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Enhancing on-pitch learning capabilities with data analytics and technologies in elite sports

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ABSTRACT

Research question: We have explored the utilisation of data analytics and technology in elite sports and the role it plays in enhancing on-pitch learning capabilities. In the competitive, complex, and dynamic professional sports environment, margins are small and critical for the success of a team or club. It is essential for sports organisations to keep learning individually and collectively to strengthen their ability to improve on-pitch. In this paper, we explore how data analytics and technology enable sports teams to develop learning organisation capabilities to add-value on-pitch by increasing their knowledge base.

Research methods: Data for this study were gathered through 33 interviews with elite sport industry experts from football (Premier League, Championship), cricket (First Class County Clubs) and rugby (Rugby League). It includes seven sports directors, 12 managers and coaches, six players and former players, six performance analysts, one member of the medical staff, and one sports analytics academic.

Results and findings: Our findings add to the understanding of players, coaches, and teams as learning entities, and discuss how they capture and transform data into knowledge with the use of data analytics and technology, which is then utilised to inform on-pitch practices and decision making. We provide a blueprint framework explaining how a sport club can add value on-pitch by achieving a learning organisation status, through the use of data analytics and technology.

Implications: This paper contributes towards the continuing discourse regarding data analytics and technology utilisation within the sports industry, in the on-pitch domain. There has been limited academic research published to date on data analytics and technology use in professional sports, particularly with respect to investigating it from a learning organisation theory perspective.

Introduction

The sports sector generates income from sponsorship fees, media rights fees, gate revenues and supporter merchandise, and this income has reached over $83 billion annually in North America (PwC, 2019). In the UK it has become a £20 billion sector, supporting and generating over 400,000 jobs, and has seen exponential development since 2010 (Morgulev et al., 2018; Yang, 2020). One of the most evident changes within the sector is the drive to use data analytics and technology to inform elite sports' performance and decision making (Millington & Millington, 2015). Researchers such as Caya and Bourdon (2016) and Bouchet et al. (2020) have started to shed some light on the utilisation of business intelligence and analytics in sports. However, they respectively stated that: (i) it is still relatively embryonic in sports; and (ii) the technology is mainly applied to off-pitch operations - for instance, to improve ticketing and revenue, sponsorships, fan retention and experience, and merchandising. Having said that, the trend of using analytics for on-pitch activities (training optimisation, injuries prevention, player performances, team tactics, player selection) has grown significantly. First, as a result of improved technological innovations such as GPS, smart sensors, cameras and drones, and second, as sport coaches and players recognise that these innovations can improve aspects of training and performance (Passfield & Hopker, 2017). In this context, on-pitch refers to aspects of player management, player evaluation, game management, injury prevention, tactics decision making, and competition analysis (Davenport, 2014). Our research focuses on the on-pitch domain. This paper explores the utilisation of data analytics and technology in elite sports and the role it plays in enhancing on-pitch learning capabilities. Analytics is defined by Chen et al. (2012), and as cited in Caya and Bourdon (2016, p. 1061), as 'the techniques, technologies, systems, practices, and applications that analyse critical data to help an organisation better understand its processes, operations and performance, in order to make timely decisions.'

One way that organisations are keeping up with constant change is by becoming a *learning organisation*. Research conducted by Zare et al. (2010) identified that a learning organisation has a major advantage as it allows the organisation to learn and transform in order to stay ahead of the competition and also to innovate. It was predicted by Ulrich et al. (1993) that learning organisations would become organisational solutions in the twenty-first century. As per Senge's (1991, p. 3) definition, a learning organisation is one 'where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together' (Malik & Garg, 2020). Furthermore, Garvin et al. (2008) described a learning organisation as a place where individuals continually create, acquire and transfer knowledge, thereby allowing the organisation (aclub in this context) to adapt faster than its competitors to event unpredictability. To improve performance and innovate, organisations must place emphasis on continuous learning and the utilisation of gained knowledge to facilitate individual, team and organisational learning (Watkins & Marsick, 1996; Weldy, 2009). Organisations must now leverage data analytics to drive decision making and improve performance by using quantitative and qualitative analysis (Chen et al., 2012; Holsapple et al., 2014). As far as we know there are no current studies that have reported on the relationships between the learning organisation and data

analytics in sports, particularly regarding the potential role they play in knowledge enhancement (c.f. Rodger et al., 2019).

Caya and Bourdon (2016) suggest that researchers should use defined theories and concepts in studying sports analytics. Applying this logic, the learning organisation theory was chosen to study the phenomena of data analytics and technology in the on-pitch sports settings. The aim of this study is to investigate how data analytics and technology can enable elite sports teams to develop learning capabilities through the analysis of current practices. This is achieved by drawing from the elite team sports context (O'Donoghue, 2014), where elite team sports refer to the highest level of competition with an emphasis on winning prestigious competitions in football, baseball, basketball, ice hockey, cricket and rugby (Manley et al., 2016). This paper focuses on the on-pitch domain of three team sports: football, cricket, and rugby. These sports were selected as: (i) they are the most popular sports within the UK (where the research was undertaken) and globally as per Ben-Porat (2009), Lanzetti et al. (2017) and Pandey (2012); and (ii) the use of data and technology is prevalent and considered to be advanced in these particular sports (Herberger & Litke, 2021; Pantzalis & Tjortjis, 2020), which makes the research both meaningful and timely. Furthermore, the application to the on-pitch domain makes this study novel and contributive. Although the use of data analytics and technology goes beyond the elite sports mentioned above, this paper will solely focus on them to address the posit research question: *How can data analytics and technology enable sports teams to develop learning organisation capabilities as well as increase their knowledge base of the on-pitch domain?*

