emphasised that a panacea approach or "*one size fits all approach will not be effective when giving feedback*", suggesting that players will have differing rate of information absorption. Consequently, coaches must possess or develop skills necessary to be able to cater to the differing needs of players. Mascarenhas & Smith (2011) in their book on "*Developing the performance brain*" also correspondingly identified shared mental models as vital to the coach and player relationship, because it stimulates a collective understanding of specific situations where attention should be placed and in explicating information. The authors went further to state that a shared mental model is vital in the recognition of crucial performance characteristics and removing insignificant characteristics so that players do not experience information overload.

Data and technology can potentially aid in generating massive amount of actionable information, and equally findings of this study (P25 Q4) and previous studies (Wright , 2015) have indicated that the massive information being generated in sports now help create better knowledge and as a result the players are more intelligent and knowledgeable around the game. Participant P25 alluding to how digitalisation can potentially help teams in increasing knowledge described the current situation at their club by stating that “*an analyst can upload something, the player gets a notification on their phone to say this has been uploaded have a look at it [..], you might only get one or two of the players who actually go online to look at that, but if you get one or two that is one or two more than you would have done previously and that is the strength of it, the player becomes more knowledgeable because of it*” (P25 Q6). The aforesaid statement exemplifies how digitalisation approaches and strategies enable teams to develop their learning capabilities and ultimately increase their knowledge base. Accordingly, it is plausible to assume (given the above discussions and examples) that digitalisation can help speed up the learning process of players and the team, and as a result influence how much knowledge they are able to absorb at a particular point in time. Furthermore, it is equally plausible to assume that players and the team as a whole become more knowledgeable through the process of coaches/analyst sending “player-specific” updates to their mobile phones. The findings have underlined the importance of involving the players in this process, moreover, the participants believe that this inclusion is proving beneficial as the players are now more aware and conversant with the philosophy of the whole team. Participant P11 acknowledged that “*the players, I think they analyse, they look at footage, they look at stat based evidence*” (P11 Q5). This demonstrates the responsibility now placed on the players to not only absorb information given to them but also to be able to do some sort of basic analysis. The culture in sport teams is now that which incorporates learning and involves regular team meetings where players are often tasked with leading the sessions. Jones (1996) highlighted the importance of fostering a learning culture in order for an organisation to manage knowledge effectively. He emphasised that knowledge shouldn’t just be limited to individuals in managerial positions, but rather it is the responsibility of all involved including employees to be “*knowledge workers*”. This further underscore that culture enables sports teams to effectively utilise the knowledge and experience they possess towards establishing and attaining desired goals.

Typically, within all sport teams, knowledge is codified by the coaching staff and conveyed usually through certain technological means to the players. Technologies such as interactive

whiteboard and mobile phone applications are used to convey information. This information which then becomes knowledge for the players include historical and present data analysed, video clips, presentations, and specific feedback based on previous performances of the player(s). This simplifies and streamlines the process and allows the coach to transfer condensed information to the players. The players are the receivers of knowledge and also sometimes contributors, they are allowed to create innovative solutions, provide analyses and implement with the aim of successful results. Participant P13 stated that *“On Saturday we beat Southampton 1-0, [...] the fine details of the set piece that we identified could be their strength because they used zonal marking and we end up scoring from that, and that is down to the players looking into it and practicing the day before then going out and executing it”* (P13 Q2).

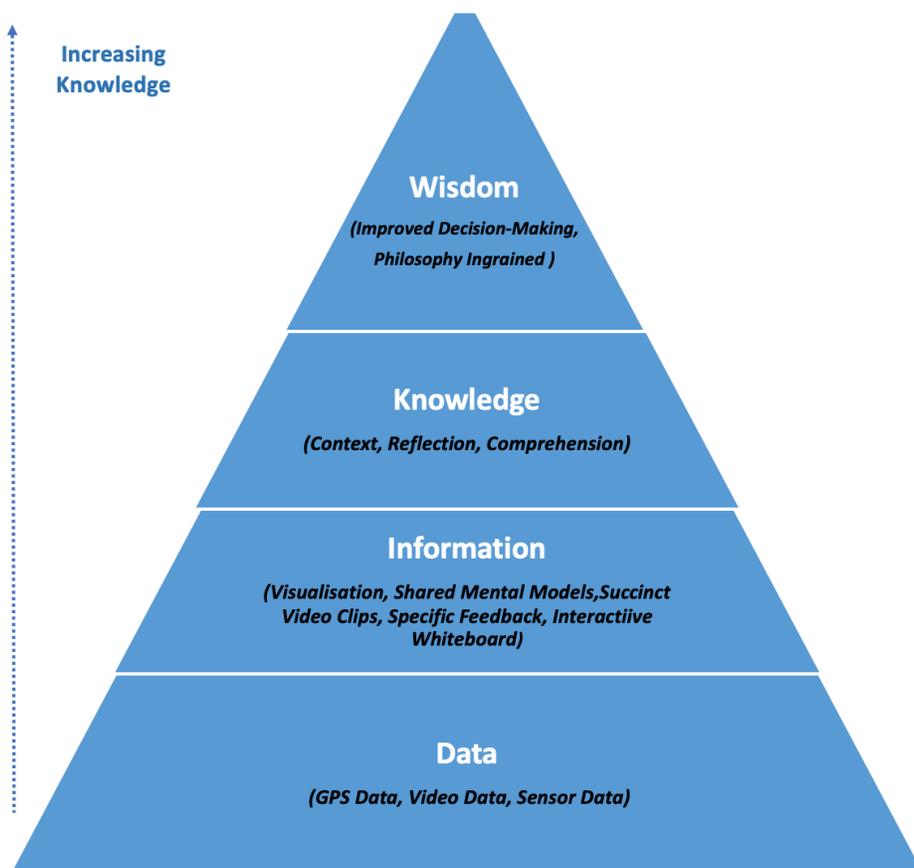


Figure 40 - DIKW Pyramid

Figure 40 above shows the DIKW hierarchy in sports with regard to the use of data and technology, and basically illustrates the transformation process of how data is transformed into wisdom. Figure 40 further delves deeper into specifics by identifying the means through which data is collected,

the type of information generated and gleaned from the processed data, how the resulting knowledge is ingrained and finally the outcome of frequent application of the knowledge, resulting in wisdom. Figure 41 below shows a more succinct graph showcasing a particular player's data to wisdom transformation process, portraying a specific example of how digitalisation can help a player increase knowledge. This example illustrates the type of information given to most players, and how the coaching staff helps them internalise the information thereby transforming it into knowledge.

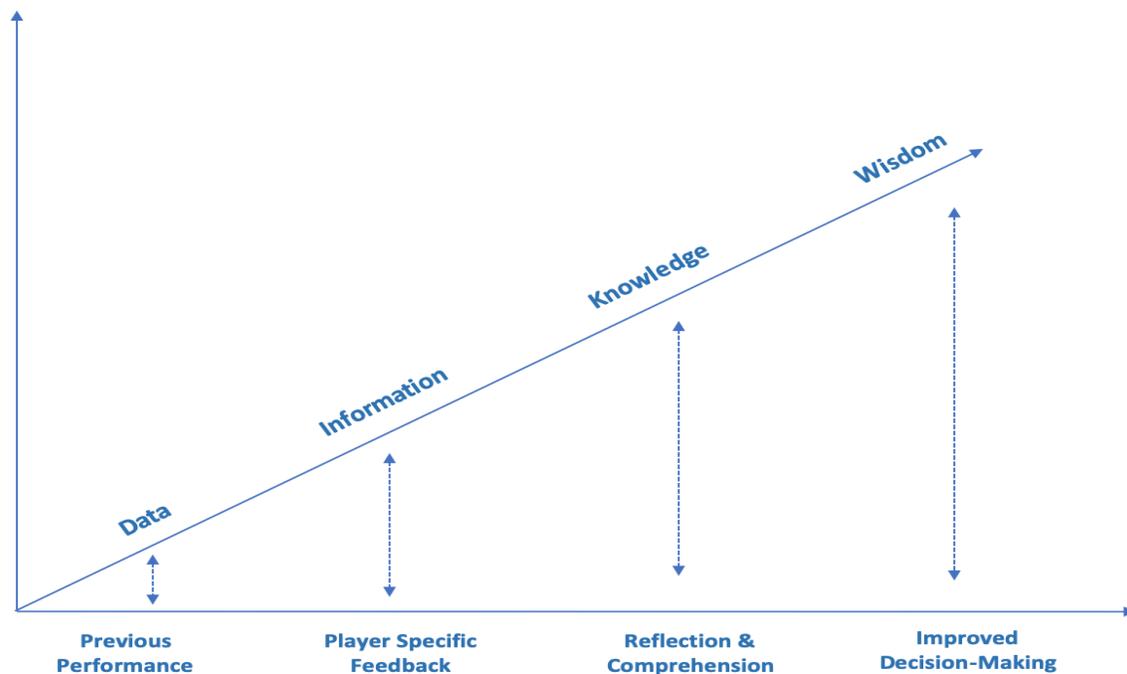


Figure 41 - DIKW Transformation Process

Figure 40 and 41 both indicate that wisdom is ultimately the final state but as discussed previously there will be a need to constantly change the final state to keep up with the unpredictable nature of sports, and this necessitates the ability to learn and unlearn. Sports has a reputation for being unpredictable and volatile in terms of what happens from one game to the next (Blair, 2011). For instance, the appointment of a new manager or coach can potentially have a domino effect by virtue of the introduction of new philosophies, principles, performances objectives and tactics. Participant P25 who is a performance analyst tasked with analysing data and presenting information to the manager/coach stated that “we've had 4 managers in just over a year now which makes it difficult to actually learn what they want and how they want it, because by the time you've learnt what they want [...] another manager comes in and you're like 'okay now where do we go,

we have to start all over again'. So, you have to keep evolving and keep changing your process. I think sometimes you have to be adapted to the environment that you're working in" (P23 Q3). Moreover, the situation described above is also true for a particular club when an opposing club appoints a new manager or coach and the former team has to learn new philosophies and principles of the new manager of the opposing club in order to outwit them. Digitalisation can potentially make the process of learning and unlearning less unwieldy, this will be further emphasised in the subsequent section. The findings have shown that sports teams can be perceived as information processing systems capable of obtaining and interpreting data, disseminating information and storing knowledge within the coaches, players and the team. This is in line with Huber's (1991) theory about organisations being seen as information processing systems, obtaining, interpreting, disseminating and storing information in the organisation. Consequently, he suggested four elements of organisational learning process: knowledge acquisition, knowledge distribution, knowledge interpretation and organisational memory (Huber, 1991). A fifth dimension – knowledge utilisation - was suggested by Oliver (2008).

