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KNOWLEDGE IN ACTION

Faculty of Business Economics

Master of Management

Master's thesis

Improving sports performance using sports analytics: a literature review

Bernice Fultang Bih

Thesis presented in fulfillment of the requirements for the degree of Master of Management, specialization Business Process Management

SUPERVISOR :

Prof. dr. Marijke SWENNEN



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1. Introduction

Sports teams are increasingly using researchers to collect and analyse data about their athletes and their sports performance, with the aim of making better decisions before and during sports events. Chen and Lin (2014) state that there has been an increase in digital innovations in sports over the years which has seen the use of sports analytics playing a central role in enhancing sports performance. Data collection has been made simpler and more in-depth, allowing for more advanced data analysis to be performed such as tracking the movements of players using software like G.I.S (Geographical Information System), and the use of digital technology such as video recording to collect data on the performance of players during the game. (Cintia et al, 2015; Carling et al, 2007; Barris and Button, 2008; Liebermann et al, 2002).

Apostolou and Tjortjis (2019) defines sports analytics as a statistical process that makes use of historical data in sports such as analysing the efficiency of an individual player or the team in order to measure their performance thereby aiding in the short or long run decision making. Bush et al (2015) state that sports analytics plays a critical role in avoiding injuries in the future, for example, video recordings have helped in analysing the health of players such as their stamina and active game time. James and Carroll (2006) further state that with the increased pressure from training and matches, sports analysis has also provided a platform in which the physiological state of the players can now be observed such as the indication of exhaustion or fatigue and restlessness.

Glazier (2010), Gerrard (2017), and Ericsson et al (2003) state that sports analytics looks at the performance outcomes that have been observed in past games to identify the fundamental causal mechanisms in order to strategize in future games. To ensure that performance of the players is maximised in the future, Alamar (2013) and Jayal et al (2018) argue that sports analytics works by using quantitative analytical techniques to improve performance such as analysing the game tactics and the fitness of the players. Carling, Williams, and Reilly (2007) argue that improved performance and growth on both the individual and team cannot be archived if they continuously rely on the same performance tactics and moves, nonetheless, to gain a competitive advantage, playing tactics must be changed and adopted to make the team less predictable to the opponents.

Thus, sports analytics is crucial to sports performance as it enables the coach to identify the loopholes in the performance of players and the team at large in order to produce strategies that address these inadequacies. Caya and Bourdon (2016), Carling et al (2008) and Patel et al (2020) argue that to attain a competitive advantage, clubs are adopting sports analytics to gather data to help in their decision making towards changing their game tactics and improving training.

Sports performance is defined by Encyclopaedia (2019) as the way in which sport contribution or participation is assessed by considering numerous factors from physical to emotional factors of the players. DiSanto et al (2019) and Bouchard et al (1997) state that sports performance is as a result of multiple performance factors that are closely correlated and these include the training levels of the athlete, their flexibility, their skills, psychological preparation, and supportive techniques to name a few.

Gerrard (2016) states that sports data analytics tends to capture data on different essential aspects of performance in which improvement can be done and these include:

1. The actions of players,
2. The psychological attitude of players,

3. The abilities of players,
4. The awareness of players

Taking these factors into consideration, this study analyses how sports analytics improves sports performance paying attention to soccer. Soccer was selected as the focus of the study because it is one of the most popular sports in the world and is highly dynamic (O'Donoghue and McNaughton, 2007; Cometti et al, 2001). As such, soccer players are trained to execute various skilled movements while playing and to be aware of tactics that occur around them (Mohr et al, 2003). Thus because of its complexity of performance, sports analytics plays an important role as a feedback mechanism to assess and evaluate performance so that the sport becomes more competitive (Hughes and Franks, 2004; Baca, 2008; Baca and Kornfeind, 2006).

1.1 Problem statement

Various scholars such as Gerrard (2017), Sarlis et al (2020), Morulev et al (2018), Carling et al, 2007; Carling et al, 2008 and Jayal et al (2018) argue that sports analytics is critical to the performance of a team as it helps in determining which sports players to recruit, the value each player will add to the team, how the programme for training will be conducted, and which playing tactics to employ so that the team will be prepared for the game. This research seeks to analyse how sports data analytics can bring about improvements in sports performance by focusing on soccer.

1.2 Aim

To analyse how sports performance can be improved by making use of soccer sports analytics.

1.3 Objectives

Gerrard (2017) defines different categories that impact sports performance and thus the objectives of the study are based on these categories, and these include.

1. To examine how sport analytics has impacted the actions and abilities of soccer players.
2. To examine how sport analytics has impacted the psychological attitude of soccer players.
3. To examine how sport analytics has impacted the awareness of soccer players.
4. To identify the challenges of using sports data analytics for the coaches towards improved performance.

1.4 Research question

1. How does soccer analytics impact the physical, psychological, technical and tactical performance of players?

1.5 Research significance

Sports is not just about the wins that are ensured by sports club, it is also about the welfare and wellbeing of its players (Hopfensitz and Mantilla, 2019). The significance of the study is to enable coaches assess the `emotional expressions` of the players during the match. Hopfensitz and Mantilla

(2019) state that the performance of players can be affected if their psychological mentality is disturbed as this would impact their performance in the field.

The research also plays a crucial role in improving the performance of players in different sports arenas such as football, netball, basketball, volleyball, or tennis. Ishikawa (2018) states that sports data analytics plays an important role in the strategic planning of coaching, in the formulation of training and in matching strategies and tactics that play a vital role in shaping the actions of players in the pitch. Liu et al (2017) state that sports analytics enables coaches to predict moves from opponents given certain variables. Thus, this enables improved tactics on the players which in turn enhances their skills and abilities in the field. In most small sports clubs, sports performance of players has been difficult to gauge (Currell and Jeukendrup (2008). Sports analytics presents a starting point towards tracking the performance of a player in an objective way (De Silva et al, 2018).

Dowling et al (2018) states that the significance of sports analytics to performance is to ensure that the sports organisations set goals and parameters that aim towards sports governance. Therefore, sports analytics is very important in setting strategic objectives which targets the abilities of players or team thus ensuring that performance goals and progress are monitored (Inoue et al, 2015).

