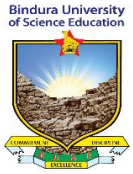

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF SPORTS SCIENCE

USING GPS WEARABLE TECHNOLOGY FOR PERFORMANCE ENHANCEMENT IN FOOTBALL AT PREMIER LEVELS IN ZIMBABWE.

KAMANGA KUDAKWASHE BROWN

B1232529

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE IN SPORTS SCIENCE

MARCH 2024

DECLARATION

DECLARATION OF ORIGINALITY

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USING GPS WEARABLE TECHNOLOGY FOR PERFORMANCE ENHANCEMENT IN FOOTBALL AT PREMIER LEVELS IN ZIMBABWE.

Submitted by: Kamanga Kudakwashe Brown **Student Number:** B1232529

In partial fulfilment of the degree of:

MASTER OF SCIENCE DEGREE IN SPORTS SCIENCE

Supervisor: PROFESSOR ISLAY PEREZ MARTINEZ

Signed: **Date:** 11/10/2024

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Finally, I am incredibly grateful to God for the ability to pursue my education. All glory, honour and praise are due to my Lord Jesus Christ for His unmerited favour.

DEDICATION

This study is devoted to my late mother, and remarkable woman Sophie Nehumayi Kamanga, my lovely wife Tafadzwa Kamanga, beautiful daughters Zoe Makatendekaishe, Makanakaishe and, Makaitaishe Kamanga, my work colleagues; Mr. James Whitehead and Mrs. Sekesai Nhokwara and, my friend Deputy Director Retired Inspector Patrick Karibe and all who appreciate technology in sport.

ABSTRACT

Wearable technology has gained significant popularity in the world of sports, especially in football. It offers real-time information and insights that can significantly enhance performance, training, and injury prevention. This research aims to explore how wearable microsensor technology can be used to improve football play at top levels of Zimbabwean football competitions. A mixed method research approach was employed as the chosen research design. The study focused on players, technical and coaching teams from two premier level football teams. Data was collected from the field area through interviews, questionnaires, and tests. Data analysis was done using SPSS for quantitative data and Nvivo 12 for qualitative data. The study's findings suggest that wearable technology has a significant impact on decision-making and technical analysis in premier level football. 30 questionnaires and interviews with a 93.3% response rate were used to collect data. The study's results show that a notable portion of participants (39.29%) used iPads to track player performance through GPS technology. Results indicate that GPS technology can effectively track and analyse player movement patterns during training sessions and matches. Findings from both the questionnaire and interviews indicate that the utilisation of technology in premier-level football to enhance player performance and monitoring is a multifaceted and constantly evolving topic. Wearable devices can aid in the rehabilitation process by monitoring players' progress, tracking recovery metrics, and facilitating a safe return to play after injuries.

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LIST OF ABBREVATIONS AND SYMBOLS

FIFA – Federation of Football Associations

GPS - Global Positioning System

GWT- GPS Wearable Technology

N12 Nvivo 12 - N12

PA - Performance Analysis

PE- Performance Enhancement

PL- Premier Levels

WC – World Cup

GLOSSARY

1. **GPS Wearable Technology**: Refers to the use of Global Positioning System (GPS) technology integrated into wearable devices such as GPS trackers or GPS-enabled smartwatches. These devices are worn by football players to collect data on their physical performance during training sessions and matches.
2. **Performance Enhancement:** The process of improving various aspects of player performance in football, including physical fitness, tactical understanding, technical skills, and decision-making abilities. The study focuses on how GPS wearable technology can contribute to enhancing player performance.
3. **Football Premier Levels:** Refers to the highest level of football competition in Zimbabwe, typically involving professional or top-tier football teams. The study specifically focuses on the utilization of GPS wearable technology in these premier-level football teams.
4. **Nvivo 12**: Refers to a popular software tool used for qualitative data analysis. Nvivo 12 helps researchers organize, code, and analyse qualitative data in a systematic and efficient manner. It provides features such as coding tools, text search functionalities, and data visualization options.
5. **Coding Framework:** A systematic structure or schema created by the researcher to guide the identification and classification of codes during data analysis. The coding framework helps organize qualitative data into meaningful categories or themes for analysis.
6. **Themes**: Overarching trends or recurrent concepts that arise from the qualitative data. Themes represent key concepts or topics that are relevant to the study and help in understanding the adoption and utilization of GPS wearable technology for performance enhancement in football at premier levels in Zimbabwe.
7. **Data Visualization:** Putting data into a visual representation by creating graphs and charts, or word clouds, to aid in understanding and interpretation.

CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.1 Introduction

This chapter is an introduction to a study on using wearable microsensor technology for performance enhancement in football at selected teams that play football at premier level in Zimbabwe. This study purposes to assess the potential of wearable microsensors technology in capturing biomechanical data pertaining to player movement, namely acceleration, deceleration, and change of direction, with regards to player health and performance in football-specific scenarios. This chapter encompasses the backdrop of the study, the problem statement, the research aims, and research questions, the significance of the research, the delimitations and limitations of the study, as well as the definition of key words.

1.2 Background to the study

The popularity and accessibility of wearable microsensor technology using Global Positioning System (GPS) technology in industrialised countries has undergone substantial increase in recent times. Wearable sensors make it possible to continuously and non-intrusively monitor biomechanical, physiological, or biochemical traits that are important for an individual's athletic performance. Researchers in the field of sports medicine gather extensive datasets including various factors, which frequently necessitate substantial time and effort for analysis, with the ultimate aim of generating valuable insights in a prompt and precise manner (Demopoulos,2016; Tierney,2021 & Govender,2021). Sports scientists, team doctors, and athletic trainers may find it easier to make therapeutic decisions if they use machine learning and artificial intelligence models (Govender, 2021). Specifically, these models can be employed to effectively interpret the data obtained from wearable sensors, enabling accurate and efficient decision-making pertaining to the well-being, safety, and performance of athletes. This study aims to reconnoiter the application of wearable microsensor technology for improving soccer player performance in the Golden Eagles and Simba Bhora Football Clubs in Zimbabwe’s Soccer premier levels.

In Zimbabwe, soccer levels are tiered as follows, Division Two where Golden Eagles play from is the third top league followed by Division One where Simba Bhora is playing and looking forward to being promoted to the Premier League (in 2024), the highest level of professional football in Zimbabwe, organised by the Zimbabwe Football Association (ZIFA), The football season spans from April to November. (Dandah & Chiweshe, 2023). Khumalo, Chitsove, Pfumorodze, & Madebwe (2022) also established that the organisation was established in 1980 after Zimbabwe's independence, as a successor to the Rhodesia National Football League, which was formed in 1962.

There has been a notable increase in interest in the application of wearable microsensor technology in sports, particularly in football, for the purpose of enhancing performance (Adesida, Papi & McGregor, 2019). Various technologies, including GPS trackers, accelerometers, and heart rate monitors, offer significant insights into athletes' movements, physiological responses, and overall performance during training and matches (Seshadri, Li, Voos, Rowbottom, Alfes, Zorman & Drummond, 2019). When considering the Zimbabwean Premier League football teams, there are various areas of research in the integration of wearable technology that require attention in order to fully utilise wearable microsensor technology for improving performance. Wearable technology use in the Zimbabwean highest levels of soccer seems to be showing some limitations which need to be further researched on.

A significant research gap exists regarding the implementation and incorporation of wearable microsensor technology in the chosen football premier levels teams in Zimbabwe. There is a dearth of studies focusing on the use of wearables to measure and monitor the performance of soccer players in Zimbabwe's premier league. It is essential to comprehend the existing state of affairs clearly of the awareness and acceptance of these technologies among coaches, players, and support staff. Furthermore, exploring the obstacles and difficulties in incorporating these devices into the training and performance analysis processes can yield valuable insights.

There is a significant research gap that needs to be addressed regarding the performance metrics tracked by wearable microsensor technology and their interpretation within the context of football in Zimbabwe. The research should prioritise identifying the most relevant performance indicators for football players in the Zimbabwean Premier League and developing methodologies for interpreting the collected data to derive actionable insights for performance enhancement.

The study comprises 2 soccer teams at premier level, each participating in 3 training sessions and 3 competitive matches. The season spans from April to November. However, some teams engage in off season sessions and matches between December and March. The majority of matches are typically scheduled for weekends, and others midweek. Postponed matches are rescheduled to be played at the most opportune time.

1.3 Statement of Problem

The use of wearable microsensors technology to measure soccer player health performance during training and competitive matches presents an opportunity to enhance player monitoring and optimize performance. Despite the growing popularity of wearable microsensors in sports, there is limited research investigating their application specifically in soccer player monitoring in Zimbabwe. The diverse movements and physical demands unique to soccer pose distinct challenges for accurately measuring player health performance using microsensors. Recent FIFA regulations have prompted additional research using GPS devices to monitor match requirements (Suarez Arrones et al., 2015; Torreño et al., 2016). The existing research on the physiological demands of football in Zimbabwe is inadequate. Therefore, there is a need to explore the efficacy of wearable microsensors in capturing relevant physiological and biomechanical data during soccer training and competitive matches, and to recognize the potential applications of this data to enhance player performance and health.

1.4 Significance of the Study

A research looking into the application of wearable microsensor technologies for performance enhancement in football at selected premier league level teams in Zimbabwe can have several significant implications. The study holds significant importance due to the following stakeholders:

1.4.1 The soccer players

The study can shed light on how wearable microsensor technology has the potential to improve the performance of soccer players in Zimbabwe's premier leagues. The study can offer valuable insights into training techniques, player conditioning, and tactical optimisation by analysing metrics such as speed, distance covered, acceleration, and heart rate.

1.4.2 Match Decision Makers

With the help of wearable microsensors, the study can generate a wealth of data on player performance and physical exertion. This data can then be analysed to make informed decisions related to player selection, injury prevention, recovery strategies, and training programs. Coaches and sports scientists can utilize this information to tailor training sessions, optimize workload management, and improve overall team performance.

1.4.3 Technical team and Medics

Understanding the relationship between wearable microsensor data and player injuries is crucial. The study can explore whether certain movement patterns, fatigue levels, or workload intensity correlate with increased risk of injuries. This knowledge can be used to design injury prevention programs and optimize player well-being, reducing the occurrence and severity of injuries.

1.4.4 Researchers

The study can contribute to player development by identifying key performance indicators and factors that separate premier league-level players from others. By examining data captured from wearable microsensors, researchers can identify physical attributes and performance markers associated with success in professional football. This information can help identify promising talent, tailor training approaches, and inform scouting and recruitment strategies.

1.4.5 Premier soccer teams and policy makers

Examining how wearable microsensors are used by top-tier Zimbabwean football teams will help the nation's sports technology develop. This study can enhance local knowledge of the possible advantages and difficulties of using wearable technology in sports. This could pave the way for future advancements and collaborations in sports technology research.

Competitive Advantage: The study's findings can provide premier levels teams in Zimbabwe a competitive advantage. By utilizing wearable microsensor technology effectively, teams can gather in-depth, objective data on player performance and optimize their training methods accordingly. This can potentially improve team performance, player development, and results on the field, ultimately increasing the competitiveness of Zimbabwean football at both national and international levels.

1.5 Conceptual Framework

The utilisation of a conceptual framework is vital in the analysis of the application of microsensors in assessing the football players' physical condition during practices and games. A conceptual framework serves as a theoretical underpinning and organised framework for comprehending the interrelationships, variables, and crucial elements encompassed within a particular study (Tamene, 2016). A conceptual framework denotes a system of interconnected concepts that collectively contribute to a full comprehension of a certain reality or phenomena. According to Jabareen (2009:51), the various concepts that comprise a conceptual framework are interdependent, as they mutually reinforce one another, elucidate their particular phenomena, and build a philosophy that is specific to the framework. The user's text is already academic in nature. The conceptual framework of a study refers to a thorough framework made up of ideas, presumptions, expectations, convictions, and theories that support and direct the research being done (Ravitch & Riggan, 2016). The term "research design" refers to a conceptual framework or model that outlines the intended study and provides an understanding of the subject matter, its dynamics, and underlying causes. It serves as a preliminary theoretical framework for researching the phenomena of interest. The principal function of this theory is to provide guidance for the remainder of your design process. It assists in evaluating and improving one's objectives, formulating realistic and pertinent research inquiries, choosing suitable methodologies, and identifying potential threats to the validity of one's conclusions.

The utilisation of a conceptual framework allows researchers to implement a systematic methodology for conducting their study, guarantee the inclusion of crucial elements, and give a robust hypothetical base for the investigation. The process of research design plays a crucial role in shaping several aspects of a study, including the development of hypotheses, selection of data collection methods, application of exploration techniques, and interpretation of findings (Andrew, Pedersen & McEvoy, 2019). Fellows & Liu, (2021) also emphasized that the selection of a conceptual framework involves determining the important variables that are pertinent to the research. Variables in this case encompass player health indicators (e.g., heart rate, body temperature, hydration levels), physical performance metrics (e.g., distance covered, sprint speed, acceleration), and contextual factors (e.g., training intensity, match conditions, player positions). This comprehensive approach significantly enhances the overall quality and validity of the research. The Technology Acceptance Model (TAM) and the Innovation Diffusion (IOD) theory are two well-known theories on which the conceptual framework for this study will be built.

1.6 Primary Research Question

How does the utilisation of wearable microsensor technology influence the monitoring and analysis of personalised performance in professional football players?

1.6.1 Subsidiary Research Questions

1.6.1.1 What are the current trends related to the use of microsensor wearable technology for monitoring and analysing the performance of professional football players?

1.6.1.2 How does biomechanical metrics affect real-time performance analysis through the utilisation of wearable microsensor technology?

1.6.1.3 In what way professional football teams can utilize the analysed data to optimize player performance, prevent injuries, and refine game strategies using wearable technology?

1.6.1.4 Which personalised interactive wearable microsensor technology is applicable to tracking football players in professional football?

1.7 Aim of the study

The aim of this study is to examine the use of wearable microsensors technology for improving performance in soccer players at Golden Eagles and Simba Bhora Football Clubs in Zimbabwe's Soccer premier levels**.**

1.7.1 Research Objectives

1.7.1.1 To establish the current trends related to the use of microsensor wearable technology for monitoring and analysing the performance of professional football players.

1.7.1.2 To measure the biomechanical metrics' effect on performance analysis through the utilisation of wearable microsensor technology.

1.7.1.3 To ascertain how professional football teams, utilize the analysed data to optimize player performance, prevent injuries, and refine game strategies using wearable technology.

1.7.1.4 To create a personalised interactive wearable microsensor technology for soccer players in professional football monitoring.

1.8 Delimitations of the Study

This study focused on 2 football teams in Zimbabwe's Soccer premier levels currently using wearable microsensors. The study will use questionnaires, interviews, and observation as data collection methods. The primary objective of gathering data from wearable microsensors was to proficiently analyse and convert it into practical insights for coaches, trainers, players and medical

personnel. This research investigated the incorporation of performance-related metrics (such as speed and distance covered), physiological parameters (including heart rate and body temperature), and the perspectives, experiences, and beliefs of professional football players regarding the utility and influence of wearable microsensor technology on their performance. A holistic comprehension of the soccer player's physical capabilities, as well as their physiological, psychological, and emotional reactions to training and match conditions, could be attained through the integration of these dimensions. This enables them to enhance player well-being and performance, make informed decisions regarding player selection, as well as coming up with automated personalised training systems monitoring players' performance during training and matches.

1.9 Study Outline

The study's background, purpose, objectives, research questions, issue statement, significance, and motivation were all covered in Chapter 1. The study's complete background on the use of wearable microsensor technology was also included in this chapter. It also named a particular scientific problem that gave rise to the investigation.

Chapter 2 covered Review of Literature. A complete assessment and analysis of relevant research literature was done in the literature review chapter. It sought to discover knowledge gaps, synthesise prior research, and defined the study's theoretical framework. This section also showed the researcher's field knowledge and established the study approach.

Chapter 3 covered research methodology describing the study's design, data gathering, and analysis. Methodology chapters clarified how research questions were answered and how data was collected and analysed. It is essential for research validity and dependability.

Chapter 4: (Results). The study's data-driven findings are presented in the results chapter. This part includes statistical analysis, data visualisations, and findings details. Each study question or hypothesis from prior chapters should be addressed in the outcomes chapter.

In Chapter 5 and 6: summary and conclusion chapters interpret results in relation to study questions, reviews implications, and compares them to past studies. It also discussed study limitations and suggests additional research. The discussion chapter sought to illuminate the findings' importance in the study field. The chapter summarises the study's findings, emphasises its importance, and analyses

its implications for theory, practice, and policy. It also evaluates the research's merits and weaknesses and advises future research. Finally, the conclusion chapter reviews the dissertation.

1.10 Chapter summary

The chapter provided a useful conceptualisation and theorisation of the theme under study. The rolling out of wearable microsensor technology in chosen football teams at premier league levels in Zimbabwe has significant potential to improve player performance, minimise injury risks, and optimise training techniques. By utilising the abundant data generated by these devices, clubs can obtain a competitive advantage while placing a high importance on the health and welfare of their athletes. While wearable technology is becoming more prevalent in the premier leagues of industrialised nations, it is believed that its usage in the local premier league in Zimbabwe is low or limited, and its potential remains uncertain. The literature review is covered in Chapter 2.