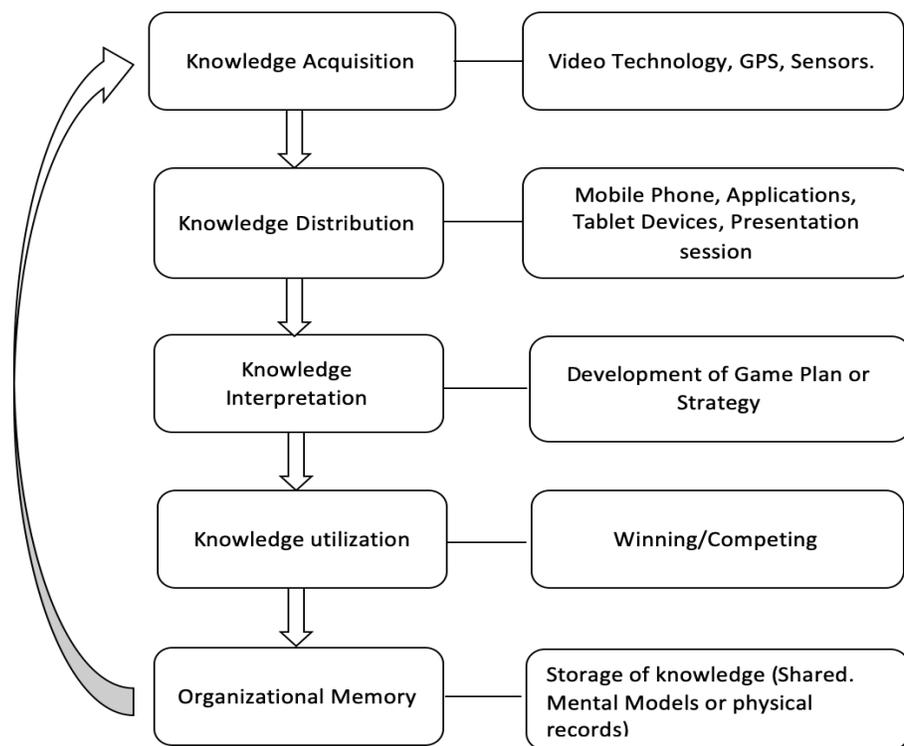


Figure 42 - Sports Information Processing (adapted from Huber, 1991; Oliver, 2008)

Figure 42 shows how sports team use data and technology as a means of knowledge acquisition and how it is then internalised into organisational memory.

Knowledge acquisition relates to the origin of knowledge and the method and procedures through which knowledge is collected in order to satisfy overall strategic goals. Oliver (2008, p.1) postulated that *“the allocation of resources to knowledge-acquisition activities could indicate the commitment of the organisation to learning”*. This follows the findings of this study which indicate that participants realise the importance of organisational learning in creating knowledge and subsequently competitive advantage, and this is demonstrated in their commitment by way of investing in data and technology. Participant P8 stated that *“what data might do is inform us of things that our opposition do and we'll then educate the players [...]”* (P8 Q3). The acquisition of knowledge is usually initiated from data collected from previous games, knowledge is acquired through video technology, GPS, sensors, observations and deductions made by the coaching staff and players. Participant P8 highlights a very crucial point in terms of how the allocation of resources (data and technology) to knowledge acquisition spawns the learning environment, which even the coaches are a part of.

Knowledge distribution involves the diffusion of the information that has been gleaned from the first phase. Within sports, this is done through a number of mechanisms and two perspectives; from a team perspective and from an individual perspective. Participant P14 stated that *“so there's a room upstairs where the team will sit down as a group and the manager will have clips on a big screen and he'll go through good and bad [...]so, they'll do it in a team framework but they'll also do it individually”* (P14 Q11). The distribution of knowledge occurs in a team setting and also individual, information is initially diffused in groups with video clips being shown to the team as highlighted by participant P14. Furthermore, the knowledge is also distributed to individual player through technological means. Participant P2 stated that *“In Leigh this season they have bought the players Ipad”* (P2 Q4). Knowledge is also distributed on an individual basis, ensuring that the players receive specific information in relation to their performance. This echoes the views of Richards et al. (2012), they postulated that individual based knowledge distribution enables players to contextualise the information given to them with reference to their own performance and even that of other players. This consequently simplifies the process of internalisation of the overall plan created by the coach (knowledge impacted by the coach). Moreover, considering the fact the players have to play together as a team, it is important

for players to receive information about their teammates as well, but only information relevant to their positions.

Knowledge interpretation is the process of attributing meaning to the information. Huber (1991, p. 102), posits that “*learning has occurred when more and more varied interpretations have been developed, because such development changes the range of the organisation’s potential behaviours, and this is congruent with the definition of learning*”. Knowledge interpretation is an important element of the organisational learning process, as individuals can develop a common interpretation or a different interpretation. The findings highlighted that players occasionally come forward to get clarification regarding some elements of the knowledge distribution phase. This highlights suggestion from previous research which stated that it is important to understand the nature of the different interpretations (Oliver, 2008). Players must have a shared understanding of the information and the coach and team must be cognisant of information asymmetry and information overload.

Knowledge utilisation involves the application of knowledge gathered in an effort to enhance and develop current capabilities and products/services. The utilisation of knowledge within sports setting involves the implementation of knowledge in order to outperform the opposition. This is the phase where the players are tasked to carry out the plan set by the coach, the resulting outcome from this application of knowledge forms what becomes the new organisational memory. Oliver (2008) suggests that organisational memory is an amalgamation of what people know about processes, mistakes and successes. This knowledge is accumulated and stored in sports teams in form of physical records, trends and patterns identified in data, strategies and tactics, and through shared mental models. The success of any sports team will be contingent on the capability to learn, and its capability to learn will be dependent on its ability to store and retrieve knowledge when needed. Consequently, as discussed above, it is evident that digitalisation enables sports teams to develop their learning capabilities and increase their knowledge base, while also facilitating the process of storing and retrieving the knowledge within its organisational memory.

Figure 43 puts forward a framework to answer the RQ2 by summarising all the key elements in this section in terms of how digitalisation enables sports teams to develop learning capabilities and increase their knowledge base.

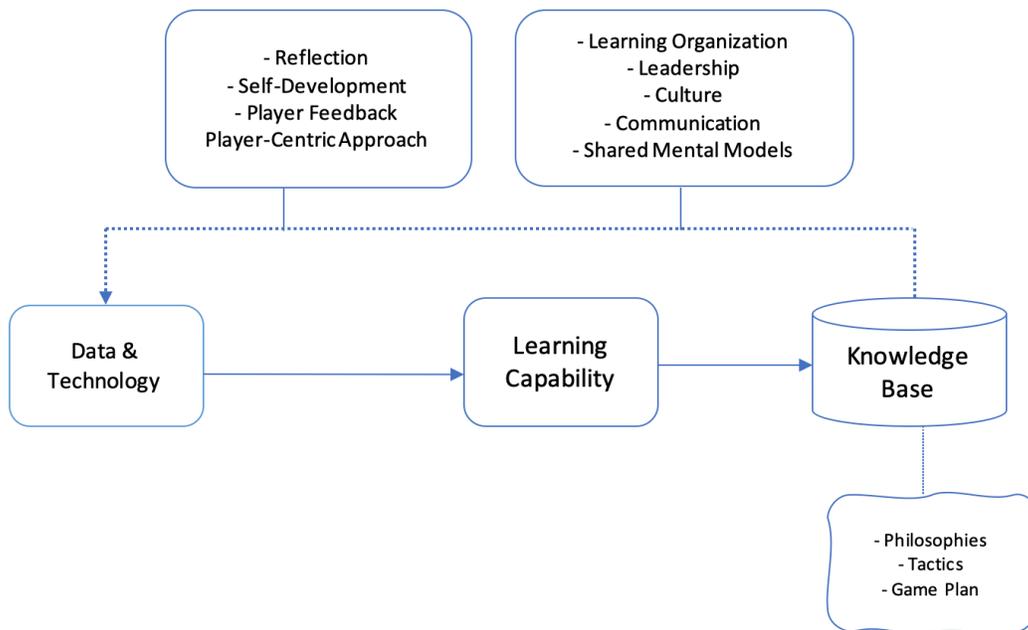


Figure 43 - Digitalisation - Learning Capabilities - Knowledge

5.4 RQ-3: How does digitalisation influence on-pitch decision-making abilities of players and coaches?

This section addresses research question RQ-3 by discussing how digitalisation influences on-pitch decision-making of players and coaches. Decision-making aptitude is very essential for successful performance in several complex and ever-changing situations (Van et al., 2016). Sports is a domain that provides an extraordinary setting for the study of decision-making due to what is referred to as ‘*decision agents*’ such as coaches and players. Following on from the above discussion of RQ-2, it is evident that knowledge creation is not the final process but rather the means through which the final goal can be achieved. The final goal for most sports teams is to improve performance and enhance decision-making. The influence digitalisation has had on monitoring performance over the years has received ample attention (Maxcy & Drayer, 2014) so much so, that it has been suggested that the sports industry is now reaching a plateau in terms of physical fitness (Horrocks et al., 2016; Relvas et al., 2010, P.166). There is, however, very little known about how digitalisation influences on pitch decision-making abilities of key decision agents such as coaches and players within sports. This is corroborated by the findings of this study, participants emphasised that decision-making is an untapped area and stressed the need for further understanding of how data can enhance players and coaches understanding. Participant P11 stated that “*at the moment that's an area we haven't really looked at too much [...] but I think that once we understand the data well enough it will really enhance the players sort of like understanding of why certain decisions are made and a lot of things that the coaches coach*” (P16 Q7). This indicates a need for this study and underscores the importance of this particular research question.