1.6 Organisation of the Study

The remainder of the paper is arranged as follows. Section 2 looks at the methodology which states how the systematic literature review (SLR) was conducted. Section 3 looks at different concepts established from the literature review. Section 4 contains a discussion of the findings from the SLR while section 5 provides recommendations for future research and conclusion.

2 Research methodology

The study uses literature analysis on sports data analytics and sports performance. Snyder (2019), Alessandro et al (2009) and David et al (2009) state that literature review analysis can be used as a research methodology to appraise the state of knowledge for a specific subject in order to identify research gaps, generate research outlines, and debate a specific issue in depth. In this case, literature review provides in-depth knowledge on sports analytics and its impact on sports performance (Searcy and Mentzer, 2003). Eagly and Wood (1994) and Meerpohl et al (2012) state that the literature review method permits the investigator to construct a study or exploration area, breakdown the state of the research and establish evolving research themes. As a result, this enables the researcher to discover the relevance of the subject matter thereby offering direction toward interpretation or assessing that area (Meredith, 1993; Meerpohl et al, 2012).

This study will explore relevant literature such as articles, books, journals and conference papers, which are going to be evaluated and categorized according to context and approach, hence generating conclusions, challenges and prospects identified from the literature (Srivastava, 2007; Singh 2020).

2.1 Systematic literature review method

Systematic literature review (SLR) allows one to develop the most relevant issues from the study and their application hence facilitating the understanding of the academic fundamentals of the study field (Meerpohl et al, 2012; Eagly and Wood, 1994; Srivastava, 2007). Kitchenham (2011) and David et al (2009) state that this research method establishes a summary of evidence by making use of coherent methodical exploration methods and a combination of selected relevant information.

Figure 1 shows the SLR research flow for the study. The literature was collected from various library databases such as Springer, Emerald, Google Scholar, Science Direct, Scopus, Wiley, SAGE Journals, ABI/INFORM, Global and Business Source Premier (EBSCO).

To collect relevant literature, a structured keyword search was employed. The keywords were based on the research objectives and questions hence included words like sports analytics, sports performance and soccer. The Boolean model of recovery was used to search in the different databases by considering the query of the user (Karimi et al, 2010). For example, the string operator OR, was used such as Sport analytics OR Big data AND sports performance. The string operator AND was used to include both search key words like `sports analytics AND sports performance` to scan for relevant research works.

To define which articles were relevant, the articles and documents were analysed according to the title, the abstract and results as shown in table 1. In addition, publications from 2000 to date were used as the information is more contextual and more updated to the current soccer environment. The articles that were used in the literature review focused on 2 approaches. The first one looked at articles that covered on sports analytics, performance, and soccer. It also focused on sports analytics and performance. The second approach was based on using the identified articles from the first approach and their relevance to soccer was then applied at the end.

The inclusion and exclusion criteria was implemented in the literature where the researcher is able to screen for relevant research work towards their study. This according to the University of Texas (2022) and Hornberger and Rangu (2020) set the boundaries upon which the SLR is based on. The

inclusion criteria according to Holley (2007) and the University of Melbourne (2022) is based on every factor that will be included in the research such as type of publication, reported outcomes, date of publication, peer review and area of interest. Whereas exclusion according to Meline (2006) and the University of Texas (2022) are the factors that will make the research study ineligible to be used towards the study. Table 1 shows the inclusion and exclusion criteria used for this research.

Table 1: Inclusion and exclusion criteria of the literature

	Criteria
Inclusion	Articles, chapters, books or conference papers
	Studies that are relevant to sports analytics, sports performance or soccer.
Exclusion	Studies that are not within the context of the study (from their title and abstract)
	Research that was published before 2000

Figure 1: SLR research flow for inclusion

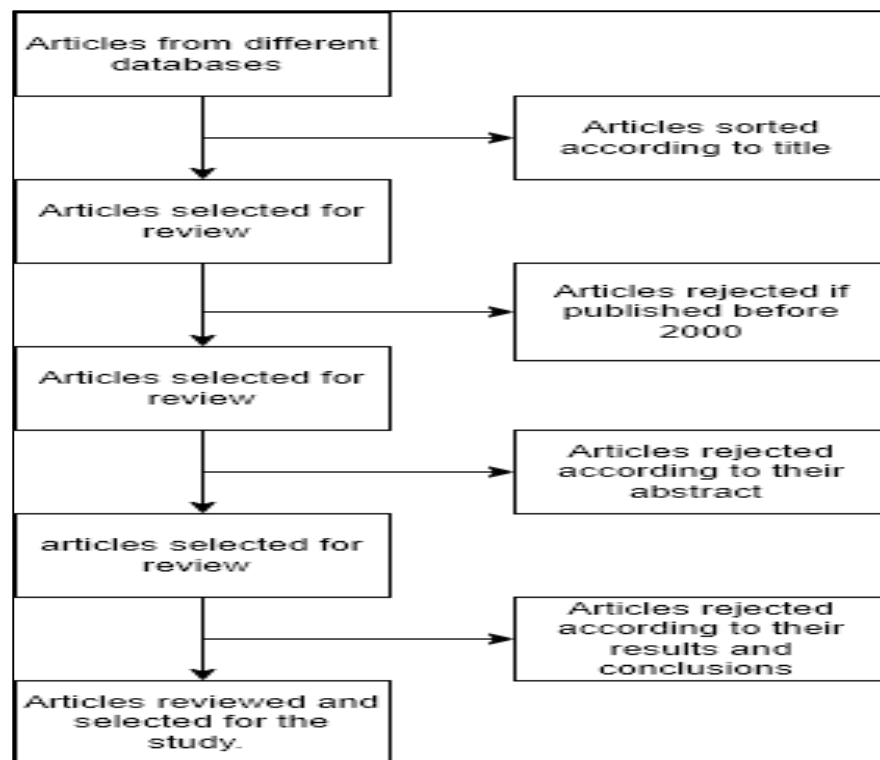


Figure 1 shows the selection process of the articles used. Articles were sorted out and reviewed from various databases according to title. Then, all articles released before 2000 were rejected while the rest were reviewed. Thereafter, articles whose abstracts did not answer the research questions and objectives were rejected. The remaining articles were screened and those whose results and conclusion were not relevant to the study were excluded. Hence, leaving the articles that were actually used for this study.