CHAPTER TWO:

LITERATURE REVIEW

2.0 Introduction

Wearable technology in the Football Premier League provides various advantages for both individual players and teams. This explanation will explore the use of wearable technology in the Premier League, focusing on its effects on player performance, injury prevention, tactical analysis, physical conditioning, and player monitoring. A literature review, according to Case (2021), is an unbiased, critical synthesis of existing research material pertinent to a topic under investigation for further study. Its goal is to familiarize readers with current ideas and research on a certain subject, and it might support further investigation into a neglected or understudied field in the past. According to Chisenga (2020), a literature review is merely an overview of what is known about a certain issue in the body of extant scholarship. It never starts with primary sources, i.e., what other people have already written on the topic; it doesn't focus on learning anything new. Wearable technology is becoming more and more popular in sports, especially football, because it may enhance player performance and provide coaches and trainers with insightful data. Hence, this chapter reviewed past and present scholarly literature on utilisation of wearable technology for the soccer performance enhancement of players in the premier league.

2.1 Theoretical framework

The use of a theoretical framework in a study is highly significant. The theoretical framework serves as the fundamental basis for constructing knowledge in a research study, both metaphorically and literally. The study's justification, problem description, purpose, importance, and research questions were based on the framework. The methodology, analysis, and literature evaluation all rest on the theoretical framework. According to Varpio, Paradis, Uijtdehaage, and Young (2020), developing a theoretical framework is crucial for conducting dissertation research.

A researcher does not choose a framework at random; rather, it is a reflection of important personal convictions and understandings about the nature of knowledge, its presence in connection to the observer, and the kinds of roles and instruments that the researcher may take on and use in the course of their work. A theoretical framework is essential for providing structure and direction to a study, similar to how a blueprint is necessary for constructing a house. In contrast, a research plan

incorporating a theoretical framework enhances the strength and structure of the dissertation study, facilitating a coherent progression from one chapter to another. This study looked into the effects of wearable GPS technology on the performance of players in football premier levels. The Diffusion of Innovation (DOI) Theory and the Technology Acceptance Model (TAM) served as the study's guiding principles.

2.1.1 Theory Innovation diffusion theory (IDT)

The transmission and gradual dissemination of an innovation among members of a social system is referred to as innovation diffusion theory, or IDT (Rogers, 2010). The work proposes five key attributes of innovation: relative advantage, compatibility, complexity, trial ability, and observability. Moore and Benbasat (1991) incorporated additional perceived characteristics of innovation into Rogers' traditional theory of innovation diffusion (Taylor and Todd, 1995). Scholars have proposed that varying interpretations of innovation can lead to divergent patterns of user adoption (Rogers, 2010; Moore & Benbasat, 1991).

Everett Rogers created the Theory of Innovation Diffusion, a framework that explains how, why, and how quickly new concepts, innovations, or goods proliferate through society (Kelly, 2021). Since it clarifies the elements influencing acceptance and integration of these gadgets into the sport, this theory can be used to the adoption of wearable technology in football.

The adoption of wearable technology in football can be influenced by a number of factors, including its perceived use, usability, and compatibility with current procedures. Furthermore, societal factors like the views of teammates, coaches, and supporters can have a big impact on how well new technologies are received. Along with specific definitions, the unifying theme found across all research is that wearable technology (WTs) should have sensors, CPUs, power sources, and be able to be worn on the body.

In order to better understand the aspects influencing the acceptance and integration of wearable technology in football, the Theory of Innovation Diffusion might be employed. Wearable technology has the ability to dramatically increase football players' performance by giving them personalized real-time input. However, challenges and limitations must be addressed, such as cost, accuracy, and potential distractions, to ensure that these devices are used effectively and responsibly.

The analysis of the adoption of wearable technology in football can be approached through the lens of the innovation diffusion theory. In the early stages of awareness, football teams and athletes

become acquainted with the presence of wearable technology (Naglis & Bhatiasevi, 2019). One way to achieve this is by utilising various channels such as media coverage, conferences, or presentations conducted by technology companies. During the interest stage, football teams and athletes demonstrate curiosity in the technology and its potential advantages. This motivation can stem from a desire to enhance competitiveness or elevate player capabilities. The evaluation stage requires teams and athletes to assess the compatibility of the technology with their current systems and practices.

2.1.2 Technology acceptance model (TAM)

The technology acceptance model (TAM) is a useful and succinct method for figuring out how people plan to embrace and utilize new technologies. This concept's ability to explain phenomena has been proven in a variety of emerging technology-related domains. Perceived utility and perceived ease of use are two cognitive characteristics that are said to impact users' intentions to accept technology, according to the Technology Acceptance Model (TAM) (Davis, 1989). Information technology adoption is influenced by a number of factors, including perceived utility, perceived ease of use, and user acceptance.

Perceived usefulness (PU) pertains to the extent to which individuals hold the belief that their work performance will be enhanced through the utilisation of a particular technology. Perceived ease of use (PE) refers to the subjective perception that individuals do not need to exert substantial physical or mental effort when using new technologies. According to Kelly's (2021) study, wearable technology could track the sporadic activity patterns of soccer players during a 90-minute game. These patterns would include periods of high-intensity activity interspersed with periods of lower-intensity activity. The total energy expended during a game is also significantly influenced by frequent bouts of high-intensity activity, numerous accelerations and decelerations, changing directional modes, unconventional movement patterns, and the execution.

Choe and Noh (2018) state that the Technology Acceptance Model (TAM) indicates that the intention to adopt technology is positively correlated with perceived utility (PU) and perceived ease of use (PE). Furthermore, it has been discovered that PU mediates the relationship between PE and the intention to use (INT). The Technology Acceptance Model (TAM) is the basis for the theories put out in this study.

An effective framework for understanding the variables influencing the integration of wearable technology into football games is provided by the Technology Acceptance Model. Through an analysis of several elements, including perceived utility, perceived simplicity of use, social impact, individual variances, and organizational support, a thorough comprehension of how football players and coaches make decisions about new technology adoption may be attained. Ultimately, this knowledge can contribute to the advancement and application of efficient wearable technology solutions for enhancing soccer performance and ensuring safety

2.2 Adoption of GPS wearable technology in monitoring and analysing the performance of professional football players at premier levels.

The integration of wearable technology with a decision support system has been found to significantly improve performance analysis and subsequently enhance athletic performance. In the past, coaches used their own observations to evaluate and guide their athletes' training. As noted by Wright (2015), Nicholls, James, Bryant, and Wells (2018), and Rein and Memmert (2016), contemporary performance analysis technologies (PATs), have had a significant impact on coaching practices and training methodologies. PATs are essential in economically successful sports contexts, including American football in the US and football (soccer) in the UK (Tierney, 2021). Diverse specialist teams use cutting edge technology in these situations, including mobile applications, wearable microtechnology sensors, video and computer-assisted analysis, and global positioning systems (GPS). These instruments are used to gather information on a range of topics, such as playing strategies, physiological and kinematic characteristics (such as distance travelled during a game, acceleration speed), and health and wellness factors (such as anxiety, sleep, and weight). Technical assistant coaches, strength and conditioning coaches, position-specific coaches for players, match and video/tactical analysts, physicians, dietitians, physiotherapists, and psychologists make up the squad. The measures and data that are routinely taken require a great deal of specialized processing before head coaches, sport managers, and club administrators can access them. These people make decisions on player selection, match play tactics, and individual and group training assignments based on the information.

Many companies and research organisations have targeted smart devices recently. A "smart device" independently collects data about users or their environment to aid self-awareness and decision-making. Smart gadgets are also called personal informatics systems (2010) and quantified self

(2014). These phrases were introduced during the 2010 computer systems human aspects conference (Choe and Noh, 2018). Laptops and cell phones are examples of smart devices, which have multiple tasks and aims. Whether implemented locally or remotely by a server, these devices serve as platforms for many typical implementations. Many smart devices and appliances are available. They are usually used by individuals in modified settings. Intelligent gadgets have a control unit and interface point. These gadgets have effective, mobile, and accessible apps and non-continuous power (synchronisation, advertising, etc.). Due to their widely accessible functions, devices are designed to serve numerous tasks and enable seamless operation and multitasking at work. People sometimes refuse to balance two desirable but incompatible features because they want as many benefits as possible from the item (Anderson, Triplett-McBride & Foster, 2019). Thus, this issue has been reduced to the extent that the system must retain hardware components and provide an effective adjustable capability to interoperation work time. Initially, computers are seen as multifunctional PCs or host computers with servers. A demonstration system and data entry tools such pointing devices, mice, and keyboards are common in these setups. In addition to complicated devices with various computing machinery systems, humans tend to engage with monocular and computing machinery systems, such as domestic appliances. The number of users per computer decreased from a big number to a single user, then climbed to a number of computers per user, according to Weiser. Computing system-based gadgets will become smaller, lighter, and cheaper to make. Thus, devices can become more portable, widespread, and less annoying. Weiser first envisioned centimetre-sized peripheral devices (tabs), decimetre-sized handheld devices (pads), and meter-sized screens. User-accessible tabs with phone features and information and communication technology allowed consumers to track frequently used products. Wall displays enable collaboration and the presentation of huge, complicated designs like charts, making screening for many customers beneficial. Lateral and vertical filtering can be done with board appliances (Poslad, 2013).

The integration of GPS wearable technology in monitoring and assessing the performance of professional football players in the Premier League has greatly revolutionised the method teams employ to assess and improve player performance. According to Anderson, Triplett-McBride and Foster (2019), GPS technology enables coaches and sports scientists to gather significant real-time data on players' physical performance throughout training sessions and matches. This technology has become indispensable for analysing performance in professional football, providing vital insights for training methods, injury prevention programmes, and tactical decision-making.

Kelly (2021) conducted one of the initial studies utilising GPS technology in real-world football settings. Over the past 20 years, GPS technology has made great strides, making it possible to precisely record the three-dimensional position and velocity of moving objects outside. Higher sample frequencies and a greater number of satellites in orbit are two reasons for this advancement (Schutz and Chambaz, 1997; Varpio, Paradis, Uijtdehaage, and Young, 2020). The sampling frequency refers to the rate at which a GPS device communicates with a satellite to determine its location. Previous studies have reported recording frequencies ranging from 1Hz to 5Hz for early devices (Coutts and Duffield, 2010; Neville et al., 2011; Smith and Bedford, 2020). Nonetheless, research in team sports are already recording at rates higher than 18Hz, because to substantial technological developments that have raised recording frequencies (Hoppe et al., 2018). 10Hz devices are frequently employed in the field sport of football (Rampinini et al., 2015; Malone et al., 2019). As opposed to timing gates (Yanci et al., 2017) and video analysis (Beato et al., 2016), some researchers have expressed doubts regarding the accuracy of these devices when operating at fast speeds. Portas et al. (2010) discovered that devices with higher sampling frequencies tend to have decreased reliability in the recorded data, despite their increased accuracy. This implies that there may be a trade-off between accuracy and dependability that must be considered.

According to El Bouchefry and de Souza (2020), machine learning is a subfield of artificial intelligence that focuses on developing algorithms that can make judgements based on data rather than predetermined programming instructions. Machine learning involves enhancing computer programmes to enhance their performance through experience. It is being used in sports, specifically in Major League Baseball (MLB). Tracking player performance data and analyzing metrics like batting average, on base percentage, runs batted in (RBIs), and other performance-related variables are done with publicly accessible tools like Statcast. This investigation contributes to the understanding of upcoming production. To further increase the rate at which season ticket holders renew their tickets from one season to the next, clubs in the National Basketball Association (NBA) have implemented machine learning models (Goh, 2019).

Football clubs are compelled to invest in wearable technology and other Personal Activity Trackers (PATs) due to the increasing accessibility of these devices and the aggressive marketing strategies used by PAT companies. Additionally, prospective investors must be equipped with the knowledge

necessary to assess differences in product quality (Luczak et al., 2020). Stakeholders need to comprehend the concepts of validity and reliability in relation to GPS systems. This is because variations in the data chips, filters, and data-processing algorithms included into the hardware and software of these systems may result in data collected by them being less accurate than others (Malone, Lovell, Varley, & Coutts, 2017). The validity and reliability of the GPS unit's measurements are influenced by several factors, including the number of satellites linked to the device, whether the measurements are taken in real-time or during a post session, and the minimum effort duration settings. Investors, in their role as experts and mentors, must recognise that the elements described above have an impact on the gathering of data and the reliability of PAT data. The limited budgets of Swedish elite men's football clubs, and potentially those of many other countries, make it crucial to address challenges related to the lack of essential knowledge about performance analysis technologies (PATs) and issues concerning their validity and reliability. Financial constraints may necessitate the re-evaluation and reallocation of funds, perhaps placing areas in need of financing at a disadvantage. Sweden's sponsorship of PATs in men's elite football may exacerbate the existing disadvantage faced by activities that already receive less support, such as girls/women's football and non-elite participation in football (Ericsson & Horgby, 2020). According to Baerg (2017), PATs contribute to a digital divide, which exacerbates inequities across different sports environments and countries. The pressure to invest in Player Acquisition Targets (PATs) remains significant, and this may have particularly unfavourable implications, especially for football clubs' budgets that have been damaged by the ongoing global pandemic such as COVID-19.

Performance aid technology has existed, but it relied on equipment that was unreliable and did not provide immediate feedback to players. During the 1950s, when physiologists initially began working with elite sports in Sweden, there was a prevailing idea that scientific measurements could be readily applied to coaches' decision-making (Ericsson and Horgby, 2020). It was considered that measuring the oxygen uptake of elite cross-country skiers by bicycle ergometer testing was a credible method for team selection (Åstrand, 1988). The act of analysing data without considering its context is currently deemed undesirable, particularly in light of the expanding capacity to gather increasingly intricate and sensitive data, as well as the growing need to personalise training (Nicholls & Worsfold, 2016). Performance analysis experts concur that the measurement of training and performance should be considered in the context of various factors, including as the competitive

season, specific match and play scenarios, referee decisions, and most significantly, the health and well-being of the players (Mackenzie and Cushion, 2013; Wright et al., 2014).

Furthermore, researchers have noted an increasing challenge in producing longitudinal data instead of isolating instances from a certain practice or game (Barnes, Archer, Hogg, Bush, and Bradley, 2014; Bush, Barnes, Archer, Hogg, and Bradley, 2015). A deeper comprehension of the practical application of wearable technology in the football industry is unquestionably necessary. The efficacy of depending on commercial suppliers for interpreting and conveying information from equipment has been scrutinised in relation to enhancing performance, monitoring performance, and averting injuries (Buchheit and Simpson, 2017; Bradley and Ade, 2018). The swift progress of technology in sports has resulted in heightened contention and opposition from important participants, along with a dearth of confidence (Weston, 2018; Jones, 2019a; Luczak et al., 2019). The proliferation of measurements offered by firms is leading to a state of perplexity in the communication of football data (Malone et al., 2019; Rago et al., 2019).

GPS wearable devices utilised in football are comprised of a small, portable gadget that is worn by players, usually in the form of a vest or harness. These units are equipped with sensors that gather data on multiple factors, such as distance travelled, velocity, acceleration, deceleration, changes in direction, heart rate, and player collisions (James, Mellalieu & Hollely, 2019). According to Whitehead, Till, Weaving, and Jones (2018), data is communicated without the use of wires to a central computer for processing by sports scientists and coaches using specialised software. The examined data allows for thorough performance analysis and the recognition of patterns or trends that might guide decision-making. The data can function as a standard for customised training of football players in the Premier League.

One advantage of GPS wearable technology is that it offers unbiased information on football players' performances. Sports scientists and coaches can efficiently monitor football players' physical performance, doing away with the need for subjective assessments (Seshadri, Thom, Harlow, Gabbett, Geletka, Hsu... & Voos, 2021). By employing data-driven methodologies, evaluations of participants' fitness levels, workload administration, and longitudinal development are all enhanced. Furthermore, athletes have the ability to employ this technology in order to monitor and trace their personal development throughout personalised training sessions.

More study is needed to increase the models' usefulness in the field of sports medicine (Claudino et al., 2019). Predictive models can function as automated data analysts, offering important insights into athletes' conditions. Prior research has demonstrated that the performance of predictive models has been subpar as a result of small sample sizes and low rates of injuries. Furthermore, there remains a dearth of knowledge regarding the components that contribute to injuries and the intricate interplay between these elements within the ever-changing framework of athletic performance (Seow et al., 2020).

Although prior research has raised doubts regarding the precision of ubiquitous GPS technology in football (Bucheit et al., 2014 and Rampinini et al., 2015), football clubs worldwide and in the United Kingdom continue to employ it frequently. Professional football players' and academy athletes' everyday routines have been significantly changed by the increasing use of wearable technology. The potential of GPS technology to enhance the development of football athletes, encompassing both performance and health dimensions, has been the subject of numerous studies. Presently, there is a notable focus on the implementation of surveillance methodologies in order to cultivate athletes into paragons of physical prowess (Radlo, 2012). Dong, Fang, Li, Sun, & Liu (2021) and Weaving et al. (2014) provide recommendations regarding the ideal amalgamation of surveillance technologies to get accurate and pertinent information. Despite recent developments, our comprehension of the day-to-day experiences of football players who are subject to continuous monitoring by wearable surveillance devices remains restricted.

Global Positioning System (GPS) enabled peripheral technology possesses the capacity to significantly augment football performance, including that of the Zimbabwe Premier League. These sophisticated peripheral devices have the capability to furnish significant data and insights that may be utilised to optimise training regimens, enhance overall team strategy, and optimise player performance. Football demands an extensive knowledge of the sport, technical and tactical expertise, and a robust physical condition. In recent years, technology has considerably improved the performance of football players. A technological marvel, the GPS is remarkably innovative and efficient. The objective of this research endeavour is to examine the effects of GPS technology on the analysis, monitoring, and enhancement of football performance for both instructors and players.