Nevertheless, participants indicated that digitalisation plays a huge role within sports, as coaches and players alike are starting to realise the benefits of utilising this phenomenon. O’Donoghue (2009, p. 3) stated that “*the main reason for doing performance analysis is to develop an understanding of sports that can inform decision-making by those seeking to enhance sports performance*”. The aforementioned statement implies that decision-making is a key element in terms of improving performance, the ability to make measured and accurate decisions can potentially influence the outcome of matches. Ultimately, the main goal of sports teams is to improve performance and stay competitive in an otherwise unpredictable environment. The sports sector is known to be one of the most volatile sectors in the world today, in terms of success and staying power. And while one of the most important elements of performance analysis is injury

prevention, perhaps decision-making is equally important, if not more important. The premise that improved decision-making will ultimately influence performance positively is more plausible than the idea of fully eradicating injury within the team. Even if that were possible, the absence of the all-important decision-making elements would contradict the overall goal of the team, which is winning and staying competitive. Figure 44 depicts the data and technology, improved decision-making and improve performance relationship.

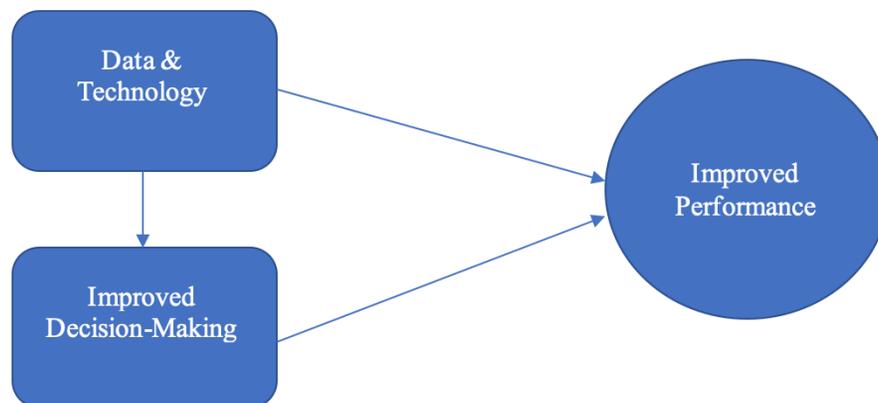


Figure 44 - Decision Making - Performance

Previous research investigating decision-making and observational accuracy of coaches discovered that they could only recollect just 59.2% of crucial events happening during a 45-minute match while also formulating unintentional bias (Laird & Waters, 2008). Subjective observation has been shown to be undependable and inaccurate, as even the most knowledgeable coaches are unable to recollect all the key moments of the game and can also be bias in their observation. This has no doubt stimulated the need for an objective way of analysing match events. Responses from participants in this study revealed that they perceive there is unprecedented amount of data being collected in sports now and affirmed that there is better knowledge now as a result of it. Participant P25 affirmed that *“I think there is better knowledge now; the players are more aware, more knowledgeable, more intelligent around the game [..]”* (P25 Q4). Furthermore, as emphasised by previous research done by Laird & Waters (2008) bias is a potential issue as a result of subjective observation, however data can help mitigate this problem (Hughes & Bartlett, 2008). Corresponding with participants’ perceptions, data and technology aids players and coach’s decision-making abilities in many ways than one. Participant P19 speaking about the inevitability of coaches developing bias through watching a live game or training stated that *“for a coach to be*

able to watch that and not formulate bias, I'm not saying that they're deliberately doing it [..]. But this is the way you know the ability for us to be able to I guess take a step away from it and to have hard numbers and data that stop biases and hopefully through that create better decisions” (P19 Q2). Intentional or unintentional bias is an issue that cannot be disregarded because this can lead the coach to make decisions in a way influenced by intuition and previous experience, and as a result create a misconception of what players should be achieving, even though it's unrealistic. As the coach is tasked with developing the overall strategy and philosophy, if this is flawed, the players reasoning and subsequently their performance will be affected because they often have to do as they are told in many situations. Basically, it is plausible to assume that bias is an element that can affect and hinder the decision-making ability of coaches and by extension the players. Moreover, the players themselves can develop personal bias. The findings have revealed that there is often a disparity between players perception of their performance and what the data and statistics shows. Players sometimes come off the field of play with a feeling of disappointment because they feel their performance was poor, but the performance data might show otherwise and actually reveal that the particular player achieved all the goals set for him by the coach at the beginning of the game. Consequently, the performance data reinforces and gives the player much needed confidence subsequently. On the opposite end of the spectrum, another player might come off the field of play feeling overly confident about his performance even though the performance data revealed that the player didn't meet the targets set by the coach. Although, bias and gut instincts can never be fully replaced by data and statistics, more objective performance data in these two scenarios will go a long way in illuminating and providing an accurate depiction of player performances, and this will no doubt form the basis for more informed decision-making processes. Participant P16 put this into perspective by affirming that *“every player comes off the pitch with an idea of how they played the game, so a player could come off the pitch thinking they've had a bad game and we can go to the statistics and say actually no you did this this and this right, you had a good game or we can have the opposite where a player thinks they're playing outstandingly but they're not actually doing what we want. So, what it can do is, it can - when needed - give an objective number to a game which can help either way, it can help reinforce people's ideas or it can help give us another idea of how that game played out”* (P16 Q18).

Digitalisation has created a culture where players are more conscious of their actions and more conscious of how they can potentially improve. The culture of sports is now such which

creates more knowledge, coaches and players are now more aware and have more information at hand going into a particular game. Cassidy et al. (2008) postulated that coaches need to be cognisant of the nature of the coach-player dynamic, as this is important in terms of getting buy-in from the player and ultimately fostering a positive growth and learning environment. Learning is a central tenet to the development of effective decision-making. Participants highlighted the importance of players understanding the reasoning behind certain decisions made by the coach, as opposed to it being an authoritative coaching system. The coaching system and method of information diffusion were identified as being enablers in terms of developing decision-making. This is corroborated by Wright (2015, p. 64), the author stated that “*decision-making process is enhanced by facilitating a common understanding of specific required behaviour, thus potentially removing misunderstanding and enhancing the clarity of the expectations of the coach*”. This particular point is highlighted in the findings as well, as participants emphasised that data and technology has introduced elements of clarity for the coaches and the players. The importance of removing misunderstanding and enhancing clarity can't be downplayed, participant P13 while highlighting the role data and technology plays in terms of clarity stated that “*it brings clarity because the pictures don't lie, it gives clarity to what actually happened on the pitch. It gives clarity to positioning, it gives clarity to decision-making*” (P13 Q1). The participant went further to affirm that “*the more you show the players that, the more they become better decision makers, so you can stop and freeze the players, so as the time goes on they will become better players*” (P13 Q1). Key findings such as the aforementioned underline that substantial focus is placed on the utilisation of video clips and visual data in an effort to help players improve their decision-making abilities. It was apparent from the findings that coaches would typically use video clips and visual data to provide feedback to the players and the team as a whole. Participant P5 highlighted this by stating that “*the coach may just pull them aside and say 'look the analyst has got these clips ready, I just want to show you that [...] you could improve your performance by doing this, this or this, here'*” (P5 Q2). The video clips and data shown to the players forms the basis for the development of their decision-making processes. Lyle (2002), emphasised the significance of video technology in aiding decision-making process of complex circumstances in various educational, coaching and instructing environments. The video clips are presented to the players individually and as a team and contains key decision-making moments during the game. This particular exercise introduces a line of questioning where the coach might ask a player or the

team the reasoning behind certain decisions they may have made. These video clips help instigate and incite the team's memory and forces evaluation and reflection of their own performance.

Moreover, Groom et al. (2012) posit that the reviewing of the video clips also instigates constructive discussion between the coach and players in terms of decision-making process. Participant P7 corroborated this by stating that *“your line of questioning, where you ask them what they were doing there, what they were thinking, asking them to explain the process, and asking them what they did well and how that felt, has an impact on them. From my experience that's only helped developed the players as well”* (P7 Q9). This is further demonstrated by another participant who stated that *“The coach generally sees pretty much most of what happens on the pitch, but data gives us things that the human eye just can't pick up because it can pick up much more complicated patterns”* (P16 Q5). This statement highlights that data can provide next level understanding for coaches, which makes it easier to facilitate constructive discussion between players and coaches. Additionally, participants made light of technologies such as Coach-Paint and Virtual Reality as technologies aiding the facilitation of discussion between coaches and players in terms of decision-making augmentation. Participant P14 while talking about Coach-Paint technology put forward that *“there's a new software called CoachPaint at the moment which is used on Monday Night Football, a lot of clubs have that now so that helps when you having your individual meetings with your players one to one basis and you can actually get them up and say – ‘ look show me where you actually was meant to be in that instance and look what happened’- so the analysis then of that individual performance is there to see”* (P14 Q7). This particular video technology allows coaches and players to literally “play”, “pause” and “rewind” key moments of game in an interactive manner, where coaches can use 3D technology to recreate the key moments. This technology enables coaches to identify individual player performance while also being able to accurately drill down to the details of the rationale behind certain decisions the players may have made or not made. In congruence with the aforementioned, another technology and perhaps the most cutting-edge identified by the participants is virtual reality technology. Although this technology is still in its infancy, virtual reality holds many benefits as confirmed by previous research. Visual information absorption is essential in terms of increasing decision-making abilities, as such this is a fundamental element in any and all sporting endeavour. Research conducted by Vignais et al. (2015) compared the effectiveness of video technology and virtual reality with regard to the absorption of visual information. The authors emphasised that virtual