The articles were categorised into the areas of their application and the classes include:

- Performance assessment or evaluation – these included papers that focused on the use of big data to advance the performance of players and diminish errors, as well as performance of the teams.
- Sports data analysis – these looked at data analytics in sport management and data mining platforms that aid the diagnosis of sports records (Bonidia et al, 2018).
- Training design – these focused on papers that looked at how sports analytics supports the preparation or planning of training sessions.
- Decision making support – the papers considered those that looked at how sports analytics has been used to support the decision-making processes of coaches and players (strategy development).
- Motion analysis – these focused on analysing motion to categorise and distinguish skills and patterns (Bonidia et al, 2018).

3 Theoretical background of sports analytics and sport performance

This chapter presents a critical analysis of previous bodies of knowledge in understanding what sports analytics and sports performance are about. We further examine the different factors of performance (as suggested by Gerrard, 2017) and how sports analytics can be used in these areas with specific focus on soccer.

3.1 An Exploration of Sports analytics

This section provides a description of the application of sports analytics. It breaks down the varied categories of sports analytics, its uses and an overview of sports analytics.

According to Patil et al (2020), sports analytics may be classified into two categories and these can be highlighted as: on-field analytics and off-field analytics. On-field sports analytics is centred on examining the performance of players on the field, both individually and as a team. This is done by evaluating their actions, fitness or technique. While off-field sports analytics focuses on analysing how sports organization increase revenue by looking at the team's reputation and status, as well as how viewers are still interested in the team, (Ye et al, 2020).

The use of sports analytics has grown in recent years because of forces that encourage clubs to be more competitive and improve performance towards enhancing revenue growth and more triumphs (winning games) (Kraaijenbrink, Spender & Groen, 2010). According to Cochran (2010), sports analytics is administered in a variety of sports disciplines among which include basketball, football, hockey and tennis as it allows sports problems to be analysed holistically. Numerous American sports franchises like the National Football League's Philadelphia Eagles, the NBA's Dallas Mavericks, and Major League Baseball's Boston Red Sox, have incorporated sports analytics in their decision-making (Cochran, 2010).

According to Carling et al (2010) and Gerrard (2016; p5), sports data analysis can be conducted quantitatively and qualitatively. The latter is based on reorganizing significant events during the game through video replays or repeats, whilst the former is based on providing a statistical analysis of the performance using statistical techniques like regression analysis (O'Donoghue, 2009).

With advancements in technology, sports data analytics has increased over time. For example, Chen et al (2021) created a vision tracking ball approach that can forecast a ball's trajectory after considering the forces exerted by the player and other external elements. To analyse performance, several technologies are subjected to a variety of statistical methods such as regression analysis, logistics regression, and recursive partitioning choice trees (Patil et al, 2020). According to Knobbe et al (2017), models have been built that consider a player's height, age, speed and gender when evaluating their performance.

3.2 Brief history of Sports Soccer Analytics

In 1950, an accountant named Charles Reep used pencil and paper to create the first sports analytics in soccer (Wilson, 2009). He would monitor and collect data on the attacks and goals that occurred during the game in his notepad. Then, he would review and analyse the statistics thereby formulating

the long ball hypothesis to help players enhance their performance (Pollard, 2002). He was later hired by the Brentford team to put his theories into practice, which allowed them to quadruple their goals (Larson, 2001).

Overtime, the analytics of soccer sports analysis evolved from paper and pencil to being more statistical to cover issues such as pass counts, distance covered and number of deceleration and acceleration. The growth and advancement of technology has seen an improvement in the collection, storage and analysis of soccer sports data. This is particularly true for the growth of private firms like Opta that have developed tracking equipment for players in soccer and other sports disciplines (Kim and Park, 2015). Specifically for soccer, these businesses have partnered with the English Premier League to provide soccer sports data such as game tracking data. They were allowed to set up their tracking equipment and supporting infrastructure on the sports grounds such as pixel tracking cameras (Cintia et al, 2015). Most European soccer sports clubs were using sports analytics by 2015 whereby they observed game data like goals, headers and passes as shown in figure 2. The data for example is crucial in recruiting athletes based on their recorded performance.

Figure 2: Sports analytics information



Source: Harrison (2017)

With the advancement of technology, live game information and statistics were broadcasted on radio and television (Sandvoss, 2004). The success of Germany 7 to 1 versus Brazil in the 2014 World Cup was credited to their assistant coach Hansi Flick, who analysed the performance of the Brazilian players during a two-year period (Apostolou and Tjortjis, 2019).

By the twenty-first century, technology in soccer monitoring had progressed to the point that data collection devices had become more portable and unnoticeable while data processing had become

more efficient (Svensson and Drust, 2005; Robertson, 2002). Carling et al (2010; 11) state that most soccer players have devices such as lightweight heart rate monitors and online breath by breath pulmonary gas analysers attached to them as they play in training or during a game, which simultaneously collects and stores data on a computer (Carling et al, 2010; 11).

Another key technology that has been used in soccer for sports analytics is the GVR (group virtual reality). According to Samano et al (2018), it is a virtual replay tool that displays tracking data and on-ball action of players and the ground field in a 3-dimensional model in soccer and was widely used during the world cups like the 2006 and 2018 FIFA world cup. It can display two separate perspectives of the same play (same players and field) from various camera lookouts of the soccer match as shown in figure 3. (Kaiser, 2021). As a result, the user can observe any player's position in the soccer game at any time.

Figure 3:2 GVR arbitrary views from the same play



Source: Samano et al (2018)

3.3 Impact of Sports analytics on sports performance

This section provides an insight on how sports analytics improves sports performance. Santos et al (2018) points that sports performance entails multiple collectives of complex tactical, technical, physical and mental behaviour and the use of sports analytics provides a platform to measure performance to provide information for coaching purposes.

Sports analytics is used to improve sports performance analysis, which O'Donoghue (2017) defines as a field that studies performance components of an individual player or a team, such as their tactics and actions. According to Franks (2004), sports analytics provides feedback to coaches which gives way for the learning and growth of performance skills over time. Coaches can use feedback to

measure, estimate, strategize, and devise appropriate treatments based on their players' performance (Carling et al, 2010).