Theoretical background

Learning organisation theory

Like Senge (1991), Marquardt (1996) defines a learning organisation as one that learns collectively and constantly transforms itself in an effort to improve the collection, management, and utilisation of knowledge for organisational success. The literature makes a distinction between learning organisation and organisational learning. Easterby-Smith defines organisational learning as 'the process of individual and collective learning that takes place within an organisation, in contrast, the learning organisation focuses on methods and tools to evaluate and improve the quality of learning processes within an organisation' (Weldy, 2009, p. 60). Consequently, a learning organisation is perceived as one with a cultural characteristic or archetype form that is nurtured to emulate learning process improvements.

Several studies have contributed to the learning organisation debate. Notable concepts include Senge's (1991) The Fifth Discipline, Pedler and Aspinwall's (1999) Learning Company Model and Argyris and Schön's (1997) Double-loop Learning. The implementation of learning at the organisational level is mainly conditioned as a collective of individual learning, training, and development (Wang & Ahmed, 2003) with individual learning playing a significant role within the concepts and practices of the learning organisation. The learning process of individuals in an organisation then serves as the foundation of a learning organisation. Nevertheless, individual learning does not automatically lead to a learning organisation (Ikehara, 1999), as it is the responsibility of

the organisation to incorporate individual learning into learning organisations (Chiva et al., 2014). According to Templeton et al. (2002) learning organisations aim to adapt their processes via specific and detailed activities and artefacts, enabling them to respond to unanticipated situations more quickly than their counterparts (Garvin et al., 2008). A review conducted by Wang and Ahmed (2003) identified five main focuses of learning organisations: (i) knowledge management (KM); (ii) continuous improvement (CI); (iii) collective and individual learning; (iv) processes and systems; and (v) culture. These are the suggested essential elements that organisations need to develop to thrive and sustain in complex environments. These features form the foundation of our conceptual model in Figure 1, which is presented later.

Role and challenges of data analytics and technology in sports learning organisation capacities

It is suggested that in the on-pitch domain, data analytics and technology have a role to play in the process of improving performances and learning capabilities (Mikalef et al., 2020). A learning organisation is perceived as one where individuals consistently develop their ability to create the results they want, and where individuals are continually learning to learn together (Senge, 1991). These capabilities are developed in the on-pitch domain by empowering players and encouraging them to be at the forefront of learning (c.f. Wright, 2015) by analysing and reflecting on their performance data (Passfield & Hopker, 2017). Recently, through technologies such as 'sabermetrics', simulation, analytics, augmented reality, virtual reality and other tools such as sensors, drones, and GPS, teams have gained access to a large amount of 'new' on-pitch data. Researchers and scholars alike have therefore called for further investigation of data analytics and
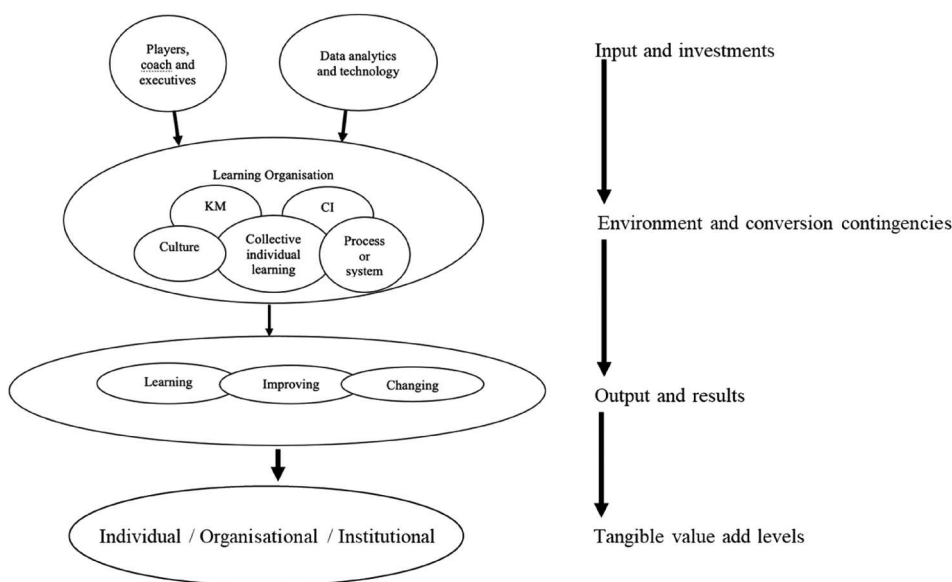

Figure 1. Learning Organisation conceptual model for understanding learning capabilities and data analytics in sport.

technology utilisation in sports from an on-pitch perspective (Caya & Bourdon, 2016; Seshadri et al., 2021; Xiao et al., 2017). This paper focuses primarily on exploring how the integration of data analytics can help facilitate elements of a learning organisation.