reality proved more effective in the uptake and retaining of visual information. Miles et al. (2012) postulated that replicating real life games in training sessions can be a bit difficult and inefficient because most times, in order to simulate the real-life event during training sessions other players have to be inactive. As a result, not all players get the same amount of benefits and stimulus from training. Furthermore, the pressure and time constraints players and coaches face often means that they need to learn and train more than one skill during training. The findings of this study have demonstrated that virtual reality can be a game-changer in terms of how training is conducted. Participant P25 while stressing it's importance stated that "*virtual reality is probably the biggest one at the moment and everyone is talking about it. So, for example to be able to recreate a scenario for a game, look at decisions made in that more accurately, looking at what would have happened if a player had made this decision instead of this, looking at it from their perspective on the pitch. So, if it is a defender their movement to get into position and a clearer cross but they don't quite get there, you can look at what were they seeing at that time, what would they have done now on reflection*" (P25 Q3). This demonstrates the extent to which virtual reality can potentially change the learning process of coaches and players. The coach and the player can both put on a pair of virtual reality goggles and watch past events unfold again. This gives the coach a better perception of the decision-making process of the player. Participants firmly believe that technology can bridge the gap and enable coaches to better understand the thought process of players. Participant P7 who is a coach corroborated this by stating that "*I think you will be able to look at it in real time and then actually as a coach be able to go into the player decision-making and the player himself go into the decision making there, see what he has done, so what he actually saw in that moment. For me I think that is just brilliant*" (P7 Q6). The ability to be able to recreate a scenario where previous games can be relived and certain events that transpired during the game can be dissected and understood is unparalleled. Furthermore, having a good understanding of the process underlying decision-making and problem solving can help explicate the reasoning behind why players choose one option over another given a set of alternatives when the result is unknown (Marasso, 2014). Müller et al. (2006) stated that it is evident individuals who are considered to be experts choose and use different sources of information in comparison to individuals who are considered to be novice performers.

The findings have also indicated that coaches are now embracing a player-centric approach in terms of learning and place players at the forefront of learning through data and technology. In

the findings section, a number of instances where participants provided examples of how data and technology can enable the player-centric approach were highlighted. This process of allowing players to reflect, examine and offer explanations of their performance has been highlighted by Groom et al. (2012) as a way of potentially allowing the players take charge of their own learning and create an effective learning environment. This is corroborated by participant P6, speaking about data and technology, the participant stated that: *“I think that is a massive sort of learning tool because you're not going to be with them on the pitch, so you have to sort of learn how they can sort of reflect and then improve on that whilst they are actually in performance”*(P6 Q4). The above statement seems to imply that sports, especially football now incorporate player-centric approaches. This is contrary to research conducted by Groom et al. (2012) cited by Wright (2015, P. 129), the authors identified that *“the practices which are demonstrated within elite football academy settings tend to be associated with oppressive, highly authoritarian styles of coaching with a clear power imbalance being maintained and sometimes being reinforced by directive approaches employed during video feedback sessions”*. The authors further stated that their findings support the previous body of research within sports that emphasise the authoritarian approach with the coach-player dynamic. The findings of this study have demonstrated that perhaps this authoritarian approach is changing.

Awasthi & Varman (2003) developed a model (in figure 45) to study the influence of information technology on decision-making in the business sector, while highlighting the stages of decision making. This framework will be adopted in this section in an effort to further exemplify how digitalisation influences decision-making of players.

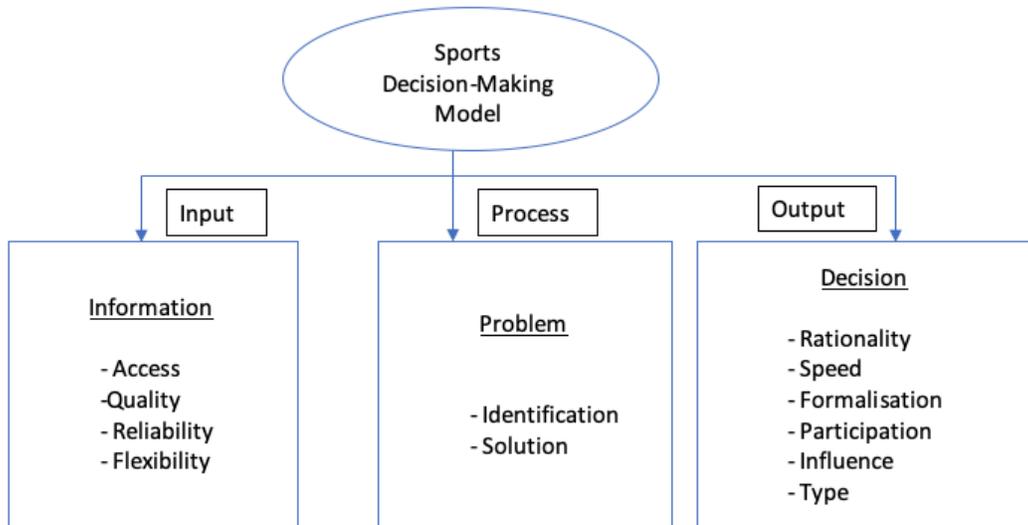


Figure 45 - Decision-making model (adapted from Awasthi & Varman, 2003)

As explicated in **section 2.4.1**, this model shows that decision making process involves three main stages: *input, process and output*.

The first stage which is the “*input*” stage involves amassing information. In the context of sports this will first involve the team collecting data through GPS, sensors and video, which is then transformed into information. This entire process has been detailed in the discussion of RQ2 above in **section 5.3**. This information is usually given to the players through technological means, for instance some teams send players daily updates based on their previous performances and other relevant information. As per the model in figure 45, this information will usually be defined by ease of access, quality of the information, reliability of the information and flexibility in terms of ability to receive varying information. Participants of this study indicated that the players receive information easily on their phone and since some participant stated that data is the foundation for everything they do, it can be surmised that they go through a painstaking process in terms of making sure that the data they based their decisions on is of good quality and reliable. Data and technology also ensure flexibility by allowing the coach to send multiple information to the players, thereby allowing them to take on board different information at any point in time. Consequently, data and technology streamline the “*input*” stage.

The second stage which is the “*process*” is where the player is applying the knowledge either in training or real-life matches. During a game of football for instance, players have to make decisions throughout the game in time constrained situations which necessitates the need for the

first phase, which is “*input*”. The process phase is where the player identifies the problem and also solution to the problem while the game is in play. The following quote from participant P12 exemplifies how data and technology can help a player identify a problem as well as finding a solution to the problem - “*if you are standing on the corner of their penalty box(of the opponent) and you have got three options of people to pass it too and one is slightly covered, one is closer to the goal I think you can use data to try and inform ‘okay, I can then make a gut feeling based on what I have been taught from the data about making that decision’* (P12 Q10). This statement not only exemplifies how digitalisation influences a player’s decision-making process but also highlights the possible correlation between use of data and improved performance through better decision-making.

Third and final stage which is “*output*”, is where the decision is finally made based on the “*input*” and “*process*” stages. Furthermore, as seen in the model in figure 45 the final decision will be influenced by rationality of the player, the speed at which the decision is made, the formalisation of the decision, the number of people involved in the process (participation), the external influences, and the type of decision made. All these elements within the output phase can be influenced by data and technology. The rationality element has been identified in literature as the key idea behind understanding decision making (Salaman, 2008; Nutt & Wilson, 2010). Dehe (2014, p. 100) defined rationality as “*the quality of thinking behind the decision-making process and outcome*”. Implying that rationality is no doubt an important element. Consequently, data and technology can be used to alter this rationality element over time, thereby making the player base decision on correct information. Although, players can be dealt with unpredictability due to the nature of sports, the data will definitely go a long way in preparing the players for possible eventualities. The speed element in the “*output*” phase can be influenced by data and technology as well, the constant exposure to data and differing eventualities will potentially help the player improve the speed of decision-making. The participation element in the “*output*” phase relates to the number of players involved in the decision-making process. Data and technology can potentially influence this element as well. As previously discussed, sports teams now send player-specific information to the players, in addition to player-specific information, the players also receive information about their teammates relative to their own position. This allows the players to develop a deeper understanding of team dynamics making it easier to anticipate teammate’s actions and make decisions based on that.

The influence element in the “*output*” phase reflects the degree of concentration of decision-making activity (Awasthi & Varman, 2003). Perhaps more accurately defined as the external factors that can potentially influence the decision of players. In sports such as rugby or cricket where there are usually thousands of fans in the stadium and other external factors that can potentially distract the players or affect the decisions of players, technology can potentially help increase focus. Technologies such as virtual reality, although still in its early stages, can help the player practice before the live matches. Virtual reality can be used to recreate real life scenarios, it can enable the coaches to recreate standardised situations that help the players gather more information about the environment they are playing in and also their performance (Miles et al., 2012). This method will no doubt assist the players in honing their skill of decision-making and focus better. The final element in the “*output*” phase is the type of decision element which is basically the decision chosen by the player based on the above discussed elements.

Figure 46 below puts forward a framework to answer the RQ3 by summarising all the key elements in this section in terms of how digitalisation influence decision-making abilities of the player and coach. The framework also includes elements from RQ1 and RQ2.