Sports analytics, according to Carling et al. (2005), provides a more objective, efficient, and coherent approach to compiling and analysing performance data. According to James (2006), sports analytics records performance data during a game, which is then used for analysis and feedback. Franks and Hughes (2004), state that data such as tactics, work rate, individual movement and technique are analysed to gain an objective assessment of the performance. According to Mujika (2007), this analysis is crucial in determining an individual's strengths and shortcomings, as a step toward providing the best training interventions and techniques.

Carling et al. (2010; 9) list the following grounds for evaluating performance:

- a. To create a control or baseline profile for each member of the team.
- b. To keep track of the players' wellbeing and health
- c. To assess the success of certain training intervention in terms of progress objectively.
- d. To look at how a person's performance has improved over time.
- e. To determine the link between an individual player's performance capabilities and the competition's demands
- f. To enhance the players' acknowledged deficiencies while also building on their strengths.

According to Duarte et al (2012), while the four components of performance can be recognized independently on the ground, the aspects manifest themselves as a unit that is interconnected and tend to interact with one another. Tactical and technical performances for example are often inseparable, because players make most decisions (tactical) when they are on the field. In response to this decision, the player will take the most appropriate technical action, such as taking a goal shot (Queiroga, 2010; Praca, 2015).

3.4 Sports performance

The following section will be explaining how sports analytics impacts the different aspects or categories of sports performance adopted from Gerrard (2017).

3.4.1 Physical performance aspect

The athletes' muscle strength and endurance as well as their speed, force, mobility, stability, aerobic capacity, power, and flexibility are considered when evaluating their physical performance (Carling et al, 2010). According to Reilly (2007), for players in a game to be able to persevere throughout, the coach must ensure that they can withstand the physical and performance demands of the activity. Sports analytics enables the coach to keep track of physical performance elements that are critical in soccer, according to Carling et al (2010), because players must maintain a high work rate throughout the game, as they compete for possession of the ball.

The relevance of assessing physical performance, according to Veale et al (2007) and Reilly (2007), is to analyse each player's degree of contribution towards team effort, the distance they run and the intensity of exhaustion they undergo during a match (O'Donoghue and Tenga, 2001; Rampinini et

al, 2007b; Carling et al, 2008). This improves the performance of soccer players according to Bartlett et al (2012) and Rampinini et al (2007b) in that, a coach may find it useful to access a player's distance ran when they are defending or attacking to provide a picture of their playing tactics, style, work rate, and effort inputted into the game.

According to Kelly and Drust (2009) and Rampinini et al (2007a), a player's heart rate can help measure their fitness because their work rate is closely proportional to their aerobic fitness. The heartbeat of the players can be measured whether they run, stroll, shuffle or jog, according to Bloomfield et al (2004a). Having such information is vital towards improving the performance of the soccer players in that they help determine the level of training required for each athlete, such as whether they should focus on strength or speed (Bloomfield, 2007b). According to Reilly (2007), in most soccer matches, players must sprint every 90 seconds, necessitating interim activities. This is because the player must be taught to be accustomed to performing high-intensity labour on a regular basis (Spencer et al, 2005; Carling et al, 2005).

In addition, Soccer sports analytics allows for the assessment of physiological parameters such as heart rate, which is employed in the management of soccer players' training sessions (Henriques, 2018). According to Jaspers et al (2016), such indicators can be used to monitor the players' efforts and weariness. "Monitoring the heart rate of the players will enable the coaches to adapt the training activities in order to obtain the appropriate physiological reaction," Buccheit (2014) claims.

Furthermore, sports analytics aids in identifying each player's physical weaknesses. Physical characteristics of the players like force, mobility, and power can be measured to determine the level of exhaustion they can attain at any given time throughout the game (Mohr et al, 2005). This is crucial in improving the performance of the players in that according to Carling et al (2008) and Odetoyinbo et al (2007), key players must be switched at a specific point in the game as their work rate decreases. According to Mohr et al. (2003), the amount of running in the game drops by 40% in the latter 15 minutes of the game compared to the first 15 minutes. Mohr et al (2005), Bradley et al (2014), Hills et al (2018), and Odetoyinbo et al (2007) argue that substituting players before they become fatigued helps to balance out the work rate and that if they are replaced in the last 15 minutes of the game (reducing fatigue among the players), they can help provide more ground than the players already on the field. Players who come in as substitutes have better running performance than those who play the entire game, according to Bradley and Noakes (2013) and Padron-Cabo et al (2018).

An isokinetic dynamometer for example, can be used to measure a player's muscle activity and power (Gerrard, 2017). SPI Global Positioning Systems (GPS), Abatec Electronic GmbH, Trackus Inc, and Catapult Innovations are some of the technologies used to measure physical performance. The GPS can track the players' work rates and heart rates, as well as the force and frequency with which tackles and collisions occur as shown in figure 4 (Carlin et al, 2010).

Figure 4: Player tracking using Global Positioning Systems



Source: <https://globalsportmatters.com/> and Carling et al (2010)

3.4.2 Technical performance aspect

According to Lago and Martin (2009), technical performance is determined by having the required skill of movement by the players. These include the capacity to perform important movement patterns or activities such as ball control, strikes, dribbling, technical kick action, stances, shooting and specific footwork (Redwood-Brown, 2008; Jankovic and Leontijevic, 2009). According to Gerrard (2017), technical performance is defined as "selecting the right tactics and activities and executing them in the right way" and or is based on "selecting the right tactics and actions and executing them in the right way." As a result, tactical and technical performance are inextricably linked.

Ball possessions or control, dribbles, shot on target or shot accuracy, tackle, offsides, corners, crosses, headers, free kicks, passes, and defence are among the technical performance indicators that coaches can examine by making use of sports analytics (shown in figure 5) according to Taylor et al (2008), Rampinini et al (2007), Hills et al (2018), Liu et al (2013) and Lorenzo-Martnez (2021).

Figure 5: Different technical performance aspects being presented after a game



Source: Lawrence (2018)

Technical performance analysis is critical for gaining a better understanding of what is going on during a soccer match. When a shot is completed for example, sports analytics can provide an in-depth examination at the behaviours surrounding the shot. Browne (2020) claims for example, that it "provides a complete examination of other parameters such as how close the nearest defender was, were there numerous defenders, and what was their velocity." These parameters are essential for players to strengthen their talents and use different tactical settings during training thus improving their performance.