Despite evidence of impressive activity and development, the utilisation of analytics in sports is not without its challenges. Maxcy and Drayer (2014) suggested that implementing and utilising analytics was not a direct and easy process, and the sports industry has a lot to learn. Some of these challenges revolve around culture, cost and finding staff with the right skillset (Davenport, 2014). Culture acts as a key enabler and appears to play an important role in the adoption and utilisation of these technologies (Upadhyay & Kumar, 2020). For example, even when there is abundant data to base decisions on, some coaches may not employ them and would rather rely on intuition and experience. Furthermore, Davenport (2014) explained that some sports clubs do not fully exploit data analytics due to the large financial investment required to acquire and implement the technology and the lack of analytics experts.

Data analytics in sports – the literature gap

There are many ways in which organisations achieve innovation and knowledge improvement, however, data analytics is one of the most effective tools (Saqib & Satar, 2021). Although the utilisation of data in sport dates back over 50 years, it can be said a data revolution came after what is referred to as the 'Moneyball Era' when the use of data and statistics to inform practice began to be defined. Michael Lewis' novel Moneyball (2004) shares the exploits of the Oakland Athletics in Major League Baseball (MLB). The book was a catalyst, which led many sport organisations and clubs to embrace similar techniques (Stewart et al., 2007). Sport has changed enormously over the last couple of years and while 'Moneyball' and 'sabermetrics' set some of these changes in motion, multiple factors continue to influence data analytics in sport (Alamar & Mehrotra, 2011). Gerrard and Alamar (2014) defined sport analytics as: (i) the management of structured historical data; (ii) the application of predictive analytic models; and (iii) the use of information systems to inform decision makers and enable them to help their organisations in gaining a competitive advantage on the field of play. Costa et al. (2019) explained that the use of 'sabermetrics' to compare baseball players has increased exponentially in recent years. A review of the literature suggests that there has been a recent increase in the utilisation of data analytics and technology being used on the pitch within the sport ecosystem (Kapadia et al., 2020; Luczak et al., 2020; Seshadri et al., 2021).

Sport stakeholders, such as players and coaches, recognise the benefits that quality data can provide with regard to on-pitch informing decision making (Passfield & Hopker, 2017). Xiao et al. (2017, p. 9) state 'information such as the level of physical skills of certain players, players' performance data and teams has become increasingly accessible, traceable, and visible' to the players and coaches. One of the primary advantages of amassing data in professional sport 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., 2008). This allows players and coaches to be well prepared and devise a strategy to counteract the opposition, neutralise threats and exploit weaknesses.

Maxcy and Drayer (2014) conducted a study using a case study approach to evaluate the current state of analytics in the sport industry, with a focus on competition analytics and business analytics. The authors postulated that the interest and use of data analytics vary from one sport team to the other and it is important that sport teams possess a comprehensive understanding of these approaches. Francis and Jones (2014) indicated that rugby players recognise the value of performance analysis regarding preparation for games and long-term development and the authors suggested it was imperative for coaches to use various methods of delivery to accommodate different learning styles within the team and to promote engagement. Caya and Bourdon (2016) proposed a framework underscoring the significance and value of business intelligence and analytics in the sport industry. Their proposed framework highlights three main premises: (i) the value of analytics and technology can be observed at different levels; (ii) there is a 'locus of value', which refers to the primary level at which the value add can be measured: individual, organisational or institutional; and (iii) the outcome of the data analytics and technology are influenced by cultural and internal and external factors or 'conversion contingencies', which moderate the impact and value. They proposed that business intelligence and analysis tools such as data analytics are useful but also that 'conversion contingencies' such as top management, user openness to change and experiment, overall technology literacy and competitor actions significantly impede the implementation and value generated. Hence, the authors postulated that their framework is a useful starting point in elucidating the 'how' and 'where' analytics and technology are most effective in creating value for elite sport teams. Caya and Bourdon's framework was initially published in conference proceedings but has subsequently informed many doctoral thesis and other publications. It is being cited by relevant work published in a variety of peer reviewed journals (e.g. Akbar et al. 2018; Bouchet et al., 2020; Julio et al. 2018; Kamal et al. 2019). They emphasised and called for a need for future studies to not only test their developed framework but also to take a holistic approach to investigate the process of value creation in the sport industry. They further stated that some scepticism still existed in the sport industry about the actual value of data analytics and technology. This can be attributed to the fact that some argue that analytics in sport was introduced by those who are knowledgeable about statistics and analytics but have little knowledge about elite sports and their unique culture.

Despite the debate around sport data analytics and an increase in academic interest, no research appears to exist that investigates on-pitch sports analytics from a learning organisation theory perspective. Consequently, this study investigates how data analytics and technology can enable sport teams – specifically professional football, cricket, and rugby teams – to develop learning capabilities, in an effort to fill the identified gaps in the literature.