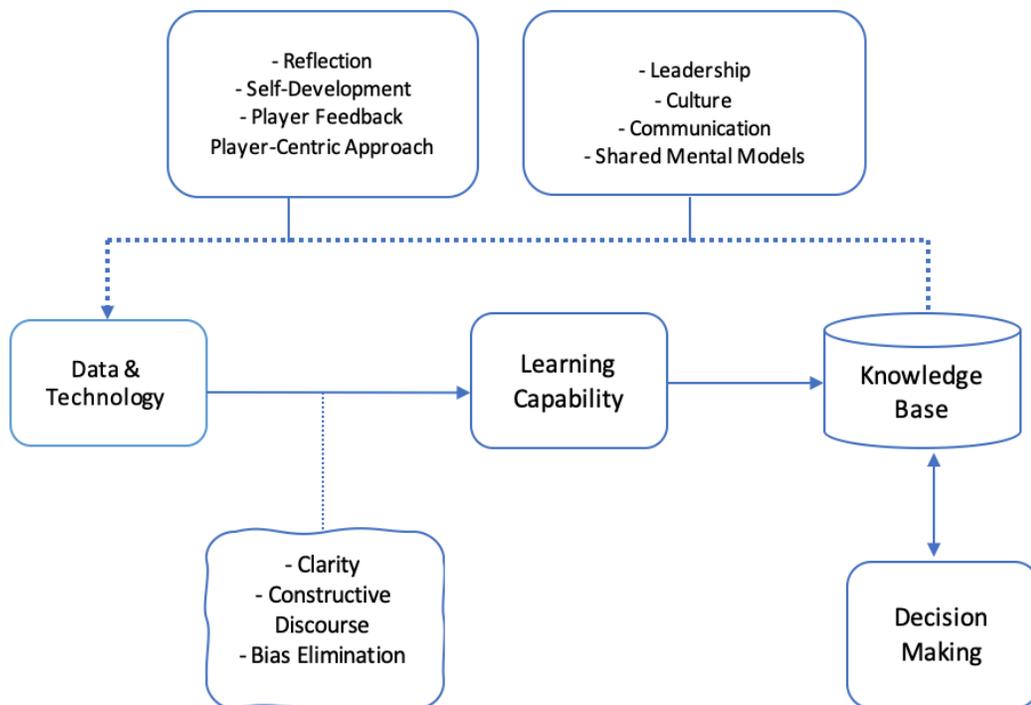


Figure 46 - Digitalisation - Knowledge Base - Decision-Making

Chapter 6: Conclusion

6.1 Introduction

The aim of this chapter is to provide a concise summary of the main findings of this research. Furthermore, the research aim, objectives and questions (outlined in **chapter 1**) will be revisited in an effort to demonstrate how the findings and subsequent discussion chapter provide answers to the research questions (RQ1 – 3). Following this, a conceptual framework will be presented towards the successful implementation and utilisation of data and technological tools. Moreover, the theoretical and practical contributions to the literature and the sports industry will be highlighted. Finally, the limitations of the study will be discussed, while also emphasising recommendations for future research.

6.2 Review of Original Aim and Objectives

This research aimed to investigate the evolution and possible future of digitalisation in the sports sector, with a focus on its influence within on-pitch decision-making and also how it enables knowledge development and dissemination within sports teams. In order to satisfy the aforementioned aim, the following set of objectives were formulated, outlined below:

- To investigate how digitalisation has influenced the sports ecosystem, specifically within the on-pitch domain.
- To analyse how digitalisation enables sports teams to develop learning capabilities and increase their knowledge base.
- To establish the influence of digitalisation within on-pitch decision-making of players and coaches.

The research objectives were used to formulate three research questions – outlined in **section 6.3** – and this will be used to discuss the findings of this study.

6.3 Overview of Research Findings - Research Questions and Answers

6.3.1 RQ-1: How has digitalisation changed the sports ecosystem, (a past, current & future perspective) and what are the current technological practices and their level of utilisation?

This research question was aimed at investigating the influence digitalisation has had on the landscape of sports, with emphasis on highlighting past, current and future state of sports. This particular research question was partly addressed through a critical review of the literature presented in **chapter 2**. Literature has indicated that sports is made up of organisational, technological, symbolic and educational components (Loy, 1968), consequently this research question was structured around how these components have been influenced. It was evident from the findings that digitalisation has had a massive impact on the evolution of sports, from how sports is structured down to how sports is now played on the pitch. From an organisational perspective, majority of the sports leagues now have technologies installed at the stadium/ground used to collect data about each individual player in great detail, exemplifying the extent to which digitalisation has been embraced. This is as a result of new entrants into the ecosystem such as the sport data companies and the sports leagues fully endorsing them. These stakeholders - sport data companies - further perpetuated its implementation and cemented its utilisation, by way of facilitating access to data and also providing an avenue for analysis and interpretation. The organisation of sports is typically structured around - "*sport producers*" - players and coaching staff with particular roles who can be considered "*assets*" and are tasked with producing "*sport situations*". However, the introduction of data and technology has seen the list of sport producers increase significantly, and it currently extends to data scientists, strength and conditioning coaches, physiotherapist, performance analysts and sport scientists. Secrets pertaining to game strategies and other technical information are now public knowledge, sports teams now have unfettered access to data regarding their performances and even other team's performances. The findings have highlighted that invariably all sports teams now utilise some sort of data-driven approach, whether it be in-house, or third party sourced. From the study it was apparent that SportsCode and Catapult are the most commonly utilised software and technology. One unexpected surprised was that the level of utilisation within football, rugby and cricket based on the software utilisation is very disproportionate, with football appearing to have higher utilisations and more initiatives. The findings suggest a digital divide between the sports examined as a result of imbalanced financial

clout and resources. Challenges such as lack of resources and personnel have been underlined as issues still being experienced by sports teams.

The amount of technology available in sport now is remarkable and participants of this study think that there is nowhere to go but up for sports in terms of technological advancement. The future of sports promises to bring more technological advancements. Virtual and augmented reality predictive analytics, internet of things (IOT), artificial intelligence (AI), machine learning (ML), blockchain, player tracking, and big data analytics are technologies set to further revolutionise the sports industry in the nearest future. These technologies are already being introduced and implemented in other sectors such as business and banking (Gandomi & Haider, 2015). Although we are starting to see some of these technologies implemented in sports, it is currently in the early stages according to participants.

6.3.2 RQ-2: How does digitalisation enable sports teams to develop learning capabilities and increase their knowledge base?

This research question was aimed at investigating how digitalisation enables sports teams to develop learning capabilities and increase their knowledge base. It is evident that organisations that continue to learn and facilitate the learning of its employees will always remain a cut above the competition. A learning organisation develops as a result of the complexities of modern organisations and allows them to continue to remain competitive in an ever-changing environment (Wang & Ahmed, 2003). The same circumstances operate within sports, due to its dynamic and unpredictable nature, it remains imperative for sport teams to not only win but to keep that momentum constant. Organisational learning capability is the ability of an organisation to process knowledge, in essence, the skill to generate, acquire, transfer and incorporate knowledge, while also altering their behaviour to adapt to new situations with the goal of improving performance (Gomes et al., 2017). Digitalisation has been identified in literature as knowledge enabler that leads to organisational effectiveness in organisations. The findings have revealed that while digitalisation can certainly enable the development of learning capabilities, guaranteed success in terms of knowledge development necessitates the presence of other core elements such as leadership, shared mental models, culture and learning organisation. Nevertheless, digitalisation enables sports teams to develop their learning capabilities and ultimately increase their knowledge, and this process has been detailed and outlined in **Chapter 5.3** using excerpts from participants

and frameworks depicting the transformation process from data to wisdom. The whole process of knowledge creation is fully supported and enhanced by the use of data and technology. Sports teams now use a combination of technologies for collection, analysis and visualisation of data. This data is converted to information which then becomes knowledge when sent to specific player's phone and they start reflecting on it. For instance, the players now receive player specific feedback based on past performances right on their mobile phones or iPads allowing them to access the information when they need it. The information sent to their phones includes opposition analysis, formations, tactics, information about other players relative to their positions. This allows teams to develop new and deeper understanding, knowledge and experiences. These experiences are altered over time to keep up with the ever-changing and unpredictable nature of sports. Moreover, utilising this knowledge effectively will be dependent on the players ability to self-reflect and take on board the information. This no doubt points to the role of the coach in this process, the coach must have the capability of catering to different learning styles and ensure that the players are put at the forefront of learning to help them hone their abilities.

Although, digitalisation is not a panacea for improvement, its importance is irrefutable, particularly the nuances it brings to the sports industry, especially when all-important elements such as learning organisation and culture are taken into cognisance congruently.

6.3.3 RQ-3: How does digitalisation influence on-pitch decision-making abilities of players and coaches?

This research question aimed to investigate how digitalisation influences on-pitch decision-making of players and coaches. Decision-making aptitude is very essential for successful performance in several complex and ever-changing situations (Van et al., 2016). Following on from the above discussion of RQ-2, it is evident that knowledge creation is not the final process but rather the means through which the final goal can be achieved. The final goal for most sports teams is to improve performance and enhance decision-making. Sports is a domain that provides an extraordinary setting for the study of decision-making due to what is referred to as '*decision agents*' such as coaches and players. Consequently, this research question is an important one, as it has been suggested that good decision-making equals better performance. Previous research investigating decision-making and observational accuracy of coaches discovered that coaches only recall 59.2% of key factors accurately during matches, while also formulating unintentional bias

(Laird & Waters, 2008). This has no doubt stimulated the need for an objective way of analysing match events. Data and technology now influence coaches and players decision making processes in a massive way. For instance, video clips are presented to the players individually and as a team and contains key decision-making moments during the game. This particular exercise introduces a line of questioning where the coach might ask a player or the team the reasoning behind certain decisions they may have made. These video clips help instigate and incite the team's memory and forces evaluation and reflection of their own performance. Additionally, sports teams now use sophisticated video technology which allows coaches and players to basically “play”, “pause” and “rewind” key moments of game in an interactive manner, where coaches can use 3D technology to recreate the key moments. This technology enables coaches to identify individual player performance while also being able to accurately drill down to the details of the rationale behind certain decisions the players may have made or not made. The video clips and data shown to the players forms the basis for the development of their decision-making processes.