The application of technology enables technical teams to more efficiently monitor and analyse the data of participants. The prevailing wearable technology employed by teams in the Premier League

is vests that are endowed with devices designed by Catapult Sport Deal (Martins, Marques, Franca, Sarmento, Henriques, Ihle,.. & Gouveia, 2023). Teams ought to exhibit a dedication to integrating technology through the use of applications that enable the tracking of players' advancements (Rossi et al., 2018; Pappalardo, Cintia, Iaia, Fernandez, Medina). Numerous metrics, including distance travelled, maximum speed achieved, heart rate, number of completed passes, and interceptions executed, can be monitored by means of these applications. This information is easily accessible through the utilisation of a single click. Zililo (2023) asserts that Bulawayo Chiefs are the only organisation in Zimbabwe to utilise technological tools for the purpose of monitoring player development and generating statistical data to aid in athlete promotion.

2.3 Benefits of GPS wearable technology adoption in optimising training and match preparation strategies in Soccer

There has been a significant surge in the adoption of wearable technology by both athletes and support personnel (Drust & Green, 2013). Despite the escalating prevalence of wearable technology, a dependable conceptual framework for comprehending its application in educational and performance football settings is presently absent. Wearable tech tools like Catapult, Statsports, Polar, Titan, Playermaker, GPEXE, GPSports, and SPT have potential uses in education, but their relevance is still up for debate. Seshadri et al. (2017) report that Catapult and Statsports systems, which are frequently employed in elite environments, produce more than one thousand data points per second by utilising over two hundred and fifty distinct metrics and parameters. Additionally, these systems integrate a multitude of proprietary metrics or parameters that demonstrate discrepancies among one another. Therefore, in order to facilitate translation and communication with numerous stakeholders in a privileged setting, it is imperative to employ full-time personnel. According to Rago et al. (2019), Collins, Carson, & Cruickshank (2015), and Malone et al. (2017), there is increasing skepticism and uncertainty surrounding the systems under consideration.

The implementation of GPS wearable technology has witnessed a surge in popularity within professional sports, such as the Premier League, owing to its capacity to enhance strategies for training and match preparation (Kelly, 2021). In addition to distance travelled, speed, acceleration, and deceleration, these wearables can provide crucial information regarding the physical performance of the athlete, including heart rate and workload. In addition to collecting data, the

ubiquitous technology incorporates a communication mechanism for monitoring an individual's performance.

Through the application of the data collected by wearable technology, sports scientists and instructors are able to customise training regimens in order to accentuate particular players' strengths and rectify any physical shortcomings. In addition to aiding in the prevention and recuperation of injuries, GPS wearable technology can provide information that can inform tactical and strategic decisions throughout matches (Miao et al., 2019). In their 2016 study, Malone, di Michele, and Morgans examined the impact of GPS technology on physical performance and player profiling in elite football. The results of their investigation demonstrated that GPS technology is effective in generating insightful data that can inform individualised training interventions. Similarly, Barrett et al. (2017) examined how GPS tracking affected professional football players' physical performance and ability to avoid injuries, emphasizing the benefits of using it in the lead-up to and during training. Therefore, the implementation of wearable technology can be manipulated to provide participants with individualised training.

According to Kelly, (2021), GPS technology revealed that elite-level competitors cover approximately 10-13 kilometres in a 90-minute game. Previous research has demonstrated that the overall distance travelled during matches can vary. These differences can be ascribed to a number of contextual elements, such as the playing position, the coach's tactical methods, the quality of the opposing team, and the type and intensity of football game played (Barnes et al., 2014; Bush et al., 2015). Therefore, it would seem that the team's tactical approach has a big impact on each member's behaviour. Prior research demonstrated high-velocity actions exhibit significant variation across games and are impacted by variables like ball position and the playing field, which arise from alterations in the game's tactical and technical according to Gregson et al. (2010).

In general, the integration of GPS wearable technology within the football premier league levels holds promise for enhancing match preparation and training strategies through the provision of exhaustive data regarding the physical performance of players. This, in turn, could ultimately augment their overall preparedness and performance in competitive settings. According to a study by Miao, Wang, Zhang, Sun, Cheng, and Liu (2019), GPS technology can determine a person's location and velocity using the satellite, just as any other GPS device does, and then divide the data into analysable components. Undoubtedly, the incorporation of GPS peripheral technology into the

premier levels possesses the capability to profoundly influence the training and preparation regimens employed by clubs' athletes (Tierney, 2021). The aforementioned technology possesses the capacity to offer substantial insights into the real-time physical performance of athletes. The aforementioned insights might subsequently be implemented in order to enhance training regimens and refine match preparation strategies. Through the surveillance of players' movements, distance covered, and other pertinent metrics, organisations can gain a deeper understanding of the physical readiness of their players, potentially leading to improved performance on the pitch. With the aim of reducing injuries and optimising player performance, this data may also be employed by instructors and sports scientists to enhance their decision-making processes concerning player conditioning and burden management.

2.4 Use of GPS wearable technology in decision-making, tactical and technical analysis in football matches.

Achieving sporting success is a catalyst for personal growth and motivation; whether through active involvement in sports (Frick & Wicker, 2016), endorsing sports-related products (Stride et al., 2015), or both, we all strive to attain a sense of connection to it. According to Fransen, van Rompay, and Muntinga (2013), sports have traditionally been employed by commercial enterprises to promote and sell a variety of products associated with sports. Renowned for their accurate timing in Olympic and other sporting occasions, Timex, Tissot, & Longines have employed this approach in their advertising campaigns to demonstrate the practical implementation of their sports technology. The objective of this strategy is to increase consumer wristwatch sales (Fransen, van Rompay, & Muntinga, 2013; Donze, 2020). Athletes utilise heart rate monitors and other wearable technologies throughout training and competition. The sports industry has embraced these innovations. Prospective consumers have been introduced to these devices by brands such as Polar Electro. Further, replica kits are available for purchase in retail stores; these kits are worn by football teams and attract lucrative sponsorship agreements.

According to reports, football is an activity that would benefit from a greater sampling frequency. This is due to the fact that football requires players to move quickly and intensely, making it possible to detect the game's numerous sudden changes in direction and speed. Nevertheless, the matter becomes intricate due to the non-cyclical and unpredictable character of football; thus, the integration of supplementary micro-technologies into the GPS devices becomes imperative (Kelly,

2021). As an example, Wagner (2018) lists the tri-axial accelerometer as the third most important technological innovation because it can provide an even higher sample frequency (100Hz). Therefore, rather than depending only on GPS, this method allows for a more precise identification of these particular movements and movement patterns that are inherent to football (Barron et al., 2014; Kelly et al., 2015; Nedergaard, Robinson, & Vanrenterghem, 2015; Fessi et al., 2018; Nicolella et al., 2018; Macadam et al., 2019; Zago et al., 2019). This idea is supported by further study that looks at the connection between movement quality and precision in motion analysis in high-speed running (Alexander et al., 2016), rugby (Howe et al., 2017), and netball (Cormack et al., 2014).

The question of privacy and ethics in the sports industry has long been a matter of scholarly discussion (Schneider, 2004; Testoni et al., 2013; Simon, 2018). Cheating, which has been documented since the beginning of athletics (Leaman, 2001), and the use of illegal substances, such as drugs (Brown, 1980 & Kelly, 2021), are serious issues related to gaining an unfair advantage. In an ongoing effort to optimise their athletic prowess, certain athletes unethically or intentionally consume substances that are prohibited in their specific sports. While the utilisation of these substances might improve performance, it also presents substantial health hazards. Moreover, the differentiation between lawful and unlawful substances is a matter of opinion and differs across various athletic disciplines (Orchard et al., 2006). Anti-doping policies and testing protocols are consistently updated by sport regulating bodies in an effort to deter athletes from utilising prohibited substances, which could grant them an unjust advantage over ethical competitors. Additionally, this measure protects athletes from the adverse consequences that hazardous substances may have on their physical and mental health (Qvarfordt et al., 2019).

Notable advancements in wearable technology include the invention of skin-applied Miao, Wang, Zhang, Sun, Cheng, and Liu, (2019); Takei, Gao, Wang, and Javey, (2019) and swallowed Berglund, Valentinuzzi, and Johnson, (2018). Electronic devices being present within the human body is not a novel phenomenon. Since the 1950s, pacemakers and other medical devices have been used to improve patient health. Furthermore, individuals also utilise a variety of external devices, including hearing-aides (Azariadi et al., 2016). Additional research is necessary to delve into the potential health and wellbeing concerns that may arise in relation to wearable technology for athletes, as highlighted in this evaluation. An array of privacy and ethical concerns has been prompted by the incorporation of wearable technology into sports. The issues addressed primarily include the

collection, scheduling, security, and use of the data generated by these devices (Page, 2015; Thierer, 2015; Wang & Destech Publicat, 2015). Recent technological advancements have exacerbated broader international concerns regarding data protection and individual privacy, of which this matter is a component. The General Data Protection Regulation (GDPR), which replaced the European Data Protection Directive (EDPD), was established by the European Parliament in 2016. In Europe, the most recent data protection laws are the aforementioned frameworks. They become regulations in May of 2018 (Voigt & Von dem Bussche, 2017).

The utilisation of GPS wearable technology, which players typically incorporate into their apparel using vests or small pods, is prevalent in decision-making processes, specifically in relation to player substitution and selection (Carling & Bloomfield, 2018). Wearable technologies equipped with sensors collect data pertaining to a variety of parameters, encompassing distance, velocity, acceleration, deceleration, pulse rate, and impact forces. For subsequent analysis, data is wirelessly transmitted to a central database or computer system. Coaches can utilise real-time data from GPS devices in order to assess the physical performance of their athletes throughout a match. This data facilitates the identification of player fatigue and the necessity for substitution, in addition to the detection of a performance decline that falls below the intended standard. Furthermore, GPS data may offer important new information about the players' positions, movement patterns, and labour rate. Based on this information, informed decisions can be made concerning formation modifications and tactical adjustments.

Wearable technology, encompassing smartwatches, fitness monitors, and GPS devices, affords football players a multitude of advantages. According to Kelly (2021), these devices possess the capacity to observe and assess various dimensions of an athlete's performance, including pulse rate, distance covered, velocity, and sprint frequency. By providing personalised, real-time feedback, the data can assist participants in making well-informed decisions and improving their overall performance. The value of GPS technology has been established in the domain of tactical analysis. Coaches and analysts can acquire significant knowledge regarding the tactics and strategies of opposing teams by conducting an examination of player movement patterns (Adesida, Papi & McGregor, 2019). The utilisation of GPS data can yield valuable insights into the whereabouts of players throughout different stages of a game, including offensive and defensive actions, team interactions, and reactions to particular circumstances (Mohammed & Karagozlu, 2021). This data

assists coaches in discerning the merits and demerits of their team's tactical methodology, thereby enabling them to make the necessary modifications.

Technical analysis entails the assessment of individual participants' technical proficiencies and capabilities via the application of GPS data. The agility, quickness, and explosiveness of athletes can be evaluated by analysts through the observation of metrics including speed, acceleration, and deceleration. Global Positioning System data can reveal important information about an athlete's ball control, passing precision, and shooting efficiency. This data assists coaches in pinpointing specific areas where athletes can enhance their performance and formulating tailored training regimens.

2.5 Ways for improving the utilising integrated GPS wearable technology in football for performance enhancement

Computer science services in specialized technological domains, like data handling and software creation for training manuals, sensor control, data visualization, and many more, are highly advantageous to sports scientists. The integration of Wearable GPS technology has transformed the analysis and optimization of sports performance. The devices come with sophisticated sensors capable of monitoring a range of physical metrics including distance, speed, acceleration, deceleration, changes of direction, and physiological parameters such as heart rate. Through the collection and analysis of these metrics, coaches, trainers, and sports scientists can acquire valuable insights into players' fitness levels, workload, and overall physical performance.

The integration of wearable technology in football has revolutionized the way players' performance is monitored and analysed. By combining wearable devices with other technological advancements, such as data analytics and machine learning, teams can gain valuable insights into various aspects of a player's performance, leading to improved training programs, injury prevention strategies, and overall team performance.

2.5.1 Tracking Physical Metrics

Currently, organising a sports event necessitates comprehensive statistical data and a plethora of figures to offer fans real-time information about their preferred teams or athletes during live broadcasts (BODACZ, 2015). Advancements in technology expand the possibilities for amateur athletes. Global Positioning System wearable devices use satellite technology to accurately track the movements of athletes in a football match during training or competition. In studies Polglaze,

Dawson, Hiscock, and, Peeling (2015) and Theodoropoulos, Bettle, & Kosy (2020) it was established that wearable technology with GPS has the ability to provide real-time data on the distance covered by players, their speed at different intervals, acceleration and deceleration patterns, as well as changes of direction. It was further stated that this information is crucial for assessing an athlete's performance on the field and identifying areas for improvement. The studies highlight the importance of wearable technology with GPS capabilities in providing real-time performance data for assessing athlete performance, identifying areas for improvement, and optimizing training and tactical strategies in football and other sports. The way athletes practise, compete, and perform at the highest levels could be completely changed by this technology. It is in therefore critical to track the physical metrics of players in football so that the coach is able to determine the physical metrics.

2.5.2 Analysing Tactical Performance

Beyond physical metrics, wearable technology can also be used to analyse players' tactical performance on the field. Coaches can obtain important insights into players' decision-making processes and overall performance by monitoring players' placement, movement patterns, passing accuracy, and other tactical aspects of the game (Goes, Kempe, Van Norel & Lemmink, 2021). The data obtained from wearable technology can be used to identify strengths and weaknesses in individual players or the team, leading to more effective game strategies and player development plans.

2.5.3 Improving Team Communication

Integrating wearable technology in football is potential as it can improve team communication and coordination. Wearable devices can be used to facilitate real-time communication between players on the field and coaching staff on the side-lines (Theodoropoulos, Bettle & Kosy, 2020). The integration of wearable devices for real-time communication between players and coaching staff represents a valuable innovation in modern football that has the potential to revolutionize the way teams prepare for and compete in matches Ráthonyi, Müller & Rathonyi-Odor, 2018). By leveraging technology to enhance communication and collaboration, teams can gain a competitive edge and elevate their performance on the field. For instance, smartwatches or earpieces can be used to relay tactical instructions, game plans, or performance feedback directly to players during matches. This seamless communication can help teams make quick adjustments during games and enhance overall team cohesion.

Sports companies make substantial use of analytics, wearables, management information systems, and fan engagement platforms, (Qi, Sajadi, Baghaei, Rezaei, & Li 2024). Analytics, statistics tools, and management information systems were found to have a substantial impact on improving organisational performance and efficiency. Wearable technologies have become essential for preventing injuries by monitoring athletes' health metrics (Jones, 2019). The potential of cutting-edge technology in the sports sector, such as augmented reality, athlete tracking, predictive analytics, exoskeletons, and artificial intelligence (AI) coaching, was brought to light by the expert interviews.

2.5.4 Enhanced Fan Engagement

The future of technology with regards to utilization of wearable technology cannot be underrated. Sport informatics is a discipline that has grown during the last three decades. The way sports are played, evaluated, and improved in today's connected world has changed dramatically thanks to the usage of wearable technology, big data analytics, social media, and sensor technologies (Cushion & Townsend, 2019). Pro athletes can better training methods, develop new skills, and have more insight into their performance with the use of numerous current advancements and apps. In addition to this, fans are searching for mobile-friendly apps that provide them with up-to-date information on their favourite players; real-time, behind-the-scenes material combined with immediate feedback from both athletes and other fans. Additionally, integrating wearable technology into football can improve the watching experience and fan engagement (Luczak et al., 2019; Nosek et al., 2020). Fans may learn more about the game and the contributions of players by using broadcast visuals or smartphone apps that offer real-time player performance data and insights. This increased transparency and access to data can create a more immersive viewing experience for fans and foster a stronger connection between them and the sport.

2.6 Research Gap

Despite numerous research investigating technology-driven performance, there remains a lack of understanding of how these wearable technologies might be utilised for personalised performance analysis in football players (Mohammed & Karagozlu, 2021; Adesida, Papi & McGregor, 2019). Wearable sensing devices, also known as smart electronic devices, have garnered significant attention in recent years. These gadgets, which can be worn as accessories or implants on the body, are the focus of a lot of research (Adesida, Papi, & McGregor, 2019). Their rapid breakthroughs in

manufacturing and sensor technologies are enabling them to make significant progress in terms of technology, functionality, size, and real-time applications.

Several scholarly investigations, such as Anderson, Triplett-McBride, & Foster (2019) and Kelly (2021), have extensively examined the field of human-computer interaction, which plays a crucial role in our everyday existence. These studies have examined the process of gathering data from individuals, transmitting it to a computer for additional analysis, and generating feedback. The studies demonstrate that the conventional method of human-computer interaction, ranging from the traditional keyboard to the contemporary mouse, joystick, and wireless input device, significantly enhances the interaction between individuals and computers. This facilitates computer operation for people and enhances work efficiency.

Studies have indicated that technology has been around for a very long time. However, the effective utilisation of technology for providing real-time personalised feedback is still an important area that requires additional investigation. Nevertheless, the utilisation of wearable technology for performance analysis falls short of fully satisfying the specific requirements of individual players, primarily because it relies on the presence of supplementary input hardware devices. Therefore, the utilisation of on-body wearable technology that may be worn on hands and arms could be a viable project. Devices worn on the arms and hands can detect and transmit a range of information related to a person's physiological state and physical movements. Mohammed and Karagozlu (2021) emphasised the heightened utility of hand gestures, which can be described as movements or gestures performed by the hands and arms either alone or in conjunction. Hand gestures effectively convey a signer's intention, making them a suitable method of natural communication between humans and robots.