Conceptual model development

The framework in Figure 1 shows our developed conceptual model for understanding learning organisation capabilities and provides our interpretation of the concepts discussed in the literature review section. We position that elements of the integration of data analytics help facilitate learning organisation capacity. It suggests that players, coaches, and executives, as well as data analytics and technology investments, are the

inputs required to activate and drive the five key components of the learning organisation. These components are knowledge management (KM), continuous improvement (CI), individual and collective learning, processes and systems, and culture, which are required to learn, improve and change, and provide the foundations upon which players and coaches can base their on-pitch decisions. It is critical to appreciate the level at which these cycles of learning, improvement and changes happen: individual, organisational or institutional, and to what extent it creates value for the club, as per the concepts detailed in Caya and Bourdon (2016).

Methodology

Qualitative research and sample definition

To address the research question, 33 semi-structured interviews with industry experts and sport stakeholders from elite football (Premier League, Championship), cricket (First Class County Clubs) and rugby (Rugby League) were undertaken, as per Table A1. These included 23 participants from football, seven from cricket and three from rugby. Specifically, the participants were seven sports directors, 12 managers and coaches, six players or former players, six performance analysts, one member of the medical staff, and one sport analytics academic. Interviews were approximately 60 min and the interview protocol had six key sections and 25 open ended questions, which were adapted based on the role of the participants. Each interview investigated participants' opinions regarding sport data analytics, their utilisation and their views regarding future potential and issues. As part of the interview protocol, data analytics was defined and there was no presumption that coaches or players would conduct data analysis themselves and this was clarified as required. All interviews were recorded and verbatim transcribed. Careful selection of suitable participants ensured that data was collected from people with relevant knowledge and experience, capable of answering the interview questions. The diversity of participants enabled us to collect rich data. It was important that professional coaches and players, as the 'main actors and subjects' of the transformed data, were included in the sample in an effort to capture their experiences of working with data analytics and technology (it is worth noting that players were the most challenging group of participants to access). We used a convenience sampling strategy and the snowball approach for selection and ensured that participants met the inclusion criteria (e.g.: knowledge and experience in the selected professional sport, experience with data analytics and technology, and willingness to share their perceptions). The sampling techniques proved appropriate and effective and helped ensure the richness and authenticity of the data (Bamford et al., 2018; Filo et al., 2018).

Tracy (2010) highlights key markers for ensuring quality in qualitative research. First, during the pilot phase with three management scholars and three sports directors, we ensured the relevance, validity and significance of the topic. We developed credibility by considering, presenting and reporting on rich and contextual data shared by the interviewees, Table A2 presented below shows samples of quotations and evidence to support the contentions made (Maylor et al., 2017). We ensured and built reliability through close collaboration with a wide range of 33 participants, which enabled us to deepen and strengthen our analysis (Maylor et al., 2017). Finally, we conducted the research in an

ethical manner following the academic institution's ethical guidelines, obtaining informed consent from participants while maintaining transparency and anonymity.

Interview design and protocol

Bernard and Bernard (2013) advised on the value of interviews and implied that qualitative methods also lend themselves to data saturation. The interview guide was based on the developed conceptual model (c.f.: Figure 1) and Caya and Bourdon's (2016) framework. We designed the interviews taking their findings into consideration, including questions that helped elicit how data analytics and technology are currently used in elite sport. We structured the questions in line with three main levels of analysis or locus of value: individual, organisational and institutional (c.f.: Caya & Bourdon, 2016). Table A2 presents the mechanics of the methodology from design to analysis using abductive logic (Thornberg, 2022). It shows the links between the conceptual model and the interview questions and provides sample quotes as well as the coding developed and validated by three of the authors, such as in Dehe et al. (2022) and Minshull et al. (2022). Whilst the learning organisation theory was used as a lens to view participant comments, we employed an abductive approach in terms of data analysis and coding (Braun & Clarke, 2006). According to Thornberg (2022) it involves using a creative process to examine how the data supports existing theories and hypotheses as well as how the data may call for interpretations within the existing understandings. Our approach includes inductive and deductive elements, which are not necessarily mutually exclusive (Braun & Clarke, 2012), hence the abductive approach seemed suitable given the nature of the research and our pragmatic worldviews.

Data analysis

The analysis process was structured using NVivo12. All collected data were examined meticulously and the framework method of analysis was utilised (Gale et al., 2013) which is rigorous, systematic, and gave credence to the findings. The transcripts were analysed through a five stage process: (i) familiarisation with the data, (ii) associating the data with the conceptual framework by identifying recurrent and important themes, (iii) indexing and identifying initial codes, (iv) summarising data in the analytical framework, and finally (v) synthesising data by extracting, interpreting and mapping the final codes. This process allowed the researchers to become immersed in the data so that reliable and meaningful themes and sub themes could emerge, as detailed in Table A2. Through this process four definitive themes were identified: (i) the role of data analytics in the learning process, (ii) empowering players, (iii) player and coach interaction, which includes player feedback, and (iv) best practices, which includes evidence-based culture, transparent communication and holistic perspectives, as per the sample of the process shown in Table A2.