The findings revealed that Intentional or unintentional bias is an issue that is usually present in sports. This bias whether intentional or unintentional can often lead the coach to make decisions in a way influenced by intuition and previous experience, and as a result create a misconception of what players should be achieving, even though it's unrealistic. As the coach is tasked with developing the overall strategy and philosophy, if this is flawed, the players reasoning and subsequently their performance will be affected because they often have to do as they are told in many situations. Although, bias and gut instincts can never be fully replaced by data and statistics, more objective performance data will go a long way in illuminating and providing an accurate depiction of player performances, and this will no doubt form the basis for more informed decision-making processes. Furthermore, data and technology has introduced elements of clarity for the coaches and the players. The importance of removing misunderstanding and enhancing clarity can't be downplayed, data and technology enables constructive discourse between the player and coach. A model developed by Awasthi & Varman (2003) towards studying the influence of information technology on decision-making within business sector has proven effective in exemplifying the influence of digitalisation on decision-making processes of players and coaches in sports.

6.4 Conceptual Framework - Effective Utilisation of Data & Technology

The goal of this section is to provide a final conceptual framework based on the findings. Drawing from the evidence based presented within this thesis, this framework will identify the factors which have potentially the most impact when implementing a sports analytics programme. Additionally, it will showcase all the key elements that must be present to ensure successful implementation and utilisation of data and technology.

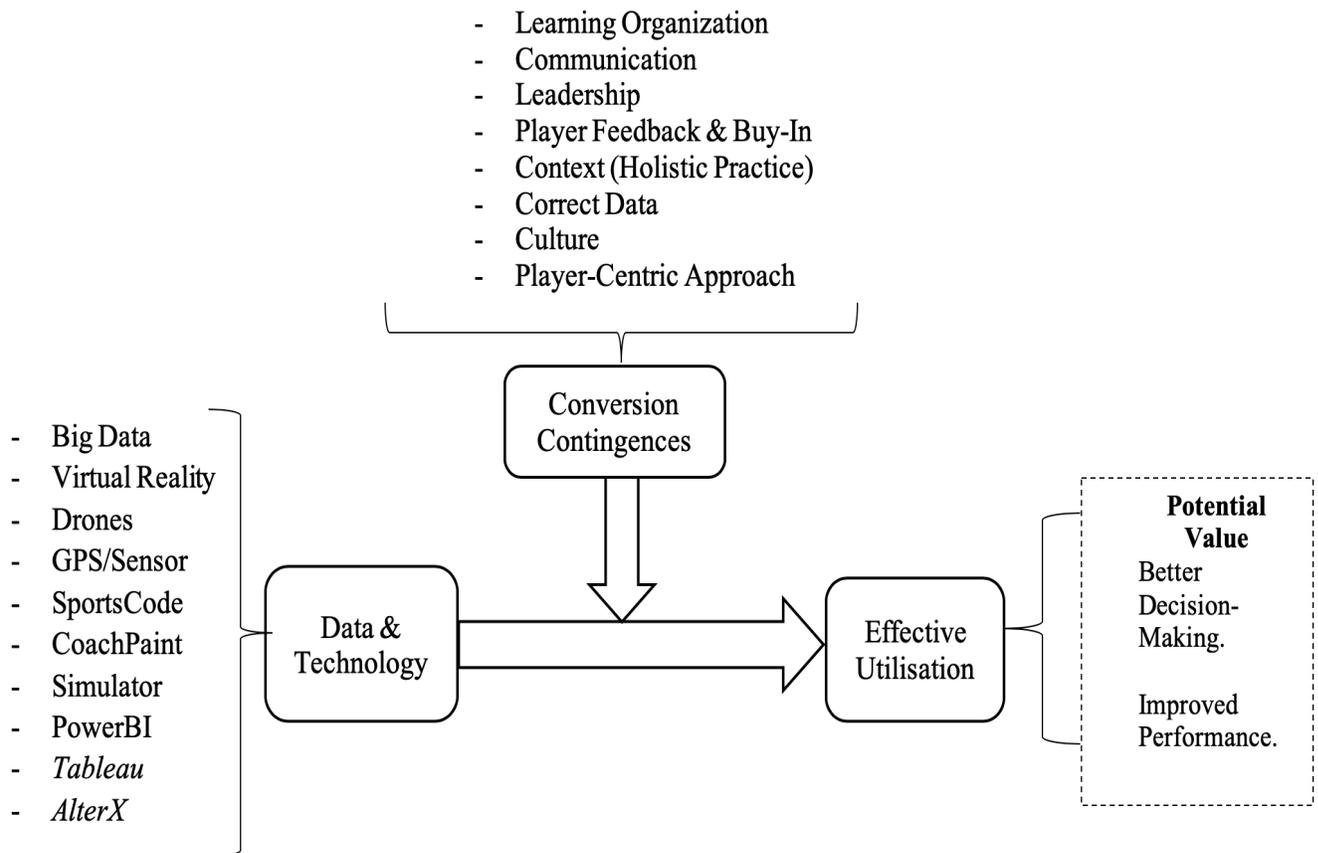


Figure 47 - Effective Utilisation of Data & Technology

The framework in figure 47 above is partially adopted from Caya & Bourdon's (2016) framework for value creation but has been totally revamped and improved on through the findings and discussion of this study. From the conceptual model above, the three main elements are: data and technologies, conversion contingences and effective utilisation. Additionally, the potential value that can be obtained from this framework has been highlighted as well.

The software programs and technologies identified are specific ones currently being utilised by sports teams and based on the findings and the enthusiasm of the participants it can be assumed that the technologies are the most effective among a sea of technologies currently in supply within the sports industry. Benjamin Alamar who wrote a book titled “*Sports Analytics: A Guide for Coaches, Managers, and Other Decision Makers*”, stated that teams today are now inundated with the data captured and produced by sport data companies, and have very little idea what to do with it. Consequently, it is important for sports teams to know the right software programs and technologies to invest in for maximum value. For instance, the findings have revealed that tools such as PowerBI and Tableau are used to visualise data after which game tactics, specific feedback and other pertinent information are sent to players through an app on their phone.

The conversion contingences are the internal and external factors that can potentially affect positively or negatively the implementation and subsequent utilisation of data and technology (in an effort to improve decision-making and performance) depending on the stimulus applied. Giving ample attention to the conversion contingences could mean the difference between the effective utilisation of data for the purpose of improved performance and the utter failure of the entire programme. The findings of this study have indicated that the fundamental aspects of the implementation of data and technology includes but is not limited to elements such as learning organisation, communication, leadership, player feedback and buy-in, context (holistic practice), correct data, culture and player-centric approach. All the aforementioned elements are related and dependent on one another. The most important, however, is the culture, the culture of the sports teams in terms of data and technology utilisation, the culture in terms of learning, the culture in terms of leadership and also communication. Organisational culture not only defines the team’s internal and external identity, but it is important to the overall success of the team in terms of utilisation of data. Furthermore, learning is a central tenet crucial to the success of organisations, especially sports organisations, given the fact that sports is renowned for its unpredictable and volatile environment. In order for teams to win trophies and stay competitive they must become learning organisations and inculcate the habit of learning. The findings revealed that sports teams now facilitate the learning of their players and even put them at the forefront of data and technology utilisation by allowing them to conduct their own analysis. This particular approach empowers the players and gives them a sense of purpose and motivation to want performance improvement. Further to this point, previous research by Caya & Bourdon (2016) identified data driven mentality

by coaching staff and openness to change and experimentation as important factors that have to be present for effective implementation and utilisation of data and technological tools. This makes it vital to get buy-in from players and the coaches before utilisation can be successful. The findings of this study indicated that coaches are now progressive towards the use of data, although there are still some coaches who prefer to rely on their gut instincts and experiences. They perceive data as a threat to their knowledge and see it as something that undermines their authority. This culture is rapidly changing as coaches and players now fully understand the benefits data and technology offers. Consequently, in order for the sports analytics programme to be a success, the key stakeholders (players and coaching staff) have to be on board with using data and also have the impetus and belief that it actively helps them from day to day. Participants were quick to emphasise that data is the foundation for everything they do and underlined the importance of having correct data to base decisions on. Otherwise there will be a culture of “*we can't trust data*”, which will be detrimental to the success of the club in terms of their pursuit of competitive advantage through data and technology. However, it is important to highlight that data should never be used in isolation, there should be harmony between the data element and human element in order to have a holistic practice. Additionally, the findings have demonstrated that solely relying on data could be an issue, as there are other factors to be considered, such as the overhead conditions, location, field conditions to mention a few in sports like cricket and rugby. Therefore, it is important to take into consideration other external factors thereby creating a holistic picture of what to expect at a certain stadium when playing an opposition.

The researcher strongly believes that implementation taking into cognisance the conversion contingences should help realise the potential value, which will include better decision-making and improve performance. The “effective utilisation” element highlighted in the framework is arguably the most important element. Having put in place the aforementioned software programs and technologies and also taken into cognisance the conversion contingences, the sports team now has to put it into practice and adapt the model to their current team philosophy.

Table 13 highlights best practice area and corresponding activities that must be followed to ensure successful implementation.

Table 13 - Framework for Effective Utilisation

Best Practice Area	Key Activities/Key Questions
Team Dynamics and Culture	<ul style="list-style-type: none"> Coaching staff, managers and all other relevant stakeholders must have progressive thinking and inculcate an evidence-based approach.
Personnel	<ul style="list-style-type: none"> It is essential to have team of data experts that can generate accurate analysis.
Data Analysis & Reporting	<ul style="list-style-type: none"> Focus should be placed on analysing only relevant data. Can be lost in data. Limit the number of people who have access to data, as this can cause data fishing.
Goals & Philosophy	<ul style="list-style-type: none"> How can analytics contribute to achieving it? Is it contributing? Is our philosophy working? Reevaluate.
Player Development	<ul style="list-style-type: none"> Coaching staff should take time to help players understand value of analytics. – Get Buy-in Data makes it easy to criticise players, rather than criticise players ask them for their reasoning behind a decision and explain the process.

6.5 Main Conclusion of the Research

This research aimed to investigate evolution and possible future of digitalisation in the sports sector, with a focus on its influences within on-pitch decision-making and also how it enables knowledge development and dissemination within a team. A set of objectives and research questions were formulated in an effort to achieve the aforesaid aim. **Section 6.3** of this chapter outlined the research question and proffered answers to the questions based on the discussion in **chapter 5**. The resulting framework from the findings and discussion has also been presented in **section 6.4**.