Sports analytics enables soccer teams to have greater technical performance by analysing and improving on their technical performance. According to Castellano et al. (2012) and Liu et al. (2016), teams that have improved technical performance have more ball possessions, more shoots and improved pass accuracy than other teams. For example, a player may opt to use the long ball method, and to do so, they must evaluate the speed and distance of the player to whom they wish to pass, among other factors (Gerrard, 2017). As a result, if the ball is hit too slowly or too short, the technique will be unsuccessful. Thus, sports analytics enables the players to be cognitive of their skills and abilities and from the analysis the coach can stage training sessions to improve on their technical performance.

Sports analytics enables the coach to improve the technical abilities of the soccer players by providing an extensive study of the players technical abilities and enabling the establishment of strategies to improve them. Russell and Kingsley (2011) and Andersen and Dorge (2011) argue that over time, the players learn how to execute technical abilities efficiently that is having the speed and accuracy with which they are executed. For example, according to Reilly et al (2000) and Malina (2005), one of the most essential variables in winning a game is the ability to surprise opponents by increasing dribbling and sprinting pace while being in control of the ball. According to Mohr et al. (2003), most soccer players do 150-250 strenuous activities per game on average.

According to Little and Williams (2005), numerous components of technical performance are considered by sports analytics when measuring technical performance, such as acceleration and agility while performing techniques like dribbling and sprinting. Carlin et al (2010;150) describe agility as the capacity to shift the posture or direction of the body without losing balance. According to Sheppard and Young (2006), tests such as the zig-zag test while being recorded in visual scanning techniques for future feedback can be used to analyse technical performance. The Slalom Sprint and Dribble Test and the Shuttle Sprint and Dribble Test, according to Lemmink et al (2004), are two tests that can be used to check for acceleration in sprinting and dribbling in soccer.

The ability to quickly recover from periods of high-intensity exercise which create weariness, is an important aspect of perfecting technical performance in soccer (Mohr et al, 2003). According to Lyons et al (2006), strong acceleration periods of sprinting or dribbling might produce weariness in the player, causing them to make mistakes while playing., To increase the technical performance of the athletes, sports analytics must be used to observe skill so that training will improve (Huijgen et al, 2009).

3.4.3 Psychological performance aspect

The player's ego, level of attention, mental preparation, confidence, anxiety control, and motivation are all key factors to be considered when evaluating mental or psychological performance (Huijgen, 2014). According to Arthur et al (2017), considering the psychological disposition of the players is crucial to boost the sport's performance as it affects their competitiveness. Several academics claim that psychological factors account for more than 40% of sports performance (Abdullah et al, 2016; Olmedilla, 2017; Anderson et al, 2014). Tools used to analyse the psychological performance of the players includes multi-camera systems. These are cameras located around the soccer field providing, virtual reality, heart rate monitors and making use of instruments like the recovery-stress questionnaire, the emotional recovery questionnaire and the profile of mood states (Nissi et al, 2017).

According to Musculus and Lobinger (2018), psychological performance is divided into two categories, and these can be pointed as personal attributes and psychological skills. The former is defined as the tendency to act in a particular way (Rasmus and Kocur, 2006; Musculus and Lobinger, 2018). Malinauskas et al (2014) found that athletes had a higher level of consciousness than non-athletes. Psychological skills on the other hand, are characterized by Eccles and Riley (2014) as systematic behaviours and reasoning those players use to govern and take control of their own psychological state.

Sports analytics enables the coaches to improve soccer performance according to Gucciardi et al (2012), by improving the mental toughness of the soccer players to handle the challenges and pressures they may face throughout the soccer game. Coopoo and Fortuin (2012) and Gucciardi et al (2009) go on to emphasise that focusing on the players' personal growth allows them to become more self-aware and enable them to respond to challenging situations more quickly and maintain a high level of performance.

The goal of undertaking a sports analysis of psychological performance is to teach players to deal with their psychological problems such as anxiety in order to maintain maximum attention, improve efficiency and flexibility in their thinking (William, 2017; Junge and Feddermann-Demont, 2016; Diana et al, 2010; Yang et al, 2014; Olmedilla et al., 2018). Sports analytics enables the coaches to observe the mental state of the soccer players like how they react when offended on the field. According to Gucciardi et al. (2009), this enables the coach to strengthen their psychological components such as self-confidence, lowering their depression and anxiety levels so that both technical and tactical performance can be improved.

For example, boosting the goalkeeper's confidence can help him enhance his technical performance when tackling crosses (Welsh, 2014). According to Gucciardi et al. (2009), team unity improves team members' confidence both as individuals and as a group, allowing them to push above their own mental and physical barriers to assure the team's victory. The use of observational video analysis technologies can aid in gaining insight into players' psychological performance on the field.

3.4.4 Tactical performance aspect

According to Gerrard (2017), the tactical part of performance is a player's ability to be "tactically and partially aware or cognizant in their judgment or decision-making during a match." This is linked to their capacity to read the game and as a result, adapt and manipulate their behaviours to fit the current circumstances. According to Carling et al (2010), evaluating tactical performance entails examining the players' play style, such as how they challenge for the ball and how they predict or make decisions on the field.

According to Goes et al (2021), sports analytics allows tactical performance aspects such as the player's positioning at any time on the field, their integration with the ball, the movement of the opponents and assessing the summation of the individual movements as a team to be captured during a soccer match. They further state that because tactical behaviour is emergent and relies on the interaction between players, sports analytics cannot provide a concise breakdown of tactical behaviour as individual players, but as a team (Goes et al 2021).

Players with outstanding tactical awareness according to Gerrard (2017), may respond faster and more efficiently in their decision to place or position themselves in a match, thus reducing the effort of taking unnecessary activities such as sprinting to get into the correct position. Sports analytics according to Di Salvo et al (2007), can help soccer players improve their tactical performance by improving their decision-making abilities. According to Henriques (2018), a player's speed is useless if they are unable to position themselves. He claims that players who are familiar with a variety of tactical approaches can enhance their placement and make better ball passes than those who are not (Henriques, 2018). As a result, sports analytics in soccer assists coaches in teaching their players about the various tactical patterns that opponents can employ (Araujo & Hristovski, 2006; Leser et al., 2011; Gudmundsson & Wolle, 2013). The three-dimensional distribution of pass origins, the interval, nature of ball possession, and pass incidence are all examples of tactical performance components that can be mastered by the players (Bloomfield et al, 2005; Noldus Information Technology, 2002; Redwood-Brown, 2008; Taylor et al, 2010; Lago, 2009; Lago and Martin, 2009).

