AN INVESTIGATION INTO THE APPLICATION OF INTERNET OF THINGS (IoT) IN HEALTHCARE: SCOPE IN THE PRIVATE HEALTH SECTOR

AFRICA UNIVERSITY

A UNITED METHODIST RELATED

UNIVERSITY

2024

AFRICA UNIVERSITY

(A United Methodist-Related Institution)

Exploring the Application of Internet of Things (IoT) in the Private Healthcare Sector a case of PSI

BY

MUNASHE PARTSON JOE

A DISSERTATION PROPOSAL SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BARCHELOR OF SCIENCE HONORS IN
COMPUTER SCIENCE IN THE COLLEGE OF ENGINEERING AND APPLIED SCIENCES

2025

Abstract

This study investigates the adoption of Internet of Things (IoT) technologies in the private healthcare sector, focusing on clinics, hospitals, and private practices. It aims to enhance patient outcomes and improve organizational efficiency through IoT integration. Utilizing literature analysis, case studies, and surveys of IT and healthcare professionals, the research identifies benefits, challenges, and effective IoT implementations. The literature review encompasses empirical findings from the past four years, while case studies provide insights into current IoT applications in private facilities. Data collected via self-constructed questionnaires will be analyzed using statistical and qualitative methods to reveal patterns and trends. This research contributes to understanding the barriers to IoT adoption, showcases best practices, and proposes strategies to maximize its advantages in private healthcare. The findings will inform governments, health technology vendors, and healthcare facilities in making evidence-based decisions regarding IoT technologies, ultimately enhancing service quality and operational efficiency in the sector.

Key Words

Internet of Things (IoT), Private health sector, Patient care, Operational efficiency, Adoption rates

Declaration Page

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree.

_____

MUNASHE JOE   Student's Signature(Date)

(Student)

_____

Main Supervisor's Full Name   Main Supervisor's Signature

_____

(Date)

Copyright

Acknowledgements

Dedication Page

I would like dedicate this work to my mother, father, and my brother expressing my appreciation for their support. To my friends and fellow classmates, I owe my gratitude for your kind support and companionship in this course. The encouragement you have given has been the motivation of my studying and striving for the best.

List of Acronyms and Abbreviations

IoT   Internet of Things

IT   Information Technology

IoT   Internet of Things

UTAUT   Unified Theory of Acceptance and Use of Technology

UTAUT 2 Updated Unified Theory of Acceptance and Use of Technology

HTAM   Healthcare Technology Acceptance Model

RBV   Resource-Based View

IoMT   Internet of Medical Things

IOSP   Internet of Smart Products

List of Tables List of figures

List of figures

List of Appendices

Table of Contents

CHAPTER 1 INTRODUCTION

1.1 Introduction

This study focuses on addressing the following research questions on how IoT could be implemented in private health care. IoT can transform heath care through linking devices and sensors for collecting and the sharing of relevant data (Ullah F, et al 2024)

The study will also focus on the advantages, drawbacks and use cases of IoT in private hospitals and clinics. Real and remote monitoring of a person's health is possible through the use of the Internet of Things to improve patient outcomes. It is possible to identify the diseases at an early stage and therefore treat with ease. In addition, IoT can also enhance the healthcare organisation processes, including the procedures' automation, resources management and optimisation, and work processes' streamlining (Ala'i & Moghavvemi, 2022)

However, there are various challenges of applying IoT in private healthcare for instance; Security, Privacy, and compatibility. The ability to expand IoT facilities and the differing levels of organizations' participation are additional factors that should be discussed.

Several research techniques will be employed in the course of this study including literature review, and case analysis in line with interview, questionnaires, and survey methods. The gathered data set will reveal migration and adoption of IoT together with healthcare changes, outcomes, efficiency and financial impact patterns for patient care.

The findings of the study aim at contributing useful information advocation on the challenges of adoption, possibilities of deployment and strategies of enhancing benefits

of IoT for the industry. Thus, it can help the governments, the providers of the healthcare technologies, as well as the private healthcare organizations to make a better decision regarding the application of IoT technologies, leading to the improvement of the outcomes in this sphere and the quality of patient treatment.