6.6 Recommendations

The nature of sports necessitates the need to continue learning so as to keep up with this rapidly developing sector. Congruently, the findings of this study have indicated that data and technological innovations will continue to evolve within sports, making it imperative for sports teams to have strategies in place to keep up with this rapidly developing phenomenon. The framework presented in **section 6.4** certainly provides sports teams with a good starting point in terms of effective utilisation. They should implement the framework and use it around their current team philosophy and principles. However, it is equally important for sports team to keep working and adjusting the framework.

6.7 Review of Contributions

This thesis aimed to make a number of contributions which fall into the following categories: contribution to knowledge and contribution to practice. **Chapter 3.14** of this thesis identified and highlighted the types of contribution strategies in research (Nicholson et al., 2018), and further outlined which strategies the researcher aimed to use in explicitly stating the contributions of this thesis. The researcher believes that incremental (*neglected area*), revelatory (*using multiple lenses*) and consolidatory (*traditional literature reviews that advance knowledge*) are contributions strategies applicable to this thesis. Further explanation of these will be proffered below using the contribution to practice and contribution to knowledge categories. Explanations of these terms have been provided in **chapter 3.14**.

6.7.1 Contribution to Knowledge

The present study contributes towards the continuing discourse of digitalisation utilisation within the sports industry. This study falls into the category of consolidatory contribution, more specifically, the researcher believes that the traditional literature review conducted in this thesis advances knowledge by way of summarising the current trends and presenting multidisciplinary approaches. This study answers the call for more qualitative approach within the realm of sport analytics and performance analysis (Wright, 2015, P. 113), this approach proved to be effective and rewarding in providing a unique insight and adding knowledge to the academic field. The study also follows an incremental contribution strategy, specifically, a traditional gap spotting approach by way of reviewing pertinent literature to identify gap and effectively embed the thesis

within the existing literature. Horrocks et al. (2016) postulated that the sports industry is reaching a plateau in terms of physical fitness (measuring performance), and there is a pressing need to better understand the acquisition of decision-making abilities. Moreover, James (2006) postulated that there is very little research investigating how data and technology influences decision-making abilities of coaches and how it impacts the players. Therefore, this research makes a defined contribution by answering the call of previous research, and advances understanding of decision-making within the sport sector. Additionally, this study involved the collection of data from elite clubs in the English Premier League, Championship and Rugby League, thereby allowing for the generation of rich findings.

This study also falls into the category of revelatory contribution, more specifically, it employed multiple lenses in an effort to explicate the research questions. This research draws from the operations management body of knowledge and it borrows the learning organisation management theory. As there is a dearth of literature investigating on-pitch sports from a learning organisation theory perspective, this study makes a contribution by starting a discourse within this untapped area and paves the way for more discussion. Furthermore, the unique findings generated through employing this theory led to understanding of sporting organisations as learning entities.

6.7.2 Contribution to Practice

This thesis made a defined contribution to practice, firstly by presenting information on how digitalisation has changed the sports ecosystem and the current technological practices within sports such as football, cricket and rugby, while also identifying current best practices. The rate at which digitalisation is growing in sports necessitates the need to fully understand it so sports stakeholders can effectively utilise it. Alamar (2013) stated that it is imperative for sport organisations to better understand analytics techniques, approaches, and also discover how to incorporate it into their operations and policies. Sport teams who do not embrace and practice analytics successfully are at a risk of falling behind. However, as accentuated by Maxcy & Drayer (2014), implementing and utilising analytics is not a direct and easy process, there are some challenges and the sport industry has much to learn. Majority of sport teams encounter a series of challenges while introducing and using data analytics to inform their practice. The findings of this study also confirm this, as seen in **chapter 4.7**. Consequently, this thesis makes a defined contribution by way of identifying current best practices which will enables sports to learn and

adapt their practices. Furthermore, the conceptual framework presented in **chapter 6.4** will show sports stakeholders the most effective technologies, the conversion contingences to be aware of during the implementation and utilisation and finally the value that can be potentially realised. The researcher believes that this conceptual framework will allow directors, managers, coaches and even players to effectively utilise data and technology. There is a dearth of academic research investigating this recent phenomenon. The thesis makes a well-defined contribution by influencing sports policy makers and certainly club managers. Additionally, this research has given insight into the future of sports with regard to data and technology utilisation. The researcher believes that this unique look into the future of sports will enable sports teams to anticipate emerging technologies and as such have strategies in place to not only implement and utilise them but to also be conversant with which technologies are applicable to their need and suitable to their overall team strategy and philosophy.

6.8 Research Limitations

This section presents the main limitations of the thesis with regard to the participant sample, research instrument, data collection and the analysis of the researcher. Firstly, the sample used for this study included: Sport Directors, Managers, Head Coaches, Players, Performance Analysts, Medical Staff and also Sport Data Companies. As stated in **chapter 3**, the sample was selected using convenience and snowball sampling approach. The goal of the researcher was to provide rich and comprehensive findings, consequently a qualitative approach was used which allowed for presentation of quotes to demonstrate the main themes. Nevertheless, it is important to note that the data was collected from sports teams predominately in the United Kingdom which makes it difficult to generalise the findings to other context and countries such as the United States, Germany and France. It can be argued that the aforesaid countries are also at the forefront of digitalisation, with its inception being traced back to the United States.

Secondly, this research only focused on three main sports; football, cricket and rugby. Although the reasoning for focusing on these sports have been stated in **chapter 3**, it would have been beneficial to include other sports such as basketball and hockey, thereby allowing for more extensive cross analysis between sports. Further to this point, an investigation into different sports would lend itself to a case study approach, consequently, this is another limitation of the study.

Thirdly, in the data collection phase, the researcher interviewed participants from the

above-mentioned positions within sports and this no doubt led to the generation of rich findings and a subsequent enthralling discussion, however it would have been valuable to include more coaches and players in the sample thereby allowing more comprehensive understanding of the decision-making element of the research.

The final limitation is that there is no “*one size fits all*” approach to conducting research, as such it is important to recognise that the outputs from this research such as the final conceptual model presented in **section 6.4** of this chapter will need further studies and results to increase its credibility. Evidently, development in this area grows really fast making it plausible that there may be further themes not identified from the participants of this research that could have potentially made the findings richer.

6.9 Recommended Future Research

Having discussed the limitations of this research in **section 6.8** above, this section will now outline and discuss potential future research areas in an effort to further this study and by so doing add more credibility to this research.

Firstly, previous research by Wright (2015, P 113) revealed that research within the realm of sports analytics and performance analysis have a propensity to focus on quantitative element thereby employing the positivistic paradigms. An important area for future research would be to provide further qualitative studies in this field investigating the practices of different sports including basketball, hockey and netball using a case study approach. The researcher believes that a case study approach can potentially allow for cross-case analysis thereby producing new knowledge in this field regarding utilisation of data and technology for performance and decision-making improvement.

Secondly, previous studies have indicated that decision-making in sports seems to be an untapped area, which was one of the motivations of this research. The findings of this study also corroborated this, with participants stating that decision-making has always been neglected possibly because injury monitoring has been the main focus. Although, the researcher strongly believes that the findings of this study have proffered a unique look into decision-making in sports with regard to data and technology utilisation, there is a need for further research to investigate this area and involve more players and coaches in the sample size.

Lastly, the conceptual framework provided in **section 6.4** will certainly go a long way in informing and educating sports stakeholder about successful utilisation of data and technology within their practice. This is applicable to potentially all sports; however, there is a need for further research to not only enhance the framework but to test its applicability to all sports teams apart from those considered in this research.

6.10 Final Reflective Commentary

This PhD thesis has given the researcher the opportunity to combine his interests of sports and information technology in order to develop expertise in the field of sports analytics and performance analysis. Throughout the course of this PhD research, the researcher has gained significant practical and theoretical knowledge about sports in relation to the use of data and technology, operations management concepts, research methodologies, project management and problem-solving techniques. Furthermore, the researcher has learnt a lot about the importance of consistency and perseverance in overcoming challenges and difficulties that might arise when conducting research and in life.

6.11 Chapter Summary

This final chapter has summarised the entire thesis. It has also provided a section on the researcher's reflective commentary and experience acquired throughout the course of this project. The chapter has succinctly discussed each research question addressed in the project. The contributions, limitations, recommendations and suggestions for future research has also been discussed.

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Appendices

Appendix A Letter of invitation to participate in a research project



LETTER OF INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

Project Title: Evolution and Future of Sports with regard to Data and Technology.

My name is Olatunbosun Olaniyan and I am a PhD student in the Business School at the University of Huddersfield, UK. I am conducting research to investigate the evolution and future of sports with regard to data and technology utilisation, from an on-pitch perspective. The sports industry has seen exponential growth over the last 20 years, the most evident of which is the capability to use technology to improve performance and decision-making. So, I am interested in predicting how sports will evolve from a data and technology perspective, seeing as how they are quite predominant and applicable in almost every sector.

I would like to meet with you to discuss the use of big data and technology in your sports and understand your opinion regarding its future direction. I envisage the interview will last between 40 minutes to 1 hour. In exchange, I will be able to provide you with an executive report summarising the key findings, highlighting current best practices across sports and recommendations for the industry going forward.

If you decide to participate, an interview would be arranged at a time and place of your convenience. I will collect some personal data from you such as your educational background. The information will be kept private and confidential. You will be given a false name and identifiable information will never be used in a publication or presentation. This is a personal research for academic purposes and is not connected with the government. Participation in this research is completely voluntary and you may choose to withdraw from the research at any time or not answer questions that you do not feel comfortable answering.

The participant information form and consent form have been attached for your purposes. If you have any further questions about the research, please feel free to contact me via details provided below.

Thank you,
Olatunbosun Olaniyan
Researcher
Email: Olatunbosun.Olaniyan@hud.ac.uk
University of Huddersfield, United Kingdom.