Another essential element in tactical performance is tactical awareness as a team, in which the soccer team must be effective as a unit to identify the scheme being used by fellow players and execute them efficiently together. For instance, the entire team should be in sync as they use the offside trick as a defensive measure or use the man to man marking tactic. Sports analytics aids a team's tactical performance by assisting them in improving their positioning throughout a game. The coach will be able to set up "strategic distances between the players in the same line so that they can better their position and passing patterns in the game" by analysing inter-player distances during a game (Henriques, 2018).

Determining the positioning of the players throughout the game as they defend, and attack is a crucial tactical performance issue in soccer. According to Gerrard (2017), attackers in the field can position themselves either by taking gaps that allow them to receive the ball clearly or by making decoy runs to generate space. Such information is crucial to soccer performance as it enables the coach to predict possession outcomes and player trajectories towards improving performance (Cervone et al, 2016; Gudmundsson & Horton, 2017). According to Van Rooyen et al. (2006), Breen

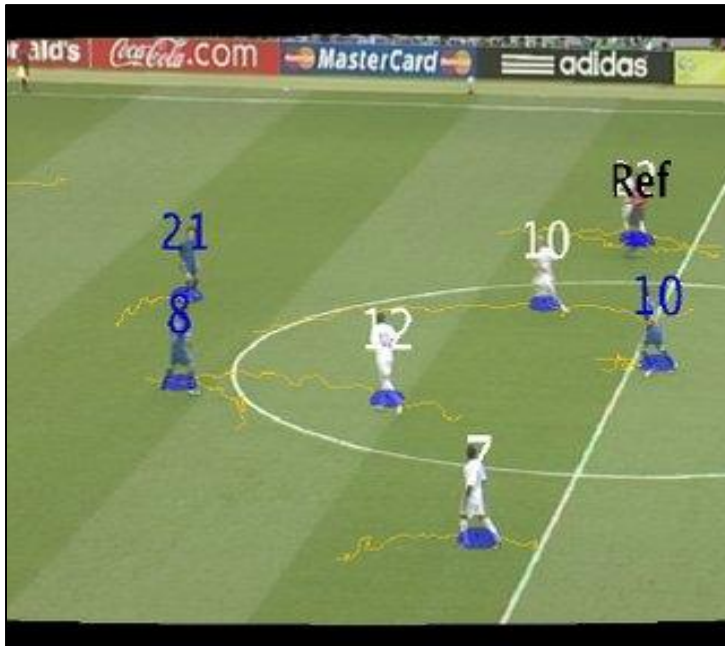
et al (2006), and Bell-Walker et al (2006), using diverse techniques such as scoring from penalties or free kicks, corner kicks and set plays as a team is more efficient. According to Breen et al (2006), most goals in soccer are scored through creating opportunities by gaining back possessions in defensive areas.

One of the most important contributions of sports analytics to improving soccer tactical performance is the provision of spatiotemporal data such as the player's position, which is specific location data (Bradley et al 2007; Gudmundsson & Horton, 2017). "The value of an assist that comes shortly before a goal is theoretically more important than an assist that occurs 30 seconds before a goal," according to Browne (2020;22), "because the pass helping the goal potentially lowers the time gap between the two events."

The System of Tactical Assessment in Soccer (FUT-SAT) is now used by coaches to evaluate tactical play (Coasta et al, 2011). The FUT-SAT examines defensive and offensive tactical elements, such as concentration, penetration, delay, offensive coverage, width and length with the ball, balance between recovery and defence, depth mobility and offensive unity (Coasta, 2011a; Giacomini, 2011b). In addition, performance analysis will then analyse the player's or team's tactical performance using sports analytics tools such as Pro Zone and Sports Code Game Breaker (Wright et al, 2012). These are tracking technologies that can determine the players' positions throughout the game, as well as their acceleration, deceleration, and position changes (Barris and Button, 2008). To improve the efficiency of performance analysis, video-based systems are utilised along them and these reveal additional motion information such as the player's speed, distance and time used to analyse various approaches such as the kicking technique as shown in figure 6 (Bradley et al, 2007).

Feedback Sport, Red Bee Media, Orad, Trackmen, and Sport-Universal SA are among the video-based tracking systems that are now in use within several soccer sports areas. During a training session, electronic tracking systems are fitted to a player to measure various reactions such as position, movement, heart responses, and effort rate (figure 5). According to Reilly (2003), most soccer fields now have multiple cameras positioned around the perimeter. The players are tagged with little microchips on their t-shirts or attached to their backs, which broadcast to an antenna positioned around the ground, according to Edgecomb and Norton (2006).

Figure 6: Player tracking using Dvideo system



Source: Hoyningen-Huene and Beetz (2009)

However, Goes et al (2021;2) argue that the challenge of using sports analytics in improving tactical performance is that “aggregating raw position data into interpretable spatiotemporal features that capture the complex dynamics of tactical behaviour have received less attention so far”. This is because tactical behaviour necessitates deductive thinking, as it becomes more difficult to unpack and analyse tactical patterns when considering the dynamic systems of tactical behaviour.

To summarise, this chapter has discussed how sports analytics can be used in soccer. Physical performance, technical performance, psychological performance and tactical performance are the four different dimensions of performance that have been identified. And how sports analytics serves as a vital feedback system for coaches, allowing them to measure and evaluate performance to develop strategies to improve performance through training. Table 2 provides a summary of the different categories of sports performance and the various tools and technologies of sports analytics that are used within them.