Both the expansion of support staff and the players' use of wearable technology is growing at a rapid rate (Drust & Green, 2013). Nevertheless, even if wearable technology is becoming more and more popular, there isn't yet a solid conceptual framework explaining how wearable technology is applied in both performance football and instructional environments. Moreover, even if there are many wearable tech products available (such as Catapult, Statsports, Polar, Titan, Playermaker, GPEXE, GPS sports, and SPT), they might not be useful for the educational field. For instance, the commonly used Catapult and Statsports systems in the elite context have around 250 different metrics and parameters, generating over 1,000 data points per second (Seshadri et al., 2017). These systems also

contain a number of proprietary metrics and parameters that are not compatible with one another. Consequently, it is necessary to hire full-time employees to translate and interact with different stakeholders in the upscale setting. More lately, there has been an increase in misunderstanding and doubt about these different systems (Rago et al., 2019) as well as the data they are supplying (Collins, Carson, & Cruickshank, 2015; Malone et al., 2017). Better knowledge of what these "black box" systems are offering, what the data actually means, and how to use it effectively in an educational setting are necessary (Bartlett & Drust, 2020). This is true not only for football but also for other sport science disciplines (Cushion & Townsend, 2019; Luczak et al., 2019; Nosek et al., 2020), with the potential to go beyond performance reporting. Insufficient research has been done on the application and understanding of this technology for performance monitoring in football environments. Thus, creating, developing, and implementing a wearable technology product for football is the main goal of this project.

2.7 Chapter Summary of Literature Review

In conclusion, GPS wearable technology has significantly transformed decision-making, tactical analysis, and technical analysis in football during Premier League matches. In football, the application of GPS wearable technology has significantly impacted tactical and technical analysis as well as decision-making. With its ability to provide insightful information about player performance and team chemistry, this technology has drastically changed the way coaches, players, and analysts interact with the sport. Real-time data on players' physical performance, gait, and technical skills can be obtained by GPS trackers. Coaches, analysts, and sports scientists can use this data to assess player performance individually and make well-informed decisions on team strategy.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

Research methodology was defined by Brick and Mill (2015:4) as a methodical approach to solving a research problem that involves gathering data using a variety of approaches, offering an interpretation of the data, and coming to research-related conclusions. The research approach that the author employed is the main topic of this chapter. Raulin (2007) states that the researcher must describe the study's methodology, including how the study will be conducted. This chapter explained the demographic, sample, sampling strategy, instruments, data collecting, data analysis, and ethical issues for the study project.

3.1 Research Approach

This study used a mixed research approach, which allowed the researchers to investigate every topic covered by the study's objectives. By employing a mixed research technique, it was possible to mitigate the drawbacks and issues associated with mono methodologies, improve the validity and reliability of the findings, and deepen understanding of the topic under study while identifying new dimensions. According to Leavy (2022), both qualitative and quantitative methods have advantages and disadvantages, and we can strengthen both by combining them. Providing empirical proof was a requirement of the data quantification process. Key informants from the study region provided narratives that served as the basis for the collection of qualitative data.

3.2 Research design

According to Bell & Waters (2018), a research design is a plan that directs the researcher while they gather data, analyze it, and make sense of what they see. Additionally, it is a logical proof model that enables the researcher to make inferences about the connections between the variables being studied. Whether or not the results may be extrapolated to a wider population depends on the research approach.

In the study, an explanatory research design was employed to efficiently and meaningfully summarise and arrange data. When there is inadequate information available on a subject,

explanatory research is a technique used to investigate the causes of events (Swedberg, 2020). When a researcher wants to learn more, gain insights, and develop hypotheses, they use an exploratory research design as a form of research approach. According to Pandey and Pandey (2021), this method enables researchers to delve into uncharted territory, spot possible correlations between variables, and lay the groundwork for future investigations. This kind of design was required to investigate how GPS wearable technology is being adopted and used to enhance the tracking of individual football player performance in Zimbabwe with respect to one or more variables.

The goal of this study was to learn more about the reasons behind certain events, which made it an explanatory research (Siedlecki, 2020). When using wearable technology in football to improve player performance, explanatory study is essential to understanding the reasons behind events. Wearable technology was utilised more and more in the context of football to collect information on players' movements, speed, distance travelled, physical effort, and overall performance during practice and games. Examples of this technology include heart rate monitors, GPS trackers, and biomechanical data. Investigating the underlying causes of the efficacy or constraints of these technologies in improving player performance is made easier with the use of explanatory research. Since data for this type of study was gathered from two football clubs which use technology for performance monitoring, a research design of this kind was necessary.

3.2 Population and sampling.

3.2.1 Target population

The population is the theoretically specified collection of research elements from which the actual sample is drawn (Lakens, 2022). Target population is "the entire aggregation of respondents that meet the designated set of criteria" (Zhao, Tian, Cai, Claggett, & Wei, 2013). The study was conducted at selected teams in the Zimbabwe's soccer premier that use the microsensors wearable technology. This study targeted players, technical and management members from 2 soccer teams at premier levels.

Table 1: 1 : Breakdown of the target population

Team Name	Target population
Team A	2 Technical manager and assistant 1 Coach 1 Match analyst 1 Team Medic 16 Players
Team B	2 Technical manager and assistant 1 Coach 1 Match analyst 1 Team Medic 16 Players
TOTAL	**32**

Source: field data 2024

3.2.1 Sampling techniques

3.2.1.1 Stratified Random sampling for quantitative sampling.

By stratifying the population according to particular attributes, such age, gender, or income level, homogeneous subgroups or strata are created for stratified random sampling. To make sure the sample is representative of the entire population, a sample is then chosen at random from each stratum. In the case of this study participants were placed in groups according to their responsibilities in the teams. When analyzing the adoption and utilization of wearables on players' performance in Zimbabwean football, stratified random sampling is a reliable technique that can improve the validity, reliability, and generalizability of research findings. By appropriately stratifying the football population based on relevant characteristics, the researcher obtained a more comprehensive understanding of how wearables are perceived and used across different segments of the population.

3.2.1.2. Purposive sampling for qualitative design

Purposive sampling allows researchers to target individuals with relevant expertise and experiences, which leads to a more thorough understanding of the research topic. As such, it is an appropriate method for selecting participants when examining the adoption and utilization of wearables on football players' performance in Zimbabwe. Purposive sampling is a non-probability sampling

technique in which the researcher selects specific individuals or groups based on predefined criteria (Campbell, Greenwood, Prior, Shearer, Walkem, Young, & Walker, 2020). This method is also known as judgmental, selective, or subjective sampling. By purposively selecting participants who could provide valuable insights, the researcher can enhance the relevance, depth, and efficiency of this study.

3.3 Data Collection Methods

Research instruments, according to Zohrabi (2013) and Taherdoost (2021), are any devices that can be used to gather, analyze, and analyze data that is pertinent to a researcher's topic. The researcher used interviews and questionnaires to collect data from participants. Selected players from Zimbabwe's top two football teams were given questionnaires to complete. To gather information from important players in Zimbabwe's two top-tier football clubs, semi-structured interviews were employed.

Relevant data was collected to enable the designing a personalised wearable technology for soccer player’s performance and training monitoring. This included physiological data, such as heart rate, as well as biomechanical data, such as speed through speed tests and endurance by the Cooper test. This data was collected using various sensors, such as accelerometers and the GPS wearables.

3.3.1 Interviews

An interview is a data gathering technique where the researcher asks the subject some questions and responses are given (Coppock, 2019). Wa-Mbaleka (2020) went further noting that interviews involve oral questioning and retrieval of requisite verbal responses from interviewees. The researcher conducted face to face interviews using the interview guide in Appendix 2.

Interviews with key informants included the technical team, coaches, and team managers. According to Wa-Mbaleka (2020), during an interview there is a possibility to achieve an excellent communication between a respondent and a researcher. An interview can explore each question or issue in much depth. Current information is acquired rather than historical experiment. Respondent will give information about their experience, opinions, attitudes and their reactions to trends and development. Both structured and unstructured questions were asked. Interviews elicit responses because they allow the researcher to go further into circumstances when respondents only provide

succinct comments, thereby obtaining additional information (Taber, 2018). According to Robson (2011:241), the interviewer has the ability to determine the degree to which the research is addressed, as well as to clarify questions and promote involvement. Interviews can have certain drawbacks, though, as they are linked to bias brought on by halo effects—the impression that interviewees give the researcher—when they interact with them.

3.3.2Questionnaire

A questionnaire based on the study's goals and research questions was employed (see appendix 1). The purpose of the questionnaire was to gather information on how wearable microsensor technology is being used to improve football players' performance in Zimbabwe. The questionnaire is highly rated since it is widely viewed as the most attractive method of data collection. A formalized component of a data collecting instrument, a questionnaire is designed to formally gather information from respondents (Maholtra, 1996 & Smith, 2021). They underlined that a questionnaire needs to inspire, encourage, and urge participants to participate in the interview, cooperate, and be a part of the study process. The questionnaire was structured and comprised of closed ended questions. This was done to allow respondents to choose among several answers.

3.3.3 Data presentation and analysis procedures

The analysis step of the research process is vital because it involves interpreting and making sense of the data that has been gathered. Data analysis is the process of examining data to look for and test links or hypotheses between variables, according to Amoakoh (2012:75). The data was analysed with version 21 of SPSS. Also, data from document review was included in this analysis, categorised by thematic area, as it served as the premise for the data analysis. After establishing the coding framework, the researcher utilised Nvivo 12 to apply the codes to the qualitative data. The software enabled efficient organisation of coded segments, enabling effortless retrieval and comparison of data pertaining to specific themes or concepts. The text search capabilities in Nvivo 12 allow for efficient navigation and retrieval of specific sections of data. Most of the information gathered from surveys and document reviews was displayed graphically in the form of tables, bar charts, and pie charts. Information from interviews and observational data was manually evaluated. To look for patterns and trends in the participant responses, the researcher tried to find common and often used terms and phrases and "cloud" them. As a result, the investigator performed another theme analysis on the collected data. The data from interviews and non-participant observation was presented in a

narrative format detailing the pertinent thematic issues uncovered by the results in relation to the quantitative patterns uncovered by questionnaires and desk research.

Descriptive statistics, such as mean, median, and standard deviation, were used to explain, summarize, and characterize the players' performance data as recorded by wearable technology. A thorough picture of the data's distribution, variability, and central tendency can be obtained from the statistical data that was collected. For instance, the distance covered, speed, sprint test, cooper test, and standard deviation of sprinting speed all offer valuable insights into player performance.

3.3.4 Hypothesis testing

This study employed repeated measurements with ANOVA. Three separate matches were used to gather data, with each game's average speed and distance travelled by players being measured. This test determined whether player performance varied significantly between the several sessions or matches.

An examination conducted using a repeated measures design ANOVA is a statistical test commonly employed to analyze the variations among the means of three or more related groups or conditions. In order to evaluate potential variations in the distance covered and average speed of a player in football matches, a repeated measures ANOVA was employed to determine if there were any noteworthy disparities in these variables (distance covered and speed of a player) across multiple matches. The following is the hypothesis statement applied in this study:

(H_0): There is no significant association between wearable technology usage and improved physical performance in the premier level football team.

(H_1): There is a significant association between wearable technology usage and improved physical performance in the premier level football team.

3.3.5 Materials used for personalized wearable technology

Sensors: The primary materials for a wearable technology for soccer players are sensors. These can include accelerometers, gyroscopes, GPS, heart rate monitors, and oxygen saturation sensors. The choice of sensors depended on the specific KPIs being monitored and the desired level of detail.

Electronics: A wearable technology for football players typically consists of essential components such as a microcontroller, memory, and a power source. The microcontroller is tasked with

processing the sensor data and conducting any required calculations. Data is stored in memory, which can be powered by a battery or energy-harvesting technology.

Wearable Device: The wearable device can be a chest strap, wristband, or other form factor that is comfortable for the player to wear during training and matches. The device should be water-resistant and able to withstand the physical demands of soccer/ football.

Software: The software for a wearable technology for football players consists of data processing algorithms, machine learning models, and a user interface. The data processing algorithms will handle the conversion of raw sensor data into meaningful insights. Machine learning models are utilised to detect patterns and trends in the data, while the user interface offers a user-friendly means for players and coaches to engage with the technology.

Digital Platform: A platform serves the purpose of storing and processing substantial volumes of data, while also granting access to coaching tools and performance tracking platforms. Coaches and players can conveniently review data and monitor progress from any location with a network connection.

3.3.6 Ethical considerations.

Connelly (2014:2) and Hagendorff (2020) argue that the issues of permission, confidentiality, and trust are interconnected in order to maintain the morality of human behaviour. Ethics, which refers to the moral principles governing research, is fundamentally a collection of ethical rules that govern moral behaviour choices and interpersonal relationships (Arifin 2018:30). The following points, which highlight the key ideas surrounding ethical considerations, were followed by the student,

3.3.6.1 All citations to other writers' works utilized in the research were acknowledged.

3.3.6.2 The researcher requested consent and authority, and the relevant authorities granted permission for the study to be carried out,

3.3.6.3 Respect for the dignity of research participants was prioritized.

3.3.6.4 All correspondence on the study was carried out in an open and sincere manner.

3.3.6.5 Finally, for scholarly purposes, this study gathered data, which will remain private.

3.4 Chapter Summary

Designing a wearable technology for monitoring personalized training for soccer players involves a combination of methods and materials. By collecting and analysing relevant data, providing

personalized insights, integrating with coaching tools, and offering an intuitive user experience, the technology can significantly improve player performance and training outcomes. Key materials include sensors, electronics, wearable devices and software, which work together to create a powerful tool for soccer players and coaches.

CHAPTER 4

RESULTS

4.0 Introduction

The results of the investigation are presented, analyzed, and interpreted in this chapter. Descriptive statistics and narratives were used to report the findings. Interviews and structured questionnaires were used to collect the data. Open-ended questions were incorporated into the questionnaire to enable participants to express their thoughts on the specified subjects. The data was analysed using SPSS version 21. A variety of graphic forms, including tables, graphs, and pie charts, were used to portray the data. The respondents' narratives, which served as the presentation format for the interview data, were used. After being sorted into topics, the questions in the interview guides and questionnaires were derived from the objectives. The questionnaire encompassed five distinct thematic sections.

4.1 Response rate of the respondents

A comprehensive set of 30 questionnaires was distributed to the participants in the premier level. A total of 30 completed surveys were sent back to the researcher, meaning that 93.3% of the questionnaires were answered. This information is presented in the table provided.

Table 4. 1. Response Rate of Participants

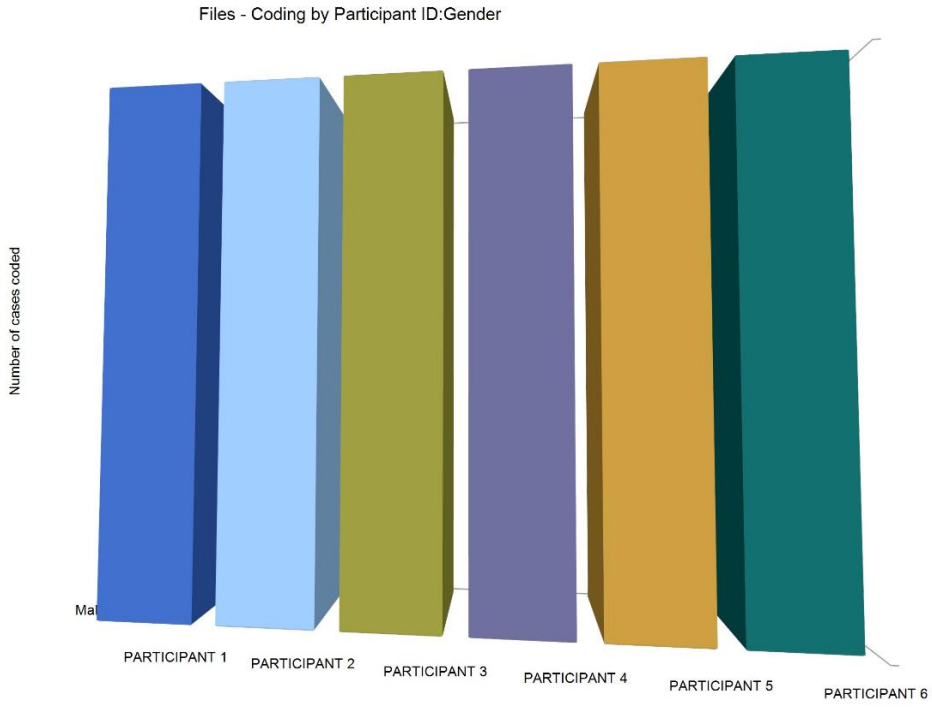
Research Instruments	**Instrument distributed**		**Response rates**	
	N	**%**	**N**	**%**
Questionnaire respondents (Executives, management and general employees)	28	100%	30	93.33%
Interview respondents (Executives and senior management)	6	100%		100%

Source: field data 2024

The research, as in Table 4.1, yielded an acceptable response rate of 93.3% based on a sample size of 28 participants, so providing sufficient data to draw conclusive conclusions. The strong response rate can be ascribed to the researcher's diligent efforts in closely following up with the respondents through telephone calls and personal visits.