Results and applications

The role of data analytics in the learning process

Informing the design of their framework, Caya and Bourdon (2016) state that despite the volume of papers published on sport analytics and metrics it is unclear how they are used

by elite sport organisations and athletes. In our study the coach participants revealed that data analytics and technology can potentially have a positive effect on the learning capabilities of players, which can provide long-term benefits to performance. A key element of this is reported to be the ability to reflect on one's own performance and hence make deductions based on past events and patterns that emerge through the data. For example, interviewee Coach04, a football coach, illustrated the importance of technology within the coaching process, 'it is creating opportunities for the coach to educate players using data. The analysis and reports aid players in developing their knowledge and expertise'. This was corroborated by Player02, a recently retired football player, saying that he has 'learned so much from looking at [reflecting on] the analysis'.

The coaching practices within football, cricket and rugby have come a long way since the inception of data analytics and technology in sport. Analyst05 mentioned that 'technology and data analytics are now part of the elite coaching process. It impacts players as coaches help them learn more effectively through streamlined approaches'. Coaches and analysts believe that technology helps speed up and consolidate the players' learning process and, as a result, can influence how much knowledge they are able to absorb. Watkins and Marsick (1996) and Weldy (2009) go further, suggesting that organisations facilitate learning to improve performance through continuous improvement and the utilisation of gained knowledge. Players become more knowledgeable by receiving 'player-specific' reports as part of this process (Analyst03). Some participants believe the benefits have become more apparent, with players now familiar with the importance of data in improving their learning abilities and consequently their performance. This awareness encourages 'players to be more inquisitive and interested in how they have performed' and how they can improve, treating the use of technology and interpretation of data as a skill clubs must develop (Coach05). Interviewee Coach05, a football academy coach shared that 'players really like the analysis and want to know their stats (e.g.: sprint statistics, number of successful passes etc …)'. This provides a learning opportunity that can be then used to set specific objectives. For example, if trying to improve a 70% pass accuracy ratio, additional work and data monitoring will objectively support and measure improvement in the following weeks.

Participant Coach02, a cricket coach, specified that 'players look at the [video] footage and the associated analytics reports to reflect on their performance based on the data they receive on their device'. Players have access to tools and analytics reports enabling them to be more proactive in their individual learning. Manager01 highlighted that at their rugby club, all players are given a tablet and are expected to actively use it as a tool during analytics and debrief sessions. This echoes the views of Richards et al. (2012) suggesting that individual-based knowledge distribution allows players to contextualise the information provided to them with reference to their own performance. This then streamlines the process of internalisation. The distribution of knowledge occurs in both a team and individual setting according to Bourbousson et al. (2011) and our research found that 'team-specific' information is initially disseminated to the whole team, followed by 'player-specific' data analytics updates related to their own performance. Therefore, data analytics and technology impact the communication process within and between players, coaches and teams, and arguably influence how much knowledge they are able to absorb and share collectively. This fits with Pedler and

Aspinwall (1999) and the learning organisation theory which identified the importance of effective communication to support collective learning.

Empowering players

The value and contribution of business intelligence and analytics can be observed at several levels of analysis according to Caya and Bourdon (2016), but for all levels, contextual contingencies moderate its impact. Interviewee Player03, a recent former football player, emphasised the importance of players learning independently with an example of a youth level team using data from previous games, 'the players [without coaches' instructions], looked into the past use of zonal marking for set pieces then, based on the analysis, practised [specific combinations] the day before the game, and executed on match day'. Through this, the players were able to identify their own weaknesses as well as those of their opponents, come up with strategies and exploit them during the match, which must feel empowering for the players. This also fits with Gartner (2014)) who suggested data could be used by an individual to help achieve objectives across a range of domains and Caya and Bourdon (2016) who found that athletes could turn tactical information through physical action into sports accomplishment; potentially informing both their own actions and responses to opponent players.

Coach04 highlighted the significant role of technology, saying that 'advanced video footage and simulations of events such as crucial phases of play, passes made, and positioning are all essential data points that players now have access to and are able to review from their tablets'. It enables players to look at a play from different perspectives afterwards. They can also use the simulation to discuss with teammates. Coach04 also shared that 'it is a critical learning and empowering tool for the players, specifically because coaches are not with them on the pitch, they must learn to reflect and improve whilst performing'. Additionally, Coach05 indicated that data informs players and coaches of new perspectives and patterns about the team and the opposition, which allow coaches and players to 'learn', 'educate' and 'empower' each other. This fits with the perception of a learning organisation as put forward by Malik and Garg (2020) who identified it as one where people continually learn how to learn together, which therefore expands their capacity to achieve the results required through new and expansive patterns of thinking. Chiva et al. (2014) also identified that the process of developing new perspectives created new organisational knowledge and was the foundation of the learning organisation.

Data analytics and technology have been identified within the literature as knowledge enablers that lead to organisational effectiveness (Khan & Vorley, 2017). They enable sport teams to develop their learning capabilities and ultimately increase their knowledge base. Although it is not a panacea for improvement, its importance is convincing, particularly the nuances it brings to the sport industry, when important ele]ments such as the learning organisation and culture are taken into consideration (c.f.: Caya & Bourdon, 2016).