Table 2: Summary of the four dimensions of performance versus feedback system from coaches

Sports performance categories	Performance metrics	Sports analytics tools or technology	How sports analytics improves performance
Physical performance	Athletes' muscle strength, endurance, speed, force, mobility, stability, aerobic	Isokinetic dynameter, Global Positioning Systems (GPS) sports, Electronic Gmbh,	Improved work rate, speed and strength, enhanced training sessions and improved tactics, style and effort inputted into the game.

	capacity, power, flexibility and intensity of exertion	Trackus Inc, and Catapult Innovations	
Technical performance	Ball possessions or control, strikes, dribbling, stances, shooting, shot accuracy, tackles, offsides, corners, crosses, headers, free kicks and passes	Ziq-zaq test, Slalom Sprint, Dribble Test, the Shuttle Sprint and Dribble Test	Strengthens players talents during training, improve player acceleration in periods of sprinting or dribbling, improve player cognitive skills and players learn how to execute technical abilities efficiently with speed and accuracy.
Psychological performance	Player's ego, level of attention, mental preparation, confidence, anxiety control, and motivation	Multi-camera systems, virtual reality, the heart rate monitor, the recovery-stress questionnaire, the emotional recovery questionnaire and the profile of mood states	Improving the mental toughness of the soccer player, optimistic creativity and imagination while on the soccer field maintain maximum attention, enhanced efficiency and flexibility in their thinking, and be able to perform efficient tactical intelligence, and strengthen their psychological components such as self-confidence, lowering their depression, and anxiety levels.
Tactical performance	Pass origins, the interval, nature of ball possession, acceleration, deceleration and pass incidence	System of Tactical Assessment in Soccer (FUT-SAT) Pro Zone, Sports Code Game Breaker, Feedback Sport, Red Bee Media, Orad, Trackmen, and Sport-Universal SA	Improved conscious and unconscious decision or thinking abilities, improved tactical skills like speed, improved strategic positioning

4 Discussion

In this section, key findings from the SLR are discussed. The issues looked at are based on the significance sports analytics plays towards improving the different aspects of soccer performance. The structure of the findings is based on tactical performance, physical performance, technical performance and psychological performance. The section will also look at the challenges of using sports data analytics towards improved performance.

4.1 Physical performance

The papers reviewed show that in terms of physical performance, sports analytics aids in the reduction of player injuries by allowing coaches to manage the players' training load (Bush et al 2015; McCall, 2018, McDevitt, et al 2022; Zadeh et al, 2021; Kelly and Drust 2009; Rampinini et al 2007; Reilly, 2007). Coaches can use sports analytics to keep track of their players' training load as well as how they respond to the training they are receiving. As a result, they can alter their training to get to the optimal degree of preparation for the level of competition they will face in the matches (Fiscutean, 2021; Seshadri et al, 2021; Carling et al 2008).

In addition, analytics allows the coach to anticipate and prevent injuries. Thus, sports analytics ensures that soccer players are sufficiently prepared to perform the physical, technical, tactical, and cognitive demands of the game and help towards reducing injury risks. It allows the coach to analyse the players' level of weariness as well as monitor their neuromuscular data and postures, for example. To prevent future harm to the players, it is necessary to analyse postures that may cause injury. Furthermore, it allows them to track how long each player can stay on the field before becoming weary and as a result, having a greater risk of injury if they spend more time on the field, whether during training or during a game, (Zadeh et al, 2021; Blanchfield et al, 2019; Theron, 2020). In addition to that, coaches must also create a balanced training sheet for their players that aligns strain and exertion with sleep, nourishment and recuperation time to prevent injury and improve performance, (Stratton et al, 2004). According to Gabbett (2016) and Eckard et al (2018), if a player's workload is excessive, whether in training or during competition, this can contribute to an increase in injury rates (Figure 7).

Figure 7: Workload ratio to likelihood of injury



Source: Gabbett (2016)

Gabbett (2016) studied the training loads, physical performance and injury rates for Australian football and rugby. His study shows that within a range of 0.8 to 1.3 of chronic workload, the risk of injury is low and considered the sweet spot (Gabbett 2016). But if the acute chronic workload of the players is greater than 1.5 then their likelihood of being injured is increased and this is deemed a danger zone (Gabbett, 2016; Windt, and Gabbett, (2017; Finch and Finch, 2016). Thus, if the training of the players becomes excessive, this will result in increased injuries thereby reducing their performance on the field.

4.2 Technical performance

In terms of technical performance, the reviewed papers show that sport analytics also increases soccer performance by assisting in the development of the team's technical talents, and strategies (Filetti et al, 2017; Beato et al, 2018; Chawla et al, 2017; Goes et al, 2021, Gerrard, 2017; Castellano et al. 2012 and Liu et al. 2016). Coaches can use sports analytics to keep track of the other team's playing strategies, motions, as well as their strengths and shortcomings. This allows the coaches to develop a variety of defensive and attacking team formations and strategies that change throughout the game, making them less predictable. Furthermore, sports analytics enables the player to make informed decisions about which technical talent to use at any given time (Gerrard, 2017; Herberger and Litke, 2021). As a result of sports analytics, the team acquires a competitive advantage by learning a variety of technical performance qualities that they can use against the opposition.

Sports analytics enables coaches to identify technical performance problems that their players are facing during their matches, (Bartlett, 2001; James, 2006; Herold et al, 2019; O'Donoghue, 2014). Analytics provides an extensive study of the technical skills and abilities of the players, how they dribble, shoot or control the ball. This helps the coach to train the players in areas they lack and establish strategies in which they can improve. Thus, training drills can be made specific towards

improving those lacking areas for example amelioration on acceleration in sprinting and dribbling, hence improving their performance, (O'Donoghue, 2014, O'Donoghue et al 2013; Castellano et al, 2012).

4.3 Psychological performance

The papers reviewed on psychological performance show that the performance of soccer players can be improved if they have mental toughness, (Gucciardi et al, 2012). Sports analytics helps coaches in analysing the psychological state of their players. The mental state of players plays a significant role on how they efficiently perform their technical abilities on the field, (Coopoo and Fortuin 2012; Gucciardi et al 2009). Thus, sports analytics enables coaches to identify for example how players react when offended by the opposite players during a match. This will enable them to establish strategies that improve their mental toughness hence playing a significant role in improving their performance (William, 2017; Junge and Feddermann-Demont, 2016; Diana et al, 2010; Yang et al, 2014; Olmedilla et al., 2018).