4.1.1 Responses from interviewees

Figure 4.1 Responses from Interviewees



Source: field data 2024

Figure 4.1 Responses from interviewees

Figure 4.1 presented illustrates the effects of utilising wearable technologies in enhancing the performance and monitoring of premier level football players. All participants in the study provided complete responses to the interview questions. The strong involvement and keen interest of important parties in this matter highlight its importance and relevance within the professional football realm. The input from all interviewees offers a thorough understanding of the subject and considers multiple perspectives in developing strategies and recommendations

for successfully integrating wearable technologies into football performance enhancement programmes.

4.2 Demographic characteristics of the participants

4.2.1 Gender of the respondents

Table 4. 2: Gender of the respondents from questionnaire

Gender of respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Male	28	100.0	100.0	100.0

Source: Field data 2024

Table 4.3 Gender of the respondents from interviews

Participant ID	Gender	Age	Position
PARTICIPANT 1	Male	37	Technical
PARTICIPANT 2	Male	45	Coaching
PARTICIPANT 3	Male	43	Technical
PARTICIPANT 4	Male	52	Management
PARTICIPANT 5	Male	35	Head player
PARTICIPANT 6	Male	41	Coaching

Source: Field data 2024

The research findings revealed that all of the participants were male. The study's participants exhibit a significant predominance of males, potentially due to various circumstances. The gender of participants gathered from the questionnaire and interviews is also displayed in Tables 4.2 and 4.3. It is important to highlight that males were present in the football clubs at the premier levels teams' training sessions and matches throughout the entire data collection period. Hence, achieving a significant presence of males in the clubs posed a challenge, given that football games are traditionally associated with male participation.

4.2.2 Age of respondents

Table 4. 4 Age of respondents

Age of respondents

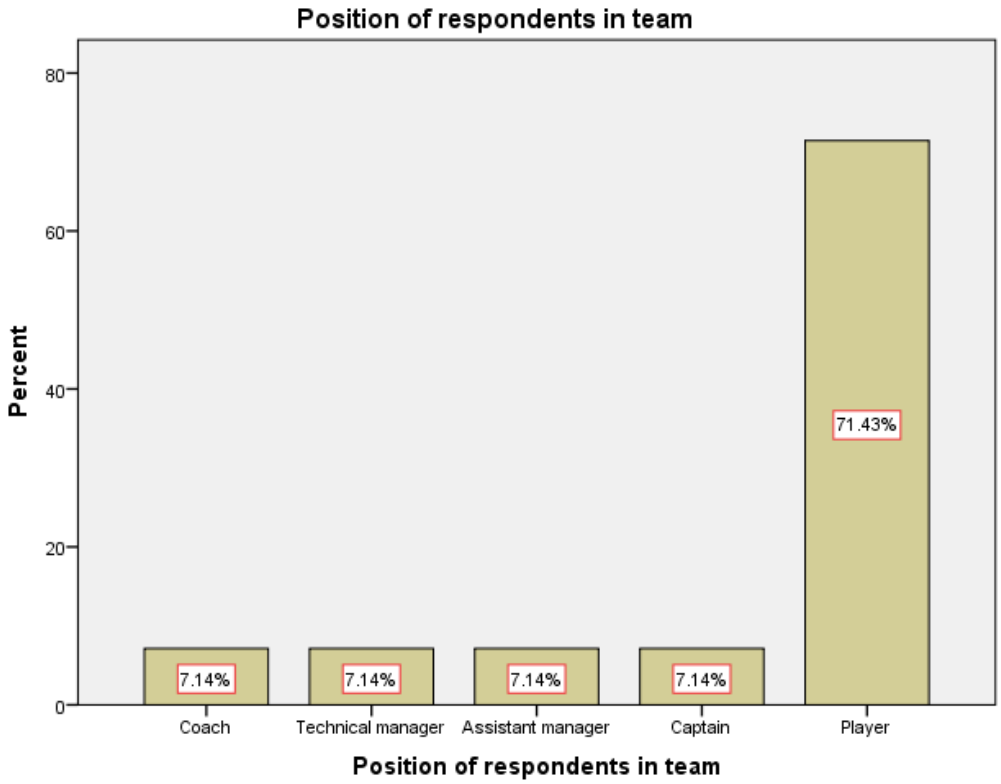
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-29 years	13	46.4	46.4	46.4
	30- 39 years	12	42.9	42.9	89.3
	40-49 years	2	7.1	7.1	96.4
	50-59 years	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

Source: Field data 2024

Table 4.4 presented above offers data pertaining to the age distribution of the participants. The study's results indicated that individuals aged 20-29 years constituted (46.4%) of the sample, while those aged 30 to 39 years accounted for (42.9%). Additionally, individuals aged 40 to 49 years constituted (7.1%) of the sample, and those aged 50 to 59 years constituted only (3.6%). The results indicated that a significant proportion of the participants fell within the age bracket of 20 to 39 years, suggesting that a majority of the respondents were youthful and dynamic.

4.2.3 Position of respondents in the team

The figure 4.2 illustrates the positions held by the individuals in the football team or club. The study found that (7.14%) of the participants were coaches, another (7.14%) were technical managers, and an additional (7.14%) held the positions of assistant managers and captains each. The majority of the participants, accounting for (71.43%), were players. Findings indicate that most of the participants occupied the role of players within the team.

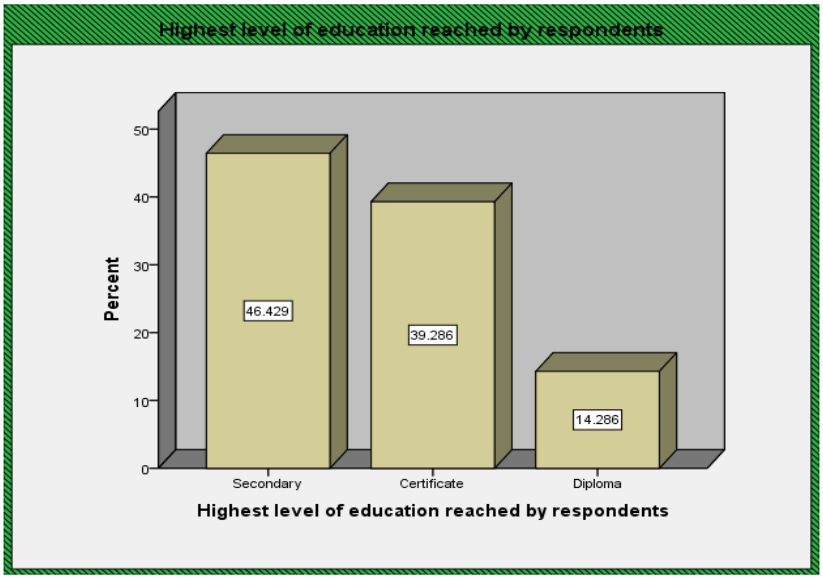


Source: field work 2024

Figure 4.2 Position of respondents in teams

Ultimately, a significant majority of the respondents 20 (71.43%) occupied the role of players within the team. The value mentioned here is notably higher than the percentages observed for coaches, technical managers, and assistant managers/captains. This highlights the fact that the majority of participants in the survey were primarily engaged in playing, rather than taking on managerial or coordinating roles. The majority of the team was made up of players, while a smaller portion held management and leadership positions.

4.2.4 Level of education of the respondents

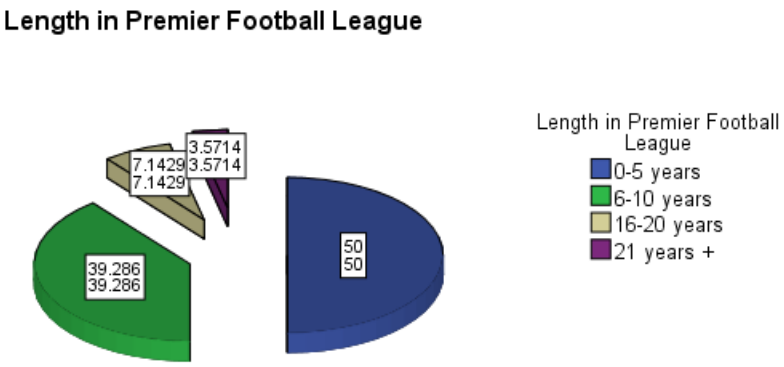


Source: field data 2024

Figure 4.3 Level of education of respondents

The educational attainment of the study participants is shown in Figure 4.3 above. According to the findings, a significant portion of the population, (46.42%), had completed secondary school. Additionally, (39.26%) of individuals held a certificate, while (14.26%) possessed a diploma. The study's findings revealed a greater percentage of individuals within the football industry who had successfully finished their secondary education. In the study, there was a higher number of individuals who had completed secondary school.

4.2.5 Length of stay in the premier level

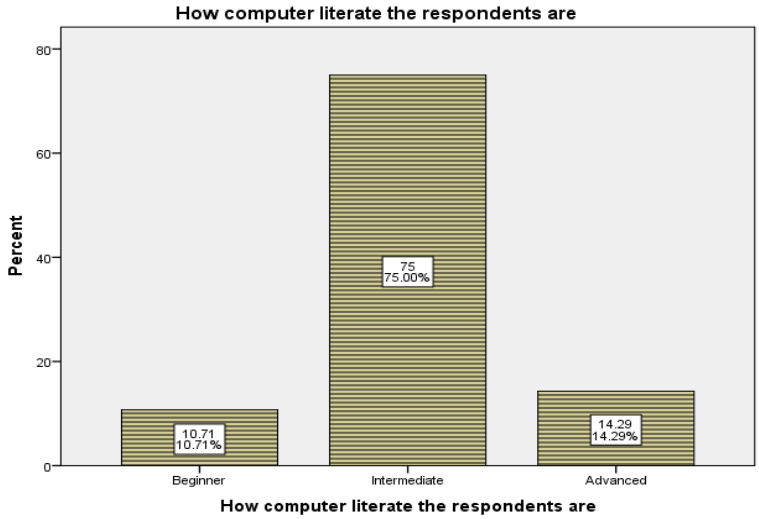


Source: field data 2024

Figure 4.4: Length of stay in the premier level

The educational background of the participants in the study is depicted in figure 4.4. The study revealed that individuals who had been part of the team for different durations exhibited varying percentages. Specifically, those who had stayed in the team for 0-5 years accounted for 50% of the participants. Meanwhile, individuals who had been with the team for 6-10 years constituted 39.2% of the sample. Participants who had a tenure of 16-20 years represented (7.1%) of the group, while those who had been with the team for 21 years and above made up (3.5%). The study was primarily conducted with participants who had 6-10 years of experience and those with 0 to 5 years of experience.

4.2.6 Level of computer literacy

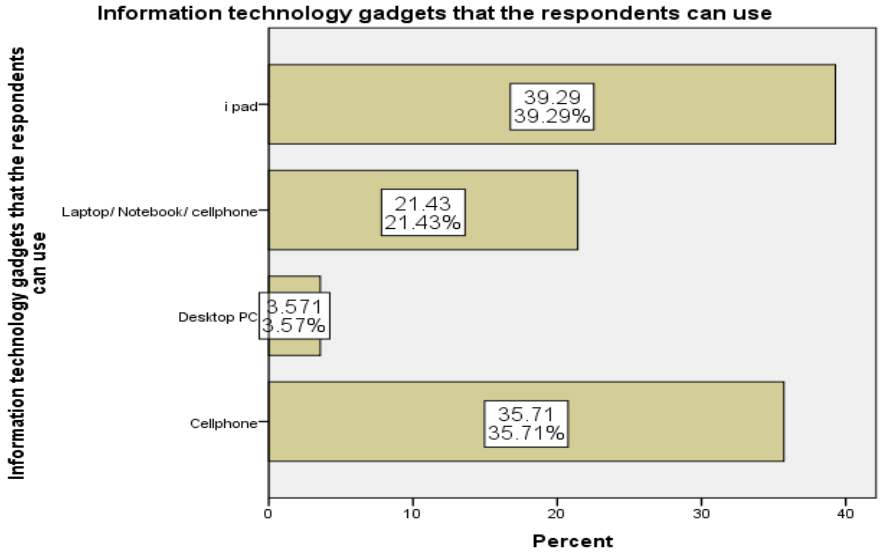


Source: field data 2024

Figure 4.5 Level of computer literacy

Figure 4.5 illustrates the participants' computer literacy levels. The findings indicated that 10.71% of participants were at the beginners' level, (75%) were at the intermediate level, and 14.29% were at the advanced level. The study's results indicate that a significant portion of the participants demonstrated an intermediate level of proficiency. This suggests that wearable technology has the potential to be utilised effectively in football matches.

4.2.7 Technological hardware used by the respondents



Source: field data 2024

Figure 4.6 Technological hardware used by the respondents.

Figure 4.6 above displays various technological hardware utilised by individuals within the study area. The study found that a majority of respondents (39.29%) utilized iPads to monitor player performance using GPS wearable technology. A smaller percentage (21.34%) relied on laptops, notebooks, or cellphones for this purpose. A very small proportion (3.57%) used desktop computers, while a significant portion (35.1%) used cellphones. The study's results indicated that most participants utilised mobile devices.

4.2.8 Age of the technological hardware used by respondents

Table 4.5 Age of technology hardware used by respondents.

Approximate age of IT gadget used by respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2 years	7	25.0	25.0	25.0
	3 years	11	39.3	39.3	64.3
	4 years +	9	32.1	32.1	96.4
	Do not know	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Table 4.5 presented above displays the results regarding the estimated age of IT hardware utilised by individuals at the premier level. Observations were made regarding the percentages of individuals with different durations of hardware usage. Specifically, those with 2 years of usage accounted for (25%), while those with 3 years accounted for (39.3%). Additionally, (32.1%) of individuals reported using their hardware for 4 years, while 3.6% were unsure about the age of their hardware. The study revealed that most participants reported owning their hardware for an average duration of 3 years. The results suggest that the use of wearable technology and its gadgets was relatively unfamiliar to professional football players.

4.3 Technology for monitoring and analysing the performance of football players at premier level.

4.3.1 Effect of wearable technology in enhancing performance in football

Table 4.6 Effect of wearable technology in enhancing performance in football

Does GPS wearable enhance performance monitoring in football?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	19	67.9	67.9	67.9
	Strongly agree	9	32.1	32.1	100.0
	Total	28	100.0	100.0	

Source: field data 2024

In the provided table 4.6, participants were requested to evaluate the extent to which GPS wearable devices improve performance monitoring during football matches. The results indicated that (67.9%) of the participants expressed agreement, while (32.1%) strongly agreed. The results indicated a general consensus among the respondents, with a majority expressing strong agreement.

4.3.2 Rate of using GPS wearable technology for injury prevention

Table 4.7 Rate of using GPS wearable technology for injury prevention

The rate of using GPS wearable technology for injury prevention

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately important	1	3.6	3.6	3.6
	Agree	6	21.4	21.4	25.0
	Very important	16	57.1	57.1	82.1
	Extremely important	5	17.9	17.9	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Participants were requested to evaluate the effectiveness of GPS wearable technology in preventing injuries as indicated in the table 4.7 above. The findings indicate that 3.6% of the participants expressed a moderate level of importance, while 21.4% agreed, and 57.1% ranked GPS wearable technology for injury prevention as highly important.

4.3.3 GPS wearable technology for performance monitoring

Table 4.8 GPS wearable technology for performance monitoring

Will you recommend GPS wearable technology for performance monitoring

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	1	3.6	3.6	3.6
	Likely	19	67.9	67.9	71.4
	Highly Likely	8	28.6	28.6	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Participants were requested to assess their inclination towards endorsing GPS wearable technology for the purpose of monitoring performance in football players, as presented in the aforementioned table. The results unveiled that (3.6%) of the participants expressed a neutral stance, whereas (67.9%) indicated likelihood, and (28.6%) expressed a strong likelihood. The results of the study indicate that individuals exhibit an overwhelming tendency to suggest the use of wearable technology to others.

4.3.4 Belief that GPS wearable technology captures performance metrics in football.

Table 4.9 Belief that GPS wearable technology captures performance metrics.

How well do you believe wearables capture performance metrics in football?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately well	2	7.1	7.1	7.1
	Very well	21	75.0	75.0	82.1
	Exceptionally well	5	17.9	17.9	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Table 4.9 illustrates that participants were requested to evaluate their perceptions regarding the effectiveness of wearable devices in capturing performance indicators during football matches. The results suggested that (75%) of respondents perceived it as very well, while (17.9%) regarded it as extraordinarily good. The results suggest that a significant proportion of the participants expressed that it was exceptionally well.

4.3.5 Wearable as valuable for tactical analysis and decision making in football

Table 4.10 Wearable as valuable for tactical analysis and decision making in football

Wearables as valuable tools for tactical analysis and decieion making in football.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderately valuable	5	17.9	17.9	17.9
	Extremely valuable	23	82.1	82.1	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Respondents as stated in Table 4.10 were asked to state their preference on the value of wearables as valuable for tactical analysis and decision making in football. It was generally stated that (82.1%) of respondents stated that it was extremely valuable and (17.9%) stated that it was moderately valuable. Wearables have brought about a significant transformation in the collection and analysis of data in sports, particularly in football. These devices, including GPS trackers, heart rate monitors, and accelerometers, offer coaches and analysts a significant amount of real-time information that was previously inaccessible. The significant number of participants who expressed a strong appreciation for wearables highlights their profound influence on tactical analysis in the realm of football. Wearables offer coaches objective data to evaluate player performance in training sessions and matches by monitoring metrics like distance covered, speed, acceleration, heart rate, and more. The data provided can greatly assist in making well-informed decisions regarding player selection, game strategies, and the overall performance of the team.