1.2 Background to the study

This research examines the use of the Internet of Things (IoT) in private healthcare. IoT can transform healthcare by linking medical devices, wearables, and systems. This enables data sharing and collaboration, leading to better patient care and more efficient operations.

The private health industry, including private hospitals and clinics, can benefit greatly from IoT integration. However, IoT adoption in this area is still in its early stages.

The study will explore the current landscape, challenges, and opportunities of using IoT in private healthcare settings. The findings will provide valuable insights to help healthcare administrators, policymakers, and technology providers make informed decisions about IoT implementation.

The goal is to investigate the potential of IoT in the private health sector to improve patient care, increase operational efficiency, and ultimately, enhance overall healthcare outcomes.

1.2.1 Statement of the Problem

Focusing on the aspect of the IoT, this work examines its use in private health care organizations. The use of Internet of Things for instance aspects such as; real time tracking, early defect determination and remote patient care can lead to better health care

in the society. It can also enhance productivity by eliminating several manual activities, organizing various methods of working, and resource management.

However, the effective adoption of IoT in private heath care is not without challenges Some of them are; Data privacy and security/ Technology compatibility, High initial costs. The acceptance rates of IoT in this area has not been identified; as such it is important to determine the factors that affect acceptance. It is for this reason that this study aims at providing a comprehensive literature review of the gains, the pains and the current state of IoT integration in private healthcare organizations. In addition, the findings will help healthcare practitioners, the policymakers and the technology suppliers to make informed decisions concerning the use of IoT. In this regard, the project's objectives are to improve patient care, reduce barriers hindering IoT's implementation, and optimise the results of healthcare organisations in the private sector.

1.3 Research Objectives

1. To explore the benefits of IoT in private healthcare

2. To Improve internal operation management and effectiveness and rationalization in the utilization of resources and expenses.

3.To identify the key challenges private healthcare face in adopting IoT

4. To assess the current IoT adoption in private healthcare

1.4 Research Questions

1. What are the key benefits of IoT integration in private healthcare settings?

2. How can IoT improve internal operation management and enhance resource utilization and expense rationalization in private healthcare?

3. What are the primary challenges faced by private healthcare institutions in adopting IoT technologies?

4. What is the current level of IoT adoption among private healthcare providers, and what factors influence this adoption?

1.4.1 Assumptions/Hypothesis

1. Private healthcare facilities have the potential resources to research and implement new technologies, such as IoT, provided they can afford the necessary devices and have the technical expertise for installation.

2. The leadership of private healthcare organizations is inclined to leverage IoT technologies, as suggested by their recognition of the benefits outlined in the survey.

3. Private healthcare organizations likely have existing structures and flowcharts in place that facilitate IoT integration, indicating that technical challenges associated with this integration can be addressed effectively..

4. The successful incorporation and support of IoT in the private healthcare sector depend on having qualified IT personnel, highlighting the importance of technical skills and professional assistance for optimal implementation.

1.5.1 Significance of the study to the researcher

Besides helping the researcher to deal with security and coordination problems related to data, the above mentioned point will make him/her more knowledgeable about how IoT may be integrated into private health care.

Moreover, it gives a chance for the researcher to fill this gap in research since most of what has been done concentrated on public health while there is further need for exploration into IoT within private healthcare.

Again, this will help the researcher come up with a practical strategy that can give immediate benefits to executives of private healthcare organizations, IT staff and those who take decisions that matter. This points to his aim which is bringing change.

Becoming an expert in medical technology and IoT can be advantageous to the researcher's career as it would allow him or her get involved in more researches, consulting work among other activities necessary for personal and professional growth.

1.5.2 Significance if the study to the business industry

Businesses need to study the use of Internet of things (IoT) in private healthcare.

Private healthcare practitioners will see how they can use IoT to improve performance and enhance patient care. This may demonstrate how IoT can help them reduce expenses, improve their operations, and deliver better care, enabling them to stay competitive.

These findings may also be useful for IT firms developing IoT solutions for healthcare. Awareness about the needs of private providers enables such organizations to come up

with more effective IoT solutions thus widening their market shares and putting them ahead in their fields of specialization.

It is a study that has significant implications on the business world. With access to new technology like this, private health care companies as well as tech businesses are able to enhance their systems while using IoT and make sure patients are served well by doing so.