The findings of this and previous studies (c.f.: Wright, 2015) indicated that the considerable amount of data generated in sport helps in creating improved understanding and as a result, players individually and collectively are more knowledgeable. Analyst03 believes it helps the team to increase knowledge, sharing that as soon as the analysts 'upload a play, the players get the notification on their phones […], to spend

time reviewing and learning about the analysis of the situation individually and collectively'. This exemplifies how data and technological strategies enable teams to develop their learning capabilities and ultimately increase their knowledge base through empowerment, feedback loops and potentially double-loop learning (Argyris & Schön, 1997). Oliver (2008) positions that the allocation of resources to knowledge acquisition activities indicates the commitment of the organisation to learning. This is in line with the findings of this research, which indicates that participants recognise the importance of learning in creating knowledge, confirmed by their demonstrated commitment to investing and using data analytics and technology.

With regard to learning organisation constructs such as empowerment and self-development, as identified by Meshari et al. (2021) and Zeimers et al. (2019) our research emphasises 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 and technology, indicating a direct relationship to empowerment and reflection. We can reflect that Wright (2015) highlighted how players are now empowered and encouraged to be at the forefront of learning. However, according to Upadhyay and Kumar (2020) this does depend on the culture of the sport and the club, as culture is an enabler of and plays an important role in the adoption of technological practices.

Player-coach interaction

Data analytics and technology have created a 'new' coach-player interaction mechanism that can make it seamless for both parties to learn more effectively. Accordingly, data analytics can 'provide new insights' to the coaches by detecting new patterns or highlighting the root causes of issues. Coaches subsequently impart that information and knowledge to the players. The players then go out onto the pitch to execute based on this knowledge. A football performance analyst, Analyst01, illustrated this by sharing that with the coaches they 'use data analytics and simulation to teach players how to best approach a particular scenario' (e.g.: four opponents to be aware of) and influence the tactics. This illustrates how coaches and players can learn from data as it demonstrates opponents' patterns and tendencies that enable identifying counterattack strategies, as per Caya and Bourdon (2016) suggesting specific game decisions can be optimised by revealing interesting patterns.

After specific data analytics sessions, players are regularly required to present or discuss their interpretations of the data analytics back to the coaches, which stimulates further co-creations discussions, which is a very modern and innovative approach to the player-coach relationship. This fits with Wang and Ahmed's (2003) perspective that individual learning plays a significant role within the concepts and practices of the learning organisation. This method puts the players at the forefront of data analytics and technology utilisation. It empowers them, and it makes it easier for them to understand why coaches are asking them to perform a particular task and to make a specific on-pitch decision. When asked about the type of information the players present back to the coaches, Player03 shared some specifics: players might say that based on the data we can see that 'the midfielders are slow to recover, they don't get back behind the ball quickly enough, so they leave gaps in wide areas'. This would then be used to strategize gameplay. The final game plans based on the players' and coaches' collation of information and co-

creation of the analysis are implemented during training sessions and subsequently during the match. The process is a continuous one and is restarted immediately after the match, reinforcing Chiva et al.'s (2014) view that it is the responsibility of the organisation to incorporate individual learning into learning organisations. The immediate period following the sporting event is crucial for analysis but only adds value if the players have a positive mindset towards it, reinforced by their organisation (Caya & Bourdon, 2016).

There is a strong indication that effective leadership plays a fundamental role in the creation, sharing and accumulation of knowledge, supporting the findings of Singh (2008). Marquardt (1996) believes that practitioners understand the need for organisations to incorporate learning organisation principles, where action to improve performance and continuous learning is consciously facilitated. The ability to keep an open mind towards the use of data analytics and to combine this with existing intuition is possibly crucial for creating evidence-based game tactics and value according to Caya and Bourdon (2016). Our paper contributes to this by revealing the role that individuals and teams play in creating learning organisation capabilities, and how data and technology can actively facilitate this.

Player feedback

Feedback plays a crucial role in facilitating the learning and development of players and coaches. One research participant, Manager01, spoke about the importance of getting the players to interact with the interpretation of the data analytics. 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 spoke at length about how some players are very receptive towards the data analytics feedback compared to others.

The learning and feedback culture within sport teams is now influenced by data analytics and technology. There is a real commitment to improving the knowledge of the player, and the coaches and a drive to make sure the information received by players and coaches is applicable and specific. Research participants stressed the importance of ensuring that players only receive specific and targeted feedback, as opposed to giving them too much information. Of course, teams can be overwhelmed by the quantity of statistics produced (Caya & Bourdon, 2016). Analyst04, a performance analyst, shared that in his experience 'the players do not have a say in the amount of data and the type of analysis done'. Nonetheless, players are expected to co-create the feedback sessions and comment on different aspects of the game (e.g.: in possession, out of possession, transition set plays, etc …) (Player02).

Participants were all in agreement that players respond to feedback differently and the learning styles of players are of crucial importance. Certain players might respond better to visual simulations than actual statistical reports, while other players might prefer a one to one discussion and review with the coach about their performance data. Player04 highlighted that the next step to change professional sport is to better understand the cognitive abilities of individual players, in terms of how they learn and how it influences the feedback process of using data and technology.