4.3.6 Analysis of data from matches

Table 4. 11 Analysis of Data from Matches

Source	SS	df	MS		
Model	16185710.5	5	3237142.09	Number of obs	= 30
Residual	1671306.91	24	69637.7881	F(5, 24)	= 46.49
				Prob > F	= 0.0000
Total	17857017.4	29	615759.22	R-squared	= 0.9064
				Adj R-squared	= 0.8869
				Root MSE	= 263.89

MATCHDISTANCE~m	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PLAYER	7.39358	8.333032	0.89	0.384	-9.804952	24.59211
DISTANCEinm	-.1972742	.1592624	-1.24	0.227	-.5259757	.1314274
AVERAGESPEEDKPH	0	(omitted)				
SPRINTTEST	328.5693	179.9385	1.83	0.080	-42.80549	699.944
COOPERTEST	.1957702	.0816516	2.40	0.025	.0272496	.3642909
AVSPEEDKPH	1440.561	106.9117	13.47	0.000	1219.906	1661.216
_cons	-1831.512	1259.66	-1.45	0.159	-4431.323	768.2996

Source: field data 2024

Average speed, sprint test and cooper test

Data from wearable technology is shown in Table 4.11, with an emphasis on training sessions and two actual matches. The average speed per game and the sprint test are the two main characteristics

that are examined in the data. The accompanying p-values of these attributes indicate their significance.

The average speed per game has a p-value of 0.000, while the sprint test has a p-value of 0.080. A statistical metric known as a p-value is employed to evaluate the probability of detecting the observed results if the null hypothesis—which asserts that there is no significant difference—is correct. A p-value of less than 0.05 is usually considered statistically significant in statistical analysis. The sprint test's p-value of 0.080 is higher than the accepted cutoff of 0.05, suggesting that it is not statistically significant. These data suggest that there might not be a substantial difference in the sprint test scores between the training matches and the real matches.

However, the p-value of 0.000 for the average speed per game is considerably lower than 0.05, suggesting a robust statistical significance. It can be inferred that there is a notable disparity in the average speed per game between training matches and competitive matches.

Based on the data from wearable technology, it can be concluded that there is a notable disparity in the average speed per game between training matches and actual matches. This is supported by the low p-value of 0.000. Nevertheless, the sprint test results for both types of matches do not show a significant difference. This is indicated by the p-value of 0.080, which does not meet the standard threshold for statistical significance.

Table 4. 12: Relationship Between the Distance Covered in A Match and The Average Speed

Source	SS	df	MS		Number of obs =	30
					F(4, 25) =	46.73
Model	6555337.13	4	1638834.28		Prob > F =	0.0000
Residual	876802.236	25	35072.0894		R-squared =	0.8820
					Adj R-squared =	0.8631
Total	7432139.37	29	256280.668		Root MSE =	187.28

MATCH1DISTANC~m	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
DISTANCEinm	.1639267	.0983443	1.67	0.108	-.0386172	.3664706
AVERAGESPEEDKPH	0	(omitted)				
SPRINTTEST	-26.76091	147.9305	-0.18	0.858	-331.4295	277.9077
COOPERTEST	.0379616	.0712587	0.53	0.599	-.1087984	.1847217
AVSPEEDKPH	1269.123	115.8426	10.96	0.000	1030.541	1507.705
_cons	509.3435	860.8394	0.59	0.559	-1263.589	2282.275

Source: field data 2024

A weak statistical correlation was found between the two variables in the test used to examine the relationship between the average speed per match and the distance traversed in a match. The statistical significance of this relationship was determined by the p-value, which was calculated to be 0.000.

A metric for determining how much evidence supports or refutes the null hypothesis is the p-value. The p-value of 0.000 indicates strong evidence to reject the null hypothesis, as it is less than the generally used significance level of 0.05 (or 95% confidence level). The average speed per match and the distance travelled during a match are clearly and significantly correlated

It is worth mentioning that although the low p-value suggests statistical significance, the strength of this relationship is considered weak. It can be inferred that the correlation between the distance covered and average speed in a match is not particularly robust or impactful.

The test results indicate that there is a modest but statistically significant correlation between the average speed per match and the distance covered in a match. This conclusion is supported by the p-value of 0.000 and the confidence level of 0.05.

4.3.7 Responses from Interviews

4.3.7.1 Frequency of words or concepts within a specific dataset

Figure 4.7 illustrates the frequency of words or concepts within a specific dataset. In this representation, words that occur more frequently are depicted as larger and highlighted in bold. Within the scope of this study on the correlation between wearable technology and performance monitoring in football, the word cloud would probably encompass terms associated with wearable technology, performance, monitoring, and potentially certain categories of devices or metrics monitored.

Source: field data 2024

Figure 4.7 Word cloud for performance of players through wearable technology adoption

Figure 4.7 and Table 4.13 above highlights the significant keywords that emerged, such as performance, wearable, player, training, data, technology, and GPS. In the table above the findings also revealed the words with more weight. The study's word cloud reveals the significant presence and importance of terms like "player," "data," "performance," "technology," "GPS," and "coaches." These keywords are prevalent, appearing in the word cloud at over 2% frequency, emphasising their prominence in the research. These keywords play a central role in the study. The words that were positioned near the key words, such as "real," "players," "team," and others, were placed in close proximity to the key words. Based on the analysis of the word placement, it can be deduced that these words play a role in enhancing comprehension of the study's goals and results.

4.3.7.2 Weight of key words from the dataset

Table 4.13 Weight of Key Words

Word	Length	Count	Weighted Percentage (%)	Similar Words
Player	6	192	4.50	player, players, players'
Data	4	168	3.94	data
Performance	11	144	3.38	perform, performance, performances
Technology	10	130	3.05	technology
GPS	3	124	2.91	gps
Coaches	7	94	2.20	coaches, coaching
Training	8	78	1.83	training
Team	4	70	1.64	team, teams
Wearable	8	70	1.64	wearable
Making	6	69	1.62	make, making
Decision	8	65	1.52	decision, decisions
Sports	6	60	1.41	sport, sports
Scientists	10	58	1.36	scientists
Analysis	8	56	1.31	analysis
Tactical	8	55	1.29	tactical, tactics
Provide	7	54	1.27	provide, provided, provides, providing
Enhance	7	50	1.17	enhance, enhanced, enhancement, enhances
Identify	8	48	1.13	identify, identifying
Effectiveness	13	46	1.08	effective, effectively, effectiveness
Monitoring	10	46	1.08	monitor, monitoring, monitors
Matches	7	43	1.01	match, matches

Source field data 2024

Table 4.13 above highlights the significant keywords that emerged, such as performance, wearable, player, training, data, technology, and GPS. These keywords play a central role in the study. The words that were positioned near the key words, such as "real," "players," "team," and others, were placed in close proximity to the key words. Based on the analysis of the word placement, it can be deduced that these words play a role in enhancing comprehension of the study's goals and results. The word cloud analysis offers a visual depiction of the key ideas and connections within the context of wearable technology's influence on player performance and monitoring in premier-level football.

The word cloud analysis offers a visual depiction of the key ideas and connections within the context of wearable technology's influence on player performance and monitoring in premier-level football.

The findings from both the questionnaires and interviews suggest that the use of wearable technology in premier-level football to improve player performance and monitoring is a complex and ever-evolving subject. There are multiple viewpoints and factors to consider when examining the influence of wearable technology in this particular context.

A significant finding is the potential advantages that arise from incorporating technology into player performance and monitoring. This integration enables the gathering of valuable data, which, when thoroughly analysed and implemented, can result in notable benefits. Through the utilisation of data insights, teams and coaches can make well-informed decisions and implement strategies to enhance player performance, optimise training programmes, and improve overall team dynamics.

4.4 Strategies for technology adoption at premier levels.

Table 4.14: Strategies for Technology Adoption at Premier Levels.

Strategies for technology adoption at premier level.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The adoption of GPS technology would significantly improve individual player performance at premier level.	50.0	46.4	3.6	0	0
GPS technology can effectively track and analyse player movement patterns during training and matches.	71.4	25.0	3.6	0	0
The implementation of GPS technology would enhance injury prevention strategies at premier level.	28.6	32.1	21.4	14.3	3.6
GPS technology can help optimize training programs by monitoring player workloads and fatigue levels.	28.6	46.4	10.7	0	3.6
The use of GPS technology would improve tactical decision-making for coaches at premier level.	50.0	32.1	17.9	0	0
GPS technology would provide valuable data for analysing team dynamics and player roles.	35.7	21.4	21.4	17.9	3.6
The implementation of GPS technology would enhance player recovery protocols at premier level.	3.6	21.4	21.4	17.9	35.7
GPS technology would lead to a higher level of competitiveness at premier level.	32.1	39.3	25.0	3.6	3.6
Adoption of GPS technology may face challenges related to infrastructure and technical expertise at premier level.	42.9	39.3	7.1	3.6	7.1
Privacy concerns associated with GPS technology implementation can be addressed at premier level.	7.1	10.7	25.0	17.9	39.3
Overall, adopting GPS technology would benefit the performance of teams and players at premier level.	51.1	39.3	7.1	1.2	1.3

Source: field data 2024

Table 4.14 provided displays different attributes of strategies for technology adoption at a premier level. The results indicated a distribution of 50% and (46.4%). Findings indicated that most respondents agreed with the statement mentioned.

The effectiveness of GPS technology in tracking and analysing player movement patterns during training and matches was assessed using an agree to disagree rating system. The study found that (94.4%) of the participants agreed, while (3.6%) remained neutral. Findings indicate that GPS technology is capable of accurately monitoring and analysing player movement patterns in both training sessions and matches. The effectiveness of GPS technology in improving injury prevention strategies at the premier level was also evaluated using a rating scale ranging from agreement to disagreement. The study revealed that a significant portion of participants, specifically (28.6%), expressed agreement, whereas (32.1%) disagreed. A smaller percentage, (21.4%), remained neutral, while (14.3%) disagreed and (3.6%) strongly disagreed. Respondents generally accepted the findings on the implementation of GPS technology in injury prevention at the premier level.

Scholars and football organisations utilise a variety of monitoring systems to monitor the performance of players, which are capable of quantifying distinct variables. (Takei, Gao, Wang. & Javey, 2019) These technologies obviate the necessity for labour-intensive procedures wherein specialised observers scrutinised recorded match films and classified the activity patterns of players.

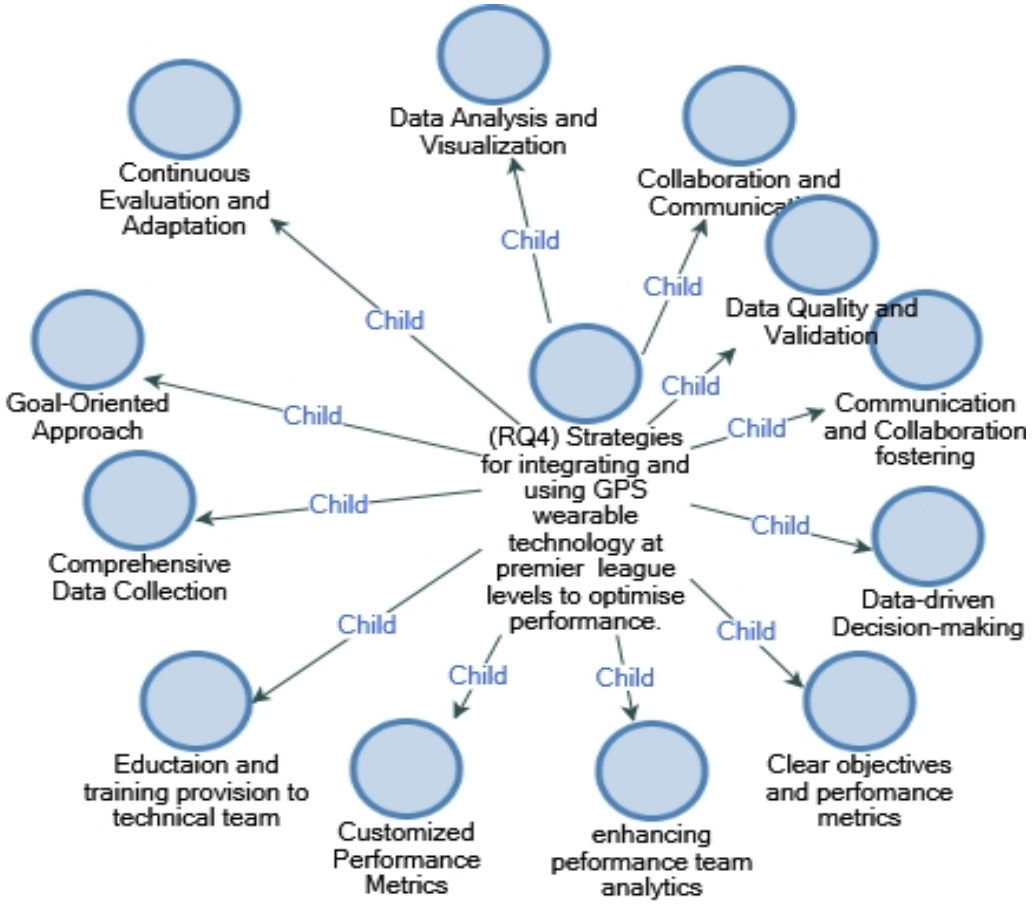
The study's results indicate that the use of GPS technology can be beneficial in optimising training programmes. Specifically, it can assist in monitoring player workloads and fatigue levels. The majority of participants, 75% in total, agreed with this statement. A smaller percentage, 10.7%, remained neutral, while only 3.6% disagreed. It is widely acknowledged that GPS technology can be instrumental in optimising training programmes through the monitoring of player workloads and fatigue levels.

Participants were also requested to evaluate the following statements: "The utilisation of GPS technology has the potential to enhance training programmes by monitoring player workloads and fatigue levels" and "The implementation of GPS technology could enhance tactical decision-making for coaches at the premier level." Both statements indicated that a significant majority of respondents (82.1% and 58.1% respectively) agreed with the aforementioned statement. Findings stated that 90.4% of the respondents agreed that “The implementation of GPS technology could enhance tactical decision-making for coaches at the premier level”.

Participants were requested to evaluate statements regarding the potential impact of GPS technology on competitiveness at the premier level, the potential challenges related to infrastructure in adopting GPS technology, and the overall benefit of GPS technology on the performance of teams and players

at the premier level. Results of all three statements were positive, with the majority of respondents agreeing with them.

The majority of responses (in Figure 4.15 below) from interviews also highlighted the most of strategies of technological adoption in enhancing player performance and monitoring. The majority of interview responses emphasized the strategies of technological adoption in enhancing player performance and monitoring. Strategies for technological adoption can play a crucial role in maximizing the benefits of wearable technology in football. Collaborating with technology providers, long-term planning, stakeholder engagement, training and education, data analysis and interpretation, continuous evaluation and feedback and integration with existing systems are some common strategies that are often highlighted as integrated.



Source: field data 2024

Figure 4.8 Participant' Responses to Strategies for Integrating and Using GPS Wearable Technology at Premier Level Football.

4.5 Extent of wearable technology in decision making tactical and technical analysis at premier league levels

4.5.1 Strategies for technology adoption at premier level

Table 4.15 Strategies for technology adoption at premier level football

Strategies for technology adoption at premier level.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
GPS wearable technology is useful for decision-making in premier level football matches.	35.7	45.2	14.3	3.6	1.2
GPS wearable technology can enhance tactical analysis in premier level football matches.	32.1	46.4	17.9	2.4	1.2
GPS wearable technology can improve technical analysis in premier level football matches.	32.1	46.4	21.4	0	0
GPS wearable technology enhances technical analysis in at premier level football matches.	32.1	46.4	21.4	0	0

Source: field data 2024

The ratings for statements regarding technology adoption at Premier were based on the level of agreement or disagreement. The Table 4.15 above shows that the majority of respondents agreed with the statements, while only a small number disagreed or strongly disagreed with the first two statements. The table indicates that there were only a small number of respondents who expressed a neutral opinion in the last two statements.

Based on the responses to the statements, it is evident that there is a significant emphasis on the value of technology adoption at premier. Nevertheless, it is evident that certain obstacles must be confronted. Based on the limited number of respondents who expressed disagreement or neutrality, it appears that certain individuals within the organisation may have a limited understanding or experience with technology adoption. In order to address this issue, it might be beneficial to offer employees extra training and support. This would help them grasp the advantages of adopting technology and learn how to utilise it efficiently.

Based on the responses to the statements, it is evident that there is a widespread recognition of the significance of technology adoption at premier. Nevertheless, certain obstacles must be overcome, such as a limited grasp or familiarity with technology implementation among certain individuals

within the organisation. Through the provision of supplementary training and support, it is conceivable to surmount these obstacles and assist Premier in attaining its objectives by embracing technology.

4.5.2 Likelihoods to use wearable technology for decision making in matches

Table 4.16 Likelihoods to use wearable technology for decision making in matches

Likelihood to use wearables data for decision-making in matches

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	3	10.7	10.7	10.7
	Likely	13	46.4	46.4	57.1
	Highly likely	12	42.9	42.9	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Results in Table 4.16 showed that (10.7%) of participants chose "neutral", while (46.4%) chose "likely" and (42.9%) chose "highly likely". Results generally showed that most participants expressed a likelihood of utilising wearable technology for decision making in football matches.