4.4 Tactical performance

The reviewed papers reveal that in terms of tactical performance, sports analytics increases soccer players' performance by allowing them to improve their team's tactics (Goes et al, 2021; Theagarajan, and Bhanu, 2020; Rein and Memmert, 2016; Di Salvo et al, 2007; Low et al, 2020; Araujo & Hristovski, 2006; Leser et al., 2011; Gudmundsson & Wolle, 2013; Memmert et al, 2017). It allows the coach to keep track of the player's formational discipline and set up training sessions to help them develop their skills and predict the most efficient actions to make. Furthermore, analytics allows coaches to scout players who will improve their team's playing strategies by recording data and video analysis after determining that the possible players' talents and biometrics will boost their team's performance (Gerrard, 2017; Jayal et al, 2018; McIntosh, 2020; (Bloomfield et al, 2005; Noldus Information Technology, 2002; Redwood-Brown, 2008; Taylor et al, 2010; Lago, 2009; Henriques, 2018).

4.5 Challenges in using sports analytics towards improved soccer performance

However, the difficulty with using sports analytics to improve soccer performance is that each sports match is different since each game has a constant flow of performance variables (Apostolou and Tjortjis, 2019). According to Oberstone (2009), playing strategies and player locations are very varied, and ball possessions change frequently, making performance tracking a time-consuming and difficult task.

Another setback involved in using sports analytics to improve soccer performance according to Bradley and Ade (2018), is the "one-dimensional approach." That is, they believe that when it comes to analysing physical performance, analytics is skewed toward reporting isolated physical outputs. As a result, the whole link between physical performance and other dimensions of performance, such as tactical and technical performance, are overlooked. For example, one may examine running distance or playing position without considering the context of the performance, therefore perceiving

it solely as a physical performance of a single player and ignoring the tactical performance of the context, such as a team-wide strategy.

Thus, for sports analytics to deliver vital information that will aid in enhancing soccer performance, historical data captured during matches must be analysed with context to construct precise training sessions and exercises that will improve the players' performance, (Carling, 2013). As a result, many angles of physical performance must be analysed as tactical or technical outputs so that they are not seen in isolation.

5 Recommendations for future research

This study paves the way for future research in various areas, one of which is gathering concrete data from selected soccer clubs to offer evidence on the ground on how sports analytics affects sports performance. The data can be used towards predicting injuries, evaluating the strategies of the team and evaluating players (Pantzalis and Tjortjis, 2000). Further research could look at different training drills, playing formations and strategies devised by coaches after utilizing analytics towards how they impact or enhance players' tactical and technical performance.

One of the findings of the study show that for tactical performance to improve, coaches need to keep track of the player's formational discipline while on the field, (Goes et al, 2021; Rein and Memmert, 2016; Di Salvo et al, 2007; Low et al, 202; Leser et al., 2011). For sports analytics to bring out relevant information there is need for coaches to understand player positional data in order to establish evolving patterns from "player interactions such as team to team or inter team interactions and inter-player coordination," (Memmert et al, 2017). Thus, future research can focus on investigating different computer science approaches that can be used to build position data and objectify tactical performance elements.

A key finding of the study shows that a crucial factor that affects the performance of the players is the influence of fatigue, (Zadeh et al, 2021; Blanchfield et al, 2019; Theron, 2020; Stratton et al, 2004; Gabbett, 2016; Eckard et al, 2018). Further studies can be done to formulate strategies that coaches might use to address the issue of fatigue among players. Future study on tiredness and injury, according to Sarlis and Tjortjis (2020), is critical in foreseeing such negative scenarios that could impair the team's performance.

The study shows that one area that is crucial to improve the performance of the players is to improve their mental toughness (William, 2017; Junge and Feddermann-Demont, 2016; Diana et al, 2010; Yang et al, 2014; Olmedilla et al., 2018). To yield meaningful results, further research on the impact of psychological disorders on soccer player performance on and off the field can be conducted. For example, coaches can examine players' social network activities, such as their social posts to be able to understand their conduct and thoughts and link them with their current and future performance in games, (Sarlis and Tjortjis, 2020).

Sarlis and Tjortjis (2020) suggest that future study should examine and quantify the expected possession value (EPV), which assesses every decision made throughout the soccer game. Fernandez et al (2021;1389) define EPV as "representing the likelihood of a team scoring or conceding the next goal at any time instance". As noted from the study, soccer is based on making tactical decisions throughout the game and understanding the impact of different decisions can have a huge impact on who the coach selects to play certain games and which players they will hire.

Gerrard (2017) recommends that there is need for future research to look at the capability gap of coaches in adopting sports analytics. Coaches now need to be equipped with the necessary skills to be able to manage sports analytics data. Thus, there is need for establishing education resources that is given to the coaches on sports analytics. Gerrard, (2017; 21) argues that "modules on sports analytics should become a standard part of all coach education programs". Thus, future research can look at how coaches are trained on sports analytics and performance analysis.

5.1 Conclusion

A structured literature review was conducted to examine how sports analytics impacts the physical, technical, psychological and tactical aspects of performance in soccer.

To answer the question of how sports analytics impacts the physical performance of soccer players, the study shows that sports analytics improves performance by lowering the risk of injury and identifying players' weariness.

The study reveals that sports analytics improves the technical performance of soccer players by enabling coaches to train them in the areas they are lacking and to also establish strategies in which they can improve thereby executing their technical skills.

In addition, literature gathered shows that sports analytics improves the psychological performance of soccer players by enabling coaches to identify psychological issues being faced by the players on the field towards establishing strategies that improve the players' mental toughness.

Furthermore, the study reveals that sports analytics improves the tactical performance of soccer players by allowing coaches to create tailored training sessions to improve their players' skills and strategies. It also helps coaches in scouting players that will offer value to the team.

This study has revealed that, the above advantages of using sports analytics has come about due to the fact that soccer clubs are investing money into sports analytics to improve on performance. They make use of technology such as Optical tracking, which measures the position of players on the field, the use of ball tracking which tracks ball passes, turnovers and shorts and the monitoring of the players' physiological data, such as their strength, heartbeat and speed are all examples of sports analytics used in soccer. However, using sports analytics in soccer requires a constant flow of performance indicators, making data analysis extremely difficult to breakdown and analyse. These indicators should not be looked at in isolation but in context as physical output can also be critical in understanding tactical or technical performance.

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