The findings have emphasised the importance of involving players in this process, moreover, the research participants believe this inclusion is beneficial as players are

more aware of the strategy and tactics of the whole team, arguably as per Argyris and Schön's (1997) Double-loop learning. Interestingly, this demonstrates the overt responsibility of the players to not only absorb information but to be able to independently interpret analysis, reinforcing what Huber (1991) suggested (albeit in a different technological era) – that learning occurs when personal development alters behaviours.

Best practices

An evidence-based culture

Organisational culture plays an important role in sports teams' success, and for data analytics and technology to be effective within a team there needs to be a commitment towards evidence-based approaches. Building on the works by Easterby-Smith et al. (2000) and Weldy (2009) we earlier declared that a learning organisation is one with a cultural characteristic or archetype form that is nurtured to emulate learning process improvements. Organisational culture not only defines the team's internal and external identity but is important for the overall success of the team in terms of the utilisation of data. For many years the sports sector has been known to have the perspective of 'it works, so why change it', and 'adhere to the status quo', so it is perhaps natural to have some resistance (or holdouts) during the implementation phase. Key stakeholders within teams must be brought on board before the data transformation can reach its peak and buy-in from players and coaches is essential. A cricket performance coach, Coach03, described a situation where they were 'able to use data analytics to obtain buy-in from a player, by simply showing relevant data which was used to highlight when the player was less effective on the pitch', and the reason for it. This is necessary to get players engaging with a culture of evidence-based feedback and improvement. Zare et al. (2010) identified that a learning organisation has an advantage here because it learns and transforms to stay ahead of the competition. Related to this, is our perspective that culture enables sports teams to effectively utilise the knowledge and experience they possess towards establishing and attaining desired goals. Bennie and O'Connor (2012) identified that culture in sports teams incorporates learning and involves regular team meetings where players are tasked with developing their knowledge base by co-creating evidence-based and feedback sessions. In earlier work, Jones (1996) highlighted the importance of fostering a learning culture for an organisation to manage knowledge effectively. It is most illuminating that this ethos is now being rapidly engaged across the sports sector regarding applied data analytics and technology.

Transparent communication

Competitive elite sport is structured such that coaches and managers have traditionally the final say in terms of on-pitch strategic and tactical decision-making. If data is not communicated well enough it is difficult for them to use it effectively (or at all), which fits with Garvin et al. (2008) who described a proactive learning organisation as one that continually creates, acquires, and transfers knowledge to adapt faster than its competitors. Research participants emphasised the importance of transparency, for instance, interviewee Analyst06 shared that in their opinion the 'most important aspect to achieve engagement is transparent communication'. Collecting and analysing data is straightforward, the challenge is how you communicate effectively and transparently to coaches and

players so they can use it. Mikalef et al. (2020) demonstrated that learning capabilities could be improved through continuous improvement in communication and our research has indicated that effective use of data analytics and technology within sports teams requires the active involvement and support from all players and coaches, especially for learning flows to occur. The findings confirm the influence that data analytics and technology have on transparent and effective communication and that the learning organisation is a state which should continuously be striven for in the professional sports ecosystem.

Holistic practice

Data analytics and technology now play a major role within the elite coaching practice of football, rugby and cricket, as demonstrated by our findings. However, some research participants also emphasised the importance of having a holistic approach, rather than relying solely on data analytics and technology. This involves the inclusion of the human element according to interviewee Doctor01, who stressed that 'technology and data have to include the human element, it is never something that will replace human interactions'. Solely relying on data analytics without considering other equally important elements could lead to issues within the team, as per Senge's (1991) suggestion that there were Five Disciplines of Learning Organisations (shared vision; systems thinking; mental models; team learning; personal mastery) and the review by Wang and Ahmed (2003) identifying five main focuses of learning organisations (knowledge management; continuous improvement; collective and individual learning; processes and systems; and culture).

The framework created by Caya and Bourdon (2016) offers an initial structure to guide future research through its positioning of investment being influenced by both conversion contingencies and external actors, resulting in value creation. It also helps identify the locus of value: individual (players, coaches), organisational (teams, clubs), institutional (sports leagues, sports federations), 'where the realised value from the technology can be assessed'. Our conceptual framework in Figure 2 illustrates and summarises the key elements and dimensions with regard to how data analytics and technology specifically enable sports teams to develop learning organisation capabilities and increase their knowledge base, from a holistic perspective.

Our study addresses gaps in the extant literature with regard to practices of data analytics and technology in on-pitch sports, through the lens of learning organisation theory (Rodger et al., 2019; Zeimers et al., 2019). We suggest in our conceptual model (Figure 2) that with the appropriate leadership and culture to promote the use of data analytics and technology, a sports club can use the technology to develop a learning process within a player-centric approach, focus on empowering the players to learn, improve and change, create new player-coach interactions and relationships, ensure that an evidence-based culture, transparent communication and holistic perspective are prioritised in order to achieve the benefit of a learning organisation. Marquardt (1996) defines a learning organisation as one that learns collectively and constantly transforms for individual, organisational and institutional success.