4.5.3 Confidence in wearable for tactical analysis in matches

Table 4.17 Confidence in wearable for tactical analysis in matches

Rate your confidence in wearables for tactical analysis in matches

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neutral	5	17.9	17.9	17.9
	Confident	12	42.9	42.9	60.7
	Very confident	11	39.3	39.3	100.0
	Total	28	100.0	100.0	

Source: field data 2024

The rating of confidence in wearable technology for tactical analysis in football matches was assessed. The questionnaire's results in Table 4.17 showed that (17.9%) of respondents were neutral, (42.9%) expressed confidence, and (39.3%) reported feeling very confident. Findings revealed that a significant proportion of individuals, specifically (42.9%) and (39.3%) respectively, expressed high levels of confidence and very high levels of confidence. A questionnaire was conducted to evaluate the confidence in wearable technology for tactical analysis in football matches, and the

findings indicated a favourable response. Based on the questionnaire's findings, a notable portion of participants demonstrated trust in the effectiveness of this technology.

Overall, a minority of participants had a neutral stance on the use of wearable technology for tactical analysis in football matches. However, the majority of respondents expressed high levels of confidence in its effectiveness. It can be inferred that there is a widespread confidence in the capacity of this technology to enhance football strategies and have a beneficial influence on the sport overall.

4.5.4 Wearable technology support technical analysis in matches

Table 4.18 Wearable technology support technical analysis in matches

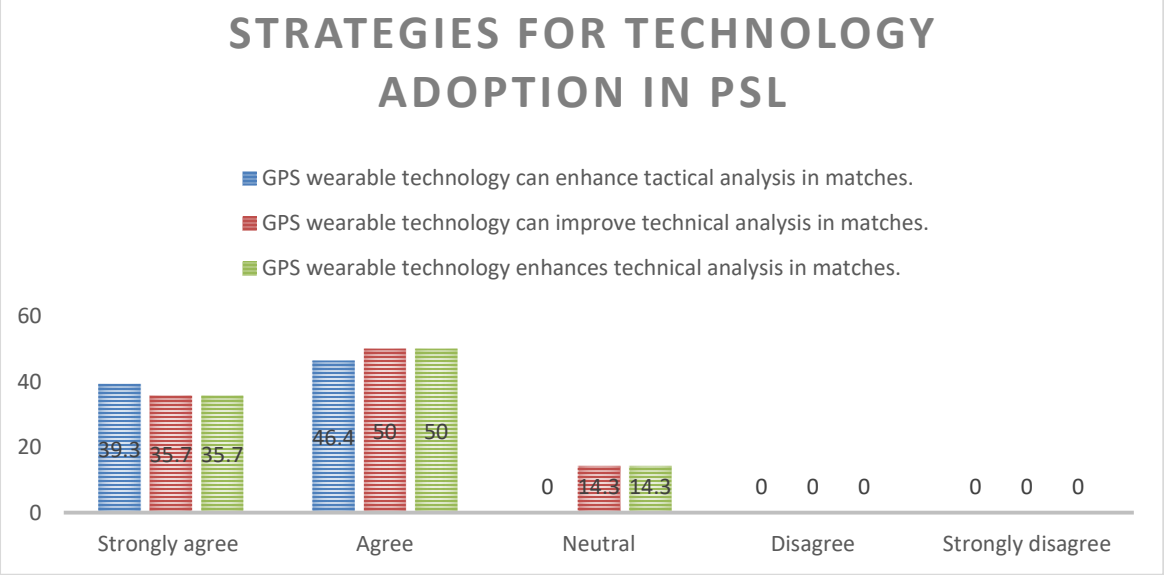
How well do wearables support technical analysis in matches?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fairly well	1	3.6	3.6	3.6
	Moderately well	4	14.3	14.3	17.9
	Very well	12	42.9	42.9	60.7
	Extremely well	11	39.3	39.3	100.0
	Total	28	100.0	100.0	

Source: field data 2024

Based on the questionnaire's findings, most participants hold the belief that wearable technology provides support for technical analysis in football matches. In the survey, one respondent (3.6%) found that the wearable technology adequately supports technical analysis, while 4 respondents, (14.3%) found it to be moderately supportive. According to the results, a notable 12 respondents who make up (42.3%) of participants expressed their belief in the effectiveness of wearable technology for facilitating technical analysis in football matches. A significant endorsement was received from (39.3%) of respondents, who expressed that it strongly supports technical analysis in football matches. According to the findings, a significant percentage of participants (39.3%) expressed strong agreement regarding the effectiveness of wearable technology in facilitating technical analysis. The study's results indicate that wearable technology plays a significant role in assisting technical analysis in football matches. A majority of participants expressed strong support for this idea.

4.5.5 Strategies for technology adoption in PSL

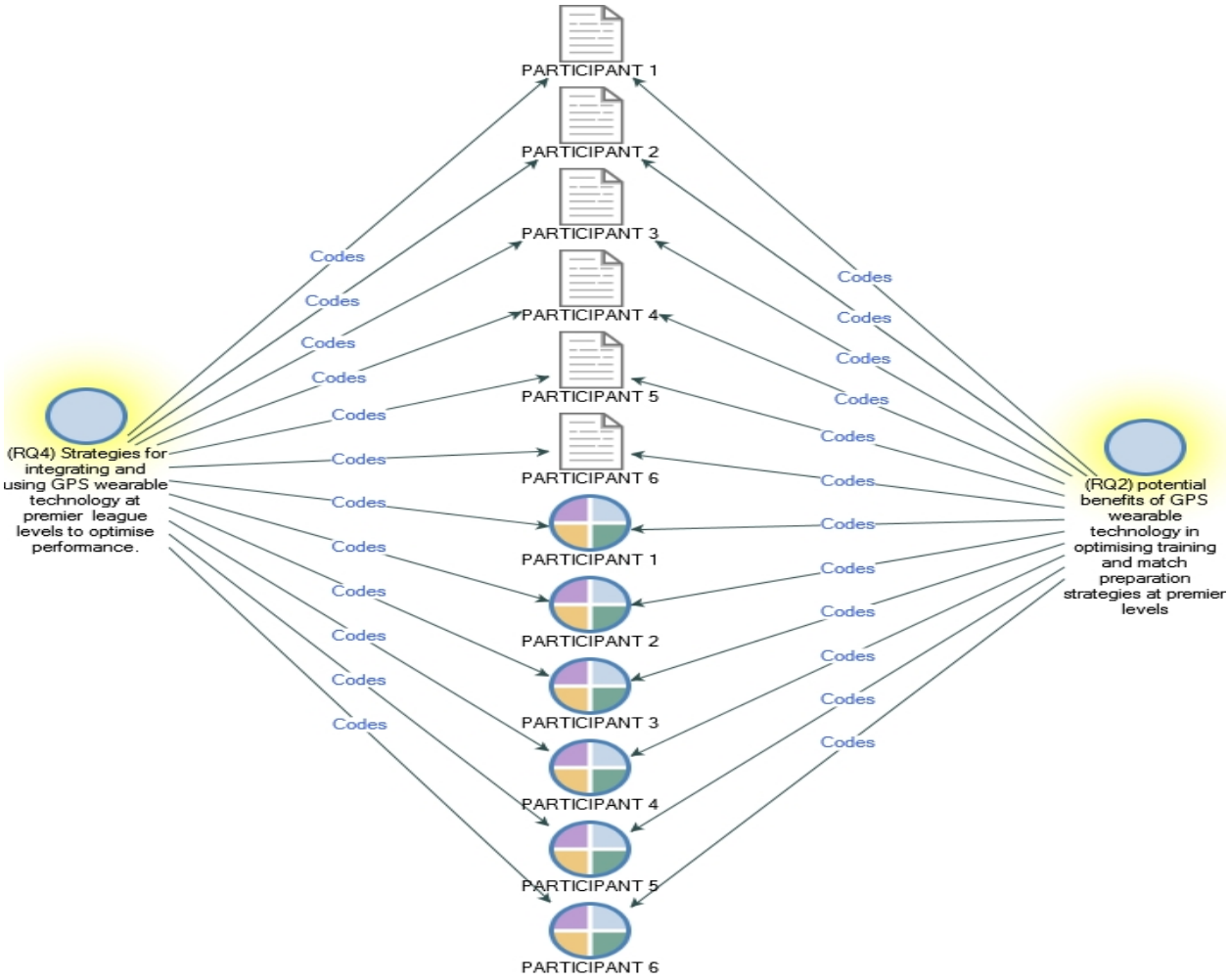


Source: field data 2024

Figure 4.9 Strategies for technology adoption at premier levels.

Figure 4.9 above shows the rating of strategies for technology adoption in the football premier level. It is indicated in the Figure 4.9 above that (39.3%) and (46.4%) strongly agreed. Findings revealed that the majority of the participants agreed that the GPS wearable technology can enhance tactical analysis in matches. Findings also highlighted that (85.7%) cumulatively agreed that GPS wearable technology can improve technical analysis in matches. It was also deduced that (85.7%) of the participants were GPS wearable technology enhances technical analysis in matches whilst (14.3 %) noted neutral. The results generally indicated that wearable technology can enhance decision making at all level.

4.6 Comparison between potential benefits and strategies of the utilisation of wearable technology in enhancement of player performance and monitoring



Source: field data 2024

Figure 4.10 Comparison between potential benefits and strategies

Figure 4.10 presents a comparison of the potential benefits and strategies for utilising wearable technology to enhance player performance and monitoring in premier level football. The study found that most participants expressed similar views on the potential benefits and strategies for adopting and using wearable technology to improve player performance and monitoring.

Wearable technology has become increasingly popular in the realm of sports, particularly football, as it offers valuable real-time data and insights that can enhance training, performance, and injury prevention. As stated in the results multiple benefits that were highlighted and associated with the utilisation of wearable technology in football:

4.6.1 Performance Enhancement: Wearable devices have the capability to monitor and record a range of metrics, including speed, distance, acceleration, and heart rate. This data can be used to analyse player performance and pinpoint specific areas that could be enhanced.

4.6.2 Injury Prevention: Wearable technology can help prevent injuries by tracking physiological data from players, like heart rate variability and level of fatigue. This data can be used to identify signs of overexertion or potential injury risks. This data can be utilised to effectively manage player workload and implement proactive measures.

4.6.3 Analysis: Coaches and analysts can gain important insights into team strategies, player positioning, and decision-making processes by using wearable technology to gather player positioning and movement data. This data can be utilised to enhance team strategies and enhance game plans.

4.6.4 Wearable devices have the potential to assist in the rehabilitation process by monitoring players' progress, tracking recovery metrics, and facilitating a safe return to play following injuries. Utilising a data-driven approach can be instrumental in effectively managing rehabilitation processes.

4.7 Chapter summary

The results of using wearable technology to track the performance of professional football players were covered and explored in this chapter. Based on the information provided in this chapter, the researcher has come to a number of conclusions and suggestions. Wearable technology has the potential to greatly enhance performance monitoring in premier level football, although its adoption is still in its early stages. Additionally, it is crucial for coaches and trainers to have a comprehensive understanding of the advantages and challenges associated with adopting wearable technology. To fully comprehend the impact of wearable technology on player development and performance in elite football, more research is necessary. Based on the previously reported data, the researcher offers conclusions and suggestions in this chapter.

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter will cover discussion on summaries of the findings. Some of the key findings that are in line with the research objectives will be covered and this where the researcher will present discussion drawn from the research results and provides summary of important points.

5.2 Discussion of Findings

5.2.1 Demographic characteristics

It was generally noted that the study indicates that the study was dominated by males. The findings suggest that individuals between the ages of 30-40 exhibited the highest response rate, while those in the 50s had the lowest response rates. A significant proportion of the participants had attained a minimal secondary school level education. The study's findings indicate that a significant percentage of participants (39.29%) utilised iPads to monitor player performance using GPS technology.

5.2.2 Technology for monitoring and analysing the performance of football players at premier level

The findings from both qualitative and quantitatively revealed that wearable technology has the potential to offer a comprehensive understanding of players' physical capabilities, movement patterns, and physiological responses due to its dynamic nature. This was exhibited by the majority (who scored 50% and above on the scale) of the participants who agreed the positive effect of wearable technology on player's performance and monitoring the player's behaviour during the matches and training. By considering a range of factors that can impact player effectiveness on the pitch, a more comprehensive approach to performance and monitoring can be achieved.

Findings varied on the effectiveness of wearable technology on enhancing player's performance and monitoring in the premier league. Nevertheless, a thorough exploration of the extent of wearable technology in decision making, tactical analysis, and technical analysis at the premier league level in Zimbabwe can provide valuable insights into the current landscape and potential opportunities for leveraging technology to enhance football performance and analysis within the country.

In addition, the incorporation of wearable technology enables real-time monitoring, enabling prompt adjustments and interventions based on the data collected. This feedback loop can effectively reduce

the risk of injuries, monitor fatigue levels, and enhance player performance in both training sessions and matches.

5.2.3 Strategies for technology adoption at premier levels.

An investigation was carried out to look at how the use of technology affects the ability to track player performance in elite football. Participants were asked to score how much they agreed or disagreed with various tactics. The majority of participants expressed agreement with these strategies. It can be inferred from the agreement of the majority of participants that there is a consensus regarding the significance and effectiveness of technology adoption in improving performance monitoring in premier-level football.

Given its dynamic nature, wearable technology can provide a thorough insight of players' physical capabilities, movement patterns, and physiological responses. By considering a range of factors that can impact player effectiveness on the pitch, a more comprehensive approach to performance and monitoring can be achieved. Study findings by Adesida, Papi & McGregor (2019) also noted that there has been a notable increase in interest surrounding the application of wearable microsensor technology in sports, particularly in football, for the purpose of enhancing performance. Various technologies, including GPS trackers, accelerometers, and heart rate monitors, offer significant insights into athletes' movements, physiological responses, and overall performance during training and matches (Seshadri, Li, Voos, Rowbottom, Alfes, Zorman & Drummond, 2019).

In addition, the incorporation of wearable technology enables real-time monitoring, enabling prompt adjustments and interventions based on the data collected. This feedback loop can effectively reduce the risk of injuries, monitor fatigue levels, and enhance player performance in both training sessions and matches.

5.2.4 Extent of wearable technology in decision making tactical and technical analysis at premier league levels

Based on the responses to the statements, it is evident that there is a significant emphasis on the value of technology adoption at premier. Nevertheless, it is evident that certain obstacles must be confronted. The small percentage of respondents who indicated disagreement or neutrality suggests that certain members of the organization might not have a deep understanding of or experience with adopting new technologies. In order to address this issue, it might be beneficial to offer employees extra training and support. This would help them grasp the advantages of adopting technology and learn how to utilise it efficiently.

Overall, a minority of participants had a neutral stance on the use of wearable technology for tactical analysis in football matches. However, the majority of respondents expressed high levels of confidence in its effectiveness. It can be inferred that there is a widespread confidence in the capacity of this technology to enhance football strategies and have a beneficial influence on the sport overall.

Overall, the findings from the study indicate that a limited percentage of participants found wearable technology to be useful for technical analysis.

It was revealed that (14.3%) of wearable technology respondents supported technical analysis moderately. Wearable technology helps technical analysis, according to (42.3%) of participants. Wearable technology aids technical analysis, according to (39.3%) of survey respondents. The study found that wearable technology aids football technical analysis. Most participants strongly supported this proposal.

The research outcomes underscore the beneficial effects of incorporating and employing technology in the realm of football, namely in augmenting the efficacy of decision-making procedures and overseeing the performance of players. Wearable technology facilitates the monitoring of behavioural patterns during matches and training sessions, hence offering significant insights for study. Based on interviews and questionnaires, most participants highlighted the importance of wearable technology in football and acknowledged its potential. The aforementioned acknowledgement highlights the significance of integrating technology within the realm of sports like football. A study by (Carling & Bloomfield, (2018) also echoed that utilisation of GPS wearable technology, which players typically incorporate into their apparel through the use of vests or small pods, is prevalent in decision-making processes, specifically in relation to player substitution and selection. Wearable technologies equipped with sensors collect data pertaining to a variety of parameters, encompassing distance, velocity, acceleration, deceleration, pulse rate, and impact forces. For subsequent analysis, the data is wirelessly transmitted to a central database or computer system.

Nevertheless, it is crucial to acknowledge that there are specific challenges that necessitate attention and resolution. An impediment that arises is the restricted comprehension or acquaintance with the application of technology among specific persons within the organisation. This may encompass anyone such as coaches, staff personnel, or even players who lack familiarity with the application of technology in the context of football. According to Kelly (2021), these devices possess the capacity to observe and assess various dimensions of an athlete's performance, including pulse rate, distance

covered, velocity, and sprint frequency. By providing personalised, real-time feedback, the data can assist participants in making well-informed decisions and improving their overall performance.

5.2.5 Creating a personalised interactive wearable microsensor technology for soccer players in football monitoring.

A personalised interactive wearable for player monitoring was designed and developed for this study. It was termed Player Health and Performance Monitoring System.

Player Health and Performance Monitoring System

The Player Performance Monitoring and Analysis System is a comprehensive solution designed to collect, analyze, and utilize data from various sensors and components to monitor and evaluate player performance. The system integrates multiple hardware components, a database, a web application for coaches, and a mobile application for players. I will explore the system in detail:

Components:

- GPS Module (NEO-6M): The GPS module captures location, speed, and altitude data, providing insights into a player's movement patterns during training and matches.
- Pulse Oximeter (MAX30100): The pulse oximeter measures heart rate and oxygen saturation levels, enabling the assessment of a player's physiological exertion and fitness levels.
- Wi-Fi Module (e.g., ESP32): The Wi-Fi module establishes an internet connection, allowing data transmission from the sensors to a centralized database.
- LEDs: Light-emitting diodes (LEDs) are used for visual indicators, providing real-time feedback or notifications to the user.
- Push Button: The push button acts as an input mechanism, triggering specific actions within the system.
- Database: A centralized database stores the collected sensor data, ensuring data integrity and accessibility for further analysis.