Appendix B – A sample of a signed consent form

The image below is presented in an effort to show one of the consent forms signed by a participant. However, identifying information in the image has been blurred to maintain anonymity and confidentiality of the participant.

The University Of Huddersfield
CONSENT FORM

Title of Research Project:
Sport data analytics and technology utilization within [REDACTED]

I have been fully informed of the nature and aims of this study as outlined in the Information.	<input checked="" type="checkbox"/>
I consent to taking part in the study.	<input checked="" type="checkbox"/>
I understand that I have the right to withdraw from the research.	<input checked="" type="checkbox"/>
I understand that no person other than the researcher/s and facilitator/s will have access to the information provided	<input checked="" type="checkbox"/>
I understand that my identity will be protected by the use of pseudonym in the report and that no written information that could lead to my being identified will be included in any report.	<input checked="" type="checkbox"/>

If you are satisfied that you understand the information and are happy to take part in this project please put a tick in the box aligned to each sentence and print and sign below.

Signature of Participant: <i>[Handwritten Signature]</i>	Signature of Researcher:
Print: [REDACTED]	Print: OLATUMBOSHA OLANIYAN
Date: 10 May 2017	Date: 10-05-20[REDACTED]

Appendix C - Ethics Approval Email

Searching "Inbox" - All Accounts Ethics approval

RE: POSTGRADATE RESEARCH STUDENT ETHICAL FORMS - BUS**ETHICS**17/18:019

Alex Thompson
Wednesday, February 21, 2018 at 3:28 PM
Olatunbosun Olaniyan (Researcher); + 1 more
[Show Details](#)

Reviewer Proforma -... 43 KB Reviewer Proforma -... 22.6 KB

[Download All](#) [Preview All](#)

You replied to this message on 2/22/18, 8:55 PM. [Show Reply](#)

Dear Olatunbosun,

I have been asked to forward the following to you:

Following consideration of the two reports from the reviewers, the decision is to approve subject to recommendations.

The recommendations are:

1. In the Participant Consent form, the number of years that the collected information will be kept in the university needs to be stated.
2. Avoid providing your personal contact details (i.e. mobile number) where possible. (re-Letter of Invitation)

Best Wishes,

Dr Andrew Jenkins
Chair of the Business School Research **Ethics** Committee

Attached are the comment forms from the Reviewers.

Regards,

Appendix D - Interview Guide

Interview Questions

A. Background Questions.

- Could you please tell me a bit about your role and responsibilities at the club?
 - How long have you been at the club?

B. Questions on Sports Environment and Evolution with regard to data and technology use.

- What major changes do you your particular sport industry has gone through over the last 10 years.
 - What are some of the factors that you think influence the aforementioned changes?
- The use of data and technology in sports has increased over the years, what has been the highlight for you?

C. Questions on Data Analytics

- Do you have a definition for sport analytics?
 - What do you feel it brings to the sports industry?
 - What effect has data and analytics had on your sports particular over the last few years?
 - How much impact is analytics having on athletes?
- Are you familiar with the Moneyball era? Do you the feel it was the driving force behind clubs being more data driven? Or it is something else?
 - How far do you think we've come since then?
- When was data analytics first implemented at the club? What was the reason behind that? What do you use it for?
 - So, what's the main the things you are working towards?
- Are you familiar with the different types of analytics?
 - Do you use descriptive, prescriptive, diagnostic or predictive analytics?

- Are the players involved in the data analytics process? When? how is feedback given? (during the match, halftime or after the game) what actions are taken based on the feedback?
 - How do you feel that helps them prepare for the next match/game?
 - Do you feel the learn from the data?
- How do you get players to digest all the information being given to them, to the point where they are able to use it instinctively on the pitch?
- Do you consider information overload a problem for players?
- Could you tell me some of the key challenges the club experience in terms of data analytics use?
- Do you feel you can fully rely on data? What are some of the factors that you feel should be taken into consideration first?
- How would do describe the coaching culture within your professional sport?
 - What do you say to people that believe there is a traditionally cautious application of analytics?
- How advance do you feel the club is in terms of its analytics use?
 - What else can be done?
- What would you say is the most important aspect of any sport analytics program?

D. Questions on Big Data

- Do you feel big data is being used in the sports industry currently or it is all just small data?
 - How is big data being used in sports? What are some of the applications of big data you have come across? Can you give some examples?
- How is big data utilized in your club? Can you give some examples?
 - What are the main reasons for investing in big data?
 - How is that data collected? How are the data analysed? What are the resources you have available?
 - Do you use the data to develop some sort of predictive model?
- So, are big data and data analytics different? What are the differences?
 - How do you define big data?

E. Question on Technology

- Could you tell me about some of the technologies that are making waves in the world of sports right now? ~~I hear some teams have started using VR and even Drones during training.~~
- How important do you think collaboration between clubs and technology company is when developing new products.
- Could you tell me about some of the Technology/software you use to collect data?
 - What about in terms of analysing and presenting the data?
 - How streamlined do you feel the whole process is?
 - What could be done better?
- What are your thoughts on virtual reality and augmented reality.
 - Do you feel it can influence aspects of decision making and to what extent?
- What challenges do you face when collecting, analysing and presenting data?
- There has been talk of technology making it easy for players to be held accountable for their actions on the field, do you see that as a good or bad thing?
- Do you feel data and technology can help improve a player's decision-making abilities?
- What do you perceive as the major opportunities of using technology in sports and what are the major constraints?

F. Questions on Performance & Decision Making in Sports

- How do you define performance and decision making in sports context?
 - How importance are these factors to any sport endeavour?
- I hear a lot about of metrics and KPI's, do you use it?
 - What is the process of creating metrics and how effective would you say it is?
- In sports performance, talent, health management and coaching are really vital, do you agree with this and are their other important factors?
 - What other factors do you think influence sports performance.
- Can you describe the different set of decision in sports?
- How important would you say decision making abilities is to any sporting endeavour?
 - Do you feel big data and technology can help in developing decision-making abilities? How?

- How do you feel the data you collect influences the team's strategies and performance on the field?
- Are there opportunities for players to improve their knowledge of the game? How?
- What is your decision-making process like?

G. Question on Future of sports

- What direction do you see the sport industry going, are there going to be more improvements in the future?
- How far do you think sports analytics will go?
 - What do you envisage will happen in the future? Any drawbacks?
 - Is there going to be a sport revolution similar to industry 4.0 IOT (Business)

Appendix E – Framework Analysis Coding Using NVivo 12 - Coding Framework

The image below is presented in an effort to show the coding process using NVivo 12. However, identifying information in the image has been blurred to maintain anonymity and confidentiality of the participants.

The screenshot displays the NVivo 12 software interface. The top menu bar includes Home, Create, Data, Analyze, Query, Explore, Layout, and View. Below the menu is a toolbar with various editing and analysis tools. The main workspace is divided into a left-hand navigation pane and a right-hand content area.

Left-hand navigation pane:

- DATA:**
 - Best Practices (18 files, 92 references, created 11/6/18, 10:54 AM)
 - Data & Technology Util... (11 files, 38 references, created 11/14/18, 6:01 PM)
 - Player Data Overload (5 files, 7 references, created 11/12/18, 6:22 PM)
 - Sports analytics progra... (12 files, 36 references, created 11/7/18, 3:23 AM)
 - Communication (5 files, 8 references, created 12/4/18, 3:57 PM)
 - Consistency (1 file, 4 references, created 4/18/19, 12:52 AM)
 - Human Element (1 file, 1 reference, created 1/14/19, 4:57 PM)
 - Player Buy-In (1 file, 1 reference, created 3/25/19, 4:54 PM)
 - Presentation of Data (1 file, 1 reference, created 4/18/19, 12:57 AM)
 - Reliable Dataset - R... (2 files, 3 references, created 4/14/19, 6:30 PM)
 - Skill Set (1 file, 2 references, created 4/16/19, 7:12 PM)
 - Specific Data (1 file, 1 reference, created 4/17/19, 6:33 PM)
 - Big Data (16 files, 36 references, created 11/6/18, 12:27 PM)
 - Challenges & Drawbacks (21 files, 77 references, created 11/6/18, 8:49 AM)
 - Current Practices and Util... (19 files, 245 references, created 11/5/18, 5:10 PM)
 - Contrast between Spor... (1 file, 1 reference, created 11/6/18, 9:09 PM)
 - Cricket (1 file, 9 references, created 11/5/18, 5:11 PM)
 - Football (17 files, 227 references, created 11/5/18, 5:11 PM)
 - Rugby (2 files, 7 references, created 11/5/18, 5:11 PM)
 - Data and Technology Cav... (15 files, 67 references, created 11/6/18, 8:51 AM)
 - Defining Decision Making... (6 files, 14 references, created 11/21/18, 2:39 PM)
 - Defining Sports Analytics (19 files, 28 references, created 11/5/18, 4:38 PM)
 - Downsides of Digitalization (2 files, 3 references, created 1/14/19, 6:20 PM)
 - Effectiveness of Digitaliza... (5 files, 5 references, created 11/6/18, 9:12 AM)
 - Factors that influenced Di... (18 files, 46 references, created 11/6/18, 10:36 AM)
 - Future of Sports (20 files, 98 references, created 11/6/18, 10:14 AM)
- CODES:** Nodes
- CASES:**
- NOTES:**
- SEARCH:**
- MAPS:**

Right-hand content area:

The content area shows a text reference with the following structure:

- Reference 1:** 0.92% coverage. The text is partially obscured by a redaction box.
- Reference 2:** 0.46% coverage. The text reads: "So it's a positive time to be there and the academy works in exactly the same way, we have numerous academy players that are employed and engrained into that process and introduce them to that process throughout the club we are lucky that we have analysts fu team al the way through the age groups now, plus they are good intern programme that enables us to provide a watered down process of as you go through the age groups."
- Reference 3:** 0.52% coverage. The text reads: "But I think at the same time I think they aren't quite aware of exactly how that can relate a performance and i think sometimes player need educating more of how that is relative"

The bottom of the interface shows a breadcrumb trail: CODES > Nodes > Best Practices.