Finally, we wanted to highlight some of the key challenges as reported by the participants. In line with the literature, the interviewees spoke about categories of issues and challenges to be overcome, respectively to the implementation and utilisation of data
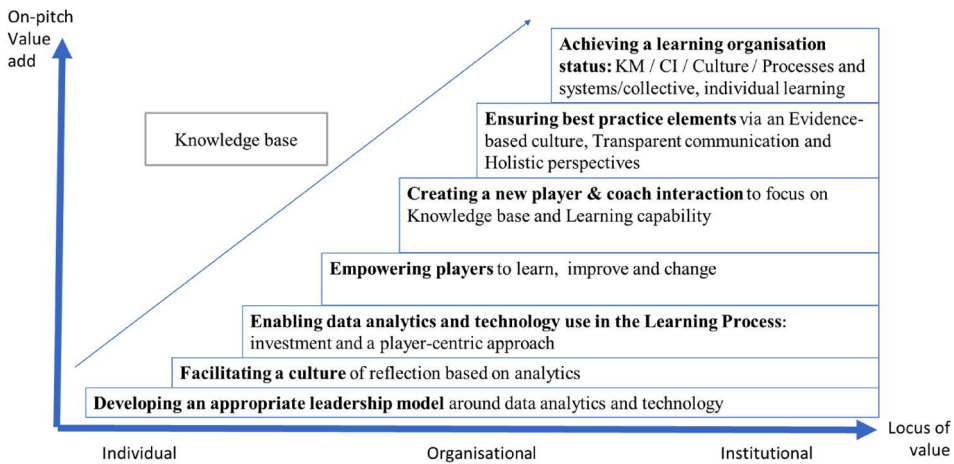
Figure 2. Data analytics and technology to achieve learning organisation capabilities model.

analytics and technologies. The majority pointed out that the cost associated with the implementation was a barrier, e.g.: it is 'very expensive', stated Analyst02. Coach05 explained that the issue was that they did not 'invest enough in the technology to fully take advantage of the analytics' and Coach02 mentioned that he 'wished more financial resources were allocated to data analytics solutions to catch up with the top clubs'. Interestingly, Player03 reflected that his current club has the means to fully utilise the technology, 'but that was not the case in the previous club, where due to the lack of data scientists, we could not record and access the training sessions' analytics reports'. This was echoed by Manager02 who said: 'we had a data scientist, but he has left, so we have been looking to replace him, but it is a very bespoke skill set and is not straightforward to find'. Perhaps in sports, as in other industries, there is still a 'digital divide'.

Conclusion

In summary, our research contributes towards the continuing discourse of on-pitch data analytics and technology utilisation within the sport industry. To date there has been limited academic research on data analytics and technology use in professional sport from a learning organisation perspective. Hence, the study contributes to the body of knowledge by analysing the learning organisation pathway and impact and identifies elements of best practices (c.f.: Bouchet et al., 2020; Caya & Bourdon, 2016). The findings increase the understanding of sporting organisations as learning entities and demonstrate how they capture and transform data into knowledge, which is then utilised to inform on-pitch practices and decisions. The importance of culture and effective leadership has been highlighted as critical to achieve a learning organisation status (c.f.: Malik & Garg, 2020). This research makes a defined contribution through the blueprint framework presented in Figure 2, which can be adopted by sport clubs and serves as a foundation for effective implementation and utilisation of technologies and data analytics in their pursuit of achieving a learning

organisation. The key practices identified centre around the culture of the team, transparent communication, empowerment and a holistic perspective involving not just analytics and technology but also the human element for instance via newly developed player-coach interaction and relationships. These elements can be seen as some of the key components for more effective utilisation and implementation of data analytics and technology to increase the on-pitch value add. Consequently, the findings of this study add to both the practitioner and academic domains.

Limitations and future research

This study has limitations that invite further research. Firstly, the sample used for this study included: seven sport directors, 12 managers and coaches, six players or former players, six performance analysts, one member of the medical staff, and one sport analytics academic. It is important to note that the data was collected from elite football, rugby and cricket teams, which needs to be appreciated before one can possibly generalise the findings to other sports. Through the need to focus on sufficient depth, the time available and the unique access we managed to facilitate, our research was pragmatically concentrated on the aforementioned three sports. We acknowledge that these are perhaps a rather select group of sports, despite their popularity, and we call for future research to include sports such as basketball, baseball and ice hockey, across a selection of representative countries such as the USA, Japan and Australia, thereby allowing for more extensive cross analysis between sports and countries. The paper also did not offer any comparison between the different sports, which may be an area of focus for the future. Additionally, our research led us to provide a positive outlook on data analytics and technology, however, we need to acknowledge this may not represent the consensus across the industry. Hence, it would be useful to explore in more depth the potential negative impacts, challenges and the digital divide between the clubs. We also believe that it would be insightful to focus future research on the use of artificial intelligence (AI) and virtual reality (VR) as key learning organisation future technologies in the sport ecosystem. Finally, from the discussion it is evident that knowledge creation is not a final process but rather a means through which team objectives can perhaps be achieved. The ambition for elite sport teams is to enhance decision making to tangibly improve performance. Consequently, it would be most interesting to investigate the extent to which data analytics and technology influence specifically the decision making processes in the minds of players and coaches.

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Disclosure statement

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