Functionality:

- Data Collection: The system continuously collects data from the GPS module and pulse oximeter. The GPS module captures location, speed, and altitude data, while the pulse oximeter records heart rate and oxygen saturation levels.
- Wi-Fi Data Transmission: The collected data is transmitted over Wi-Fi to a centralized database. The Wi-Fi module establishes the connection and sends the data using HTTP POST requests.
- Web Application for Coaches: Coaches access the data through a web application. The web app provides a user-friendly interface to view and analyze player performance data.

  Coaches can access historical data, generate reports, and visualize performance metrics. The system allows coaches to set targets and goals based on the collected data, facilitating personalized training plans for individual players.
- Mobile Application for Players: Players can monitor their performance through a mobile application. The app presents performance data in an intuitive manner, allowing players to track their progress, compare training performance with match performance, and identify areas for improvement. The mobile app serves as a tool for self-evaluation and motivation.
- Real-time Feedback and Notifications: The system utilizes LEDs to provide real-time feedback or notifications. For example, an LED might indicate when a pulse beat is detected or when a data transmission is successful.
- User Interaction: The push button allows users to trigger specific actions within the system. For instance, pressing the button can initiate data transmission, activate specific features, or provide user input for certain functions.

5.3 Chapter summary

In an effort to improve player performance, this chapter explores the research on wearable technology uptake and use in elite football teams. The purpose of the study was to investigate how wearable technology is being incorporated into elite football teams and how this is affecting player performance. I shall examine the conclusions and suggestions drawn from the study's findings in the next chapter.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This section will cover the conclusion and recommendations of the study findings. This will be done in line with the objectives of the study.

6.2 Conclusions

6.2.1 Technology for monitoring and analysing the performance of football players at premier level

The results obtained from both the questionnaires and interviews indicate that the utilisation of wearable technology in elite-level football might greatly enhance player performance. Furthermore, the process of monitoring is a multifaceted and continuously developing topic. Furthermore, it has demonstrated that the adoption and utilisation of this technology greatly improve decision-making in various aspects, including player positioning, training methods, behavioural patterns, and injury prevention and workload management.

6.2.2 Strategies for technology adoption at premier levels

The study offered a variety of strategies that could be used to help professional football teams adapt and use wearable technology. Several techniques were presented, and the majority of participants expressed concerns over the involvement of all stakeholders in technology adoption and the need for continuous monitoring of progress. The utilisation of Wearable GPS technology has revolutionised the examination and enhancement of player performance. The gadgets are equipped with advanced sensors that can detect many physical measurements, such as distance, speed, acceleration, deceleration, changes in direction, and physiological characteristics like work rate.

6.2.3 Extent of wearable technology in decision making tactical and technical analysis at premier league levels

The study's findings indicate that wearable technology can greatly influence decision-making and technical analysis in premier level football. Through the utilisation of wearable technology during training sessions and matches, teams can acquire valuable insights into the performances and characteristics of individual players. Teams can collect data on players' physical attributes, including heart rate, distance covered, speed, and acceleration, through the use of wearable technology. This data can offer valuable insights into the players' physical condition and the amount of effort they exert during training sessions and games. This data can be utilised by coaches and trainers to make

well-informed decisions regarding player selection, substitution, and tactical adjustments during games. To summarise, the integration of wearable technology in training and matches offers teams valuable insights into individual players, allowing them to make well-informed decisions and adjustments as needed. This can enhance decision-making processes and technical analysis at the highest level of football.

6.2.4 Ways for utilising integrated GPS wearable technology in football for performance enhancement

The study found that the use of integrated GPS wearable technology in Zimbabwe premier football can lead to improved performance. This technology allows for player monitoring, tactical analysis, individualised training, injury prevention and rehabilitation, performance evaluation, and team analysis. Through the utilisation of this technology, teams have the ability to enhance player performance, make well-informed decisions, and enhance overall team dynamics within the realm of Zimbabwean football.

6.3 Recommendations

6.3.1 The findings suggest that a gradual and inclusive approach should be taken when adopting and implementing wearable technology, involving all relevant stakeholders.

6.3.2 The research findings indicate that the utilisation of wearable technology can greatly enhance players' performance in various aspects. Therefore, it is recommended that teams consider allocating more financial resources towards the implementation of technology in football.

6.4 Areas for further studies

6.4.1 The use of wearable technology in Zimbabwean football teams and its impact on real-time analysis.

6.4.2 A comparative study on the adoption and utilization of technology in Premier League teams would involve examining how different teams have embraced and implemented various technological tools and systems to enhance player performance.

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APPENDICES

Appendix 1: Questionnaire

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE

SPORTS SCIENCE DEPARTMENT

TOPIC: USING GPS WEARABLE TECHNOLOGY FOR PERFORMANCE ENHANCEMENT IN FOOTBALL AT PREMIER LEVELS IN ZIMBABWE.

BY

Kamanga Kudakwashe Brown Student number B1232529

A PROPOSAL SUBMITTED TO THE BINDURA UNIVERSITY OF SCIENCE EDUCATION - SPORTS SCIENCE DEPARTMENT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF A MASTERS OF SCIENCE DEGREE IN SPORTS SCIENCE (MSc SS)

Dear respondent

My name is Kamanga Kudakwashe Brown, a student at Bindura University of Science Education (BUSE) doing a Master of Science in Sport Science Degree. I am carrying out a research study on the use of GPS wearable technology for enhancement of players' performance at premier league levels in Zimbabwe. I am focusing on teams at premier levels as my target population. Your team or soccer club is an important stakeholder in this research study and on its behalf; you are kindly being requested to contribute to the study by answering the questions on this form as truthfully and honestly as you can. Your responses will be used for academic purposes **ONLY** and as grouped data. Do not identify yourself in any way on the form. Respond by a tick in the appropriate box or write in the spaces provided.

Thank you.

Research questionnaire
SECTION A. DEMOGRAPHIC INFORMATION

Question 1. Indicate your gender.

Gender	**Response**	**Tick**
Male	**1**	
Female	**2**	

Question 2. What is your marital status?

Age Group	**Response**	**Tick**
Single	**1**	
Married	**2**	
Divorced	**3**	
Widowed	**4**	

Question 3. Kindly indicate your age group.

Age Group	**Response**	**Tick**
20 to 29 years old	**1**	
30 to 39 years old	**2**	
40 to 49 years old	**3**	
50 – 59 years old	**4**	
60 and above years old	**5**	
Below 20 years old	**6**	

Question 4. What stakeholder position do you hold in the team?

Stakeholder	**Response**	**Tick**
Coach	**1**	
Team Manager	**2**	
Technical Manager	**3**	
Assistant Manager	**4**	
Team Doctor or Medic	**5**	
Team captain	**6**	
Player	**7**	

Question 5. Kindly indicate your highest level of education.

Highest Academic Qualification	Response	Tick
Secondary level	**1**	
Certificate/ Diploma	**3**	
Degree	**4**	
Master's degree	**5**	

Question 6. For how long have you been involved in football at premier league levels?

Number of years	Response	Tick
0 to 5 years	**1**	
6 to 10 years	**2**	
11 to 15 years	**3**	
16 to 20 years	**4**	
21 and over	**5**	

SECTION B.

How GPS wearable technology can be adopted in monitoring and analysing the performance of professional football players at premier league levels.

Technology Infrastructure.

8. How would you rate yourself as a computer user?

Beginner	Intermediate	Advanced

9. Does your team have any form of technology use for performance enhancement?

Yes	No	Not Sure

10. Indicate which of the following information technology (IT) hardware you have access to?

IT hardware	Tick
Cell-phone /Mobile phone	
Desktop computer	
Laptop /Notebook	
I-pad / tablets	

11. What is the approximate age of the information (IT) technology gadget you often use?

IT hardware	**Time frame (months and years)**						
	<6 months	**≥6 months**	**1 yr**	**2 yrs**	**3 yrs**	**4 + yrs**	**Unknown**
Cell-phone /Mobile phone							
Desktop Computer							
Laptop/Notebook							
I-pad / tablets							

Technology for monitoring and analysing the performance of football players at premier level.

12. To what extent do you believe that GPS wearable technology can enhance performance in professional football?

Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**

13. Please rate the importance of using GPS wearable technology for injury prevention in football.

Not important	**Slightly important**	**Moderately important**	**Agree**	**Very important**	**Extremely important**

14. How likely are you to recommend wearable technology for performance monitoring to other clubs?

Highly unlikely	**Unlikely**	**Neutral**	**Likely**	**Highly likely**

15. How well do you believe that GPS wearable technology captures performance metrics in football?

Poorly	Fairly well	Moderately well	Very well	Exceptionally well

16. To what extent do you perceive GPS wearable technology as a valuable tool for tactical analysis and decision-making in football?

Not valuable at all	Moderately valuable	Extremely valuable

SECTION C:

17. What are the potential benefits of GPS wearable technology in optimising training and match preparation strategies at premier league levels?

Strategies for technology adoption at premier levels.

Please rate your level of agreement or disagreement with each statement by selecting the appropriate response on a scale of 1 to 5, where:

1 - Strongly Disagree **2** - Disagree **3** - Neutral **4** - Agree **5** - Strongly Agree

Strategies for technology adoption at premier level.	**1**	**2**	**3**	**4**	**5**
The adoption of GPS technology would significantly improve individual player performance at premier level.					
GPS technology can effectively track and analyse player movement patterns during training and matches.					
The implementation of GPS technology would enhance injury prevention strategies at premier level.					
GPS technology can help optimize training programs by monitoring player workloads and fatigue levels.					
The use of GPS technology would improve tactical decision-making for coaches at premier level.					
GPS technology would provide valuable data for analysing team dynamics and player roles.					
The implementation of GPS technology would enhance player recovery protocols at premier level.					
GPS technology would lead to a higher level of competitiveness at premier level.					
Adoption of GPS technology may face challenges related to infrastructure and technical expertise at premier level.					
Privacy concerns associated with GPS technology implementation can be addressed at premier level.					
Overall, adopting GPS technology would benefit the performance of teams and players at premier level.					

SECTION D:

18. To what extent can the GPS wearable technology be used for decision-making, tactical and technical analysis at premier league levels?

Rate your level of agreement or disagreement with each statement by selecting the appropriate response on a scale of 1 to 5, where:

1 - Strongly Disagree **2** - Disagree **3** - Neutral **4** - Agree **5** - Strongly Agree

Strategies for technology adoption at premier level.	**1**	**2**	**3**	**4**	**5**
GPS wearable technology is useful for decision-making in premier league level matches.					
GPS wearable technology can enhance tactical analysis in premier league level matches.					
GPS wearable technology can improve technical analysis in premier league level matches.					
GPS wearable technology enhances technical analysis in at premier league level matches.					

19. How likely are you to rely on GPS wearable technology data for decision-making during premier league level matches?

Highly unlikely	**Unlikely**	**Neutral**	**Likely**	**Highly likely**

20. Rate your level of confidence in using GPS wearable technology for tactical analysis in premier league level matches.

Not confident at all	**Not Confident**	**Neutral**	**Confident**	**Very Confident**

21. How well do you believe GPS wearable technology supports technical analysis in premier league level matches?

Poorly	**Fairly well**	**Moderately well**	**Very well**	**Extremely well**

22. Which strategies could be developed for implementing and utilising GPS wearable technology at premier league level, for performance enhancement?

Rate your level of agreement or disagreement with each statement by selecting the appropriate response on a scale of 1 to 5, where:

1 - Strongly Disagree **2** - Disagree **3** - Neutral **4** - Agree **5** - Strongly Agree

Strategies for technology adoption in PSL	**1**	**2**	**3**	**4**	**5**
GPS wearable technology can enhance **tactical** analysis in matches.					
GPS wearable technology can **improve technical** analysis in matches.					
GPS wearable technology **enhances technical** analysis in matches.					

Appendix 2: Interview Guide for key Informants

Interview guide for Key informants in soccer clubs

I am a Master of Science in Sport Science student at BUSE conducting a study on '***Using GPS wearable technology for performance enhancement in football at premier levels in ZIMBABWE***'. You have selected to participate in this study because you are the best suited candidate. The information you provide will only be used for the purpose of this study and will be treated with utmost confidentiality.

Thank you.

1. How GPS wearable technology can be adopted in monitoring and analysing the performance of professional football players in premier levels.
2. What are the potential benefits of GPS wearable technology in optimising training and match preparation strategies in the premier levels?
3. To what extent does the GPS wearable technology can be used for decision-making, tactical and technical analysis in premier levels matches?
4. Which strategies could be developed for implementing and utilising GPS wearable technology in the Premier levels, with the goal of optimising performance enhancement?

APPENDIX 3 ACCESS LETTER

BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF SCIENCE AND ENGINEERING

P. Bag 1020
BINDURA, Zimbabwe
Tel: +263662106134/0772916712
info@buse.ac.zw

DEPARTMENT OF SPORTS SCIENCE

TO WHOM IT MAY CONCERN.

RE: POSTGRADUATE DISSERTATION STUDY ACCESS REQUEST.

This is to certify that **Student MSc2424**, is a bonafide Master of Science in Sports Science student in the Department of Sports Science at the Bindura University of Science Education. He is conducting an action research study entitled: 'USING WEARABLE MICRO-SENSOR TECHNOLOGY FOR PERFORMANCE ENHANCEMENT IN FOOTBALL AT FOOTBALL PREMIER LEVELS IN ZIMBABWE'.

We are kindly requesting your organization to partner with him in the study by participating in the data collection and intervention strategy development process.

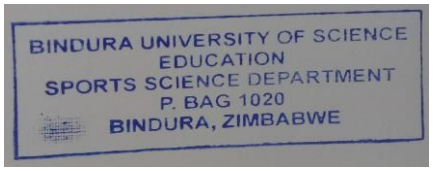
Participation in this research is completely voluntary and you may choose to withdraw from the research at any time. The information from your organization will only be used for academic purposes and be kept private and confidential. Codes will be used to identify participant organizations. This is meant to ensure that information would not be linked to the providers. Password-protected computers will be used to store any identifiable information that may be obtained from your organization. Data will also be analyzed at the group level, to ensure anonymity. You can also sign confidentiality agreements with the researcher.

A copy of the finished work will be provided to your organization after the study. The results of the study are expected to transform practice and your support will be pivotal to its success.

If you have any queries regarding this project, please phone me on 0772916712, or lysiastapiwacharumbira1968@gmail.com or lcharumbira@buse.ac.zw

We would like to thank you in advance for your support.

Yours Sincerely



Lysias Tapiwanashe Charumbira (Dr.)
Chairperson

APPENDIX 4: Permission Letter from Research Area

The researcher was verbally granted permission to conduct the study from the study areas.

APPENDIX 5 Data collection sheet

APPENDIX 6: Supervision follow up form

STUDENT NAME: Student MSc2424		**STUDENT NUMBER:** MSc2424
PROGRAMME:MSC SPORTS SCIENCE		**SUPERVISOR:**
RESEARCH TOPIC: Using wearable microsensor technology for performance enhancement in football at premier levels in Zimbabwe.		

DATE	**PROJECT STAGE**	**SUPERVISOR'S RECOMMENDATIONS**	**ACTION TAKEN BY THE STUDENT**	**SIGNATURE (SUPERVISOR)**	**SIGNATURE (CANDIDATE)**
22/10/23	**1. Research Proposal Development**	Suggestions were made related to the research design and the steps to be followed in the study.			
22/10/23	1.1 Research Topic Formulation	The scope of the research and the paths to follow for its development were evaluated.	Proceeded to adopt the working topic and started working on a proposal		
22/10/23	1.2 Problem Formulation	Changes were suggested in the formulation of the research problem, the main research question, the subsidiary questions, the research objective and the specific objectives.	Successfully done		
22/10/23	1.3 Preliminary Literature Review	Some suggestions were made regarding the way forward.	Successfully done		
22/10/23	1.4.Preliminary Methodology	The methodological strategy to follow and the methods to be used were assessed, as well as the size of the sample.	Successfully done		
22/10/23	1.5 Activities Schedule	The calendar to follow was established	The student is doing a good job until the moment.		

4/12/23	1.6 Data Collection Instruments Development	Part of the instruments to be used are already developed. The survey for the experts to value the proposal is the only one left.	Partially done.		
22/10/23	1.7 Access and Ethics Compliance Tools Development	The established premises have been satisfactorily fulfilled	Successfully done.		
	2. Research Report Development				
18/1/24	2.1 Chapter 1: The Problem and Its Setting	Suggestions were made in the writing of the research questions and the specific objectives	Successfully done		
18/1/24	2.2 Literature Review	The chapter was reviewed and the work done was rated as very good. However, suggestions were made for improvement.	Worked on suggestions given and approved to proceed to next stage		
	2.3 Research Methodology				
	2.4 Results				
	2.5 Discussion				
	2.6 Conclusion and Recommendations				
	2.6 Abstract				
	2.7 Referencing				
	3. Presentation and Preliminary Pages				

	3.1 Front Matter				
	3.2 Back Matter				
	3.4 Presentation Skills				
	4. Final Draft Approval				

DEPARTMENTAL COMMENT:

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NAME OF RESEARCH COORDINATOR…….
Signature……Date……