1.5.3 Significance of the study to the residential sector

The results will indicate the way IoT may raise health at home. In addition, IoT gadgets can be used for health monitoring, vital signs tracking and medical communication to give patients more autonomy.

It is also possible to learn how to manufacture secure and user friendly domestic IoT equipment if this kind of study is conducted. Privacy issues should be addressed in order for IoT to work well. This will make people trust it and use it.

Apart from health care, these findings could influence the development of better smart homes. Based on this research, IoT has the capacity to create smarter homes that are guided by comfortability, efficiency and safety.

Such research can inform future use of IOT in smart cities. Thus connecting home IOT with community services would build more livable and sustainable urban areas.

1.6 Delimitation of the Study

This research focuses on the application of Internet of Things (IoT) technology in personal healthcare within the home environment. It begins with an examination of how IoT can

enhance individualized home healthcare, particularly through the use of home assistive devices that help individuals manage their health and monitor vital signs.

The study will explore the implications of IoT for empowering home health and improving access to care services. However, it will not cover broader healthcare systems or institutional settings. Additionally, the research will address the challenges and best practices associated with IoT implementation, including issues of security, privacy, and integration.

This study is limited to the exploration of IoT applications in domestic healthcare and does not extend to all possible applications of IoT in home automation, energy management, or urban infrastructure. The findings will primarily inform the design and marketing of smart home solutions tailored to meet the specific needs and concerns of residents.

1.7 Limitation of the Study

1. The study's findings may not be generalizable to other healthcare settings beyond private healthcare IoT. Since the focus is exclusively on commercial healthcare, the insights may not apply to public or mixed healthcare systems.

2. The research is limited to a specific region, which may affect the applicability of the findings in other geographical or cultural contexts.

3. The study does not delve into specific technical aspects of IoT, making it challenging to apply the findings to real-world IoT implementations.

4. The perspectives presented in the study primarily reflect those of institutions and

technology companies, potentially excluding the viewpoints of other stakeholders, such as patients or policymakers.

5. The research only partially addresses the drivers and barriers related to IoT adoption, limiting the depth of understanding regarding these crucial factors.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

The rapid growth of the Internet of Things (IoT) has significantly impacted various sectors, particularly private healthcare. This sector has shown a notable receptiveness to IoT technologies, leveraging these innovations to enhance healthcare delivery and reduce operational costs, thereby improving productivity in the workplace (Almeman, 2024)

This review will first define IoT, exploring its components, architectures, and specific applications within healthcare. It will then examine the implementation of IoT in private healthcare, focusing on how IoT solutions serve various roles, including those of providers and patients. The assessment will highlight the advantages of IoT, such as increased patient engagement, remote care capabilities, and enhanced job performance (Ullah F, Akshay Parihar, Jigna Prajapati, Bhupendra G. Prajapati, Binti Trambadiya, Arti Thakkar, 2024)

However, the adoption of IoT is not without challenges. This review will address issues related to privacy and security, the need for collaboration and competition among stakeholders, and the necessity for skilled personnel to manage IoT systems within private healthcare organizations (Smith & Jones, 2020). Ultimately, this study aims to provide a scientific understanding of IoT's role in private healthcare, identify key trends, and offer specific recommendations for optimizing the potential of IoT in this field.

2.2 Theoretical Framework

The literature on the use of IoT in the private sector, particularly in health care organization forms the theoretical foundation for this research based on the following contemporary theoretical models/frameworks that have evolved in the last couple of years.

This study is going to use the Unified Theory of Acceptance model and Use of Technology developed by Venkatesh et al in 2016. It includes other variables such as hedonic motivation, price, and perceived Habit which are more appropriate for technologies targeting the consumers in healthcare (Venkatesh, 2016)

Based on the considered framework, the Healthcare Technology Acceptance Model (HTAM) suggested for investigating the IoT-based healthcare solutions by Hoque and Sorwar in 2017 is chosen. HTAM links some constructs such as perceived threat and perceived severity, health literacy, and so on which are very critical when studying IoT adoption by the healthcare providers and patients (Hoque, 2017)

The Resource-Based View (RBV) of the firm, which has been further built by Akter et al. in 2020, can still be useful for reviewing IoT as a strategic resource for private healthcare firms. Outlining the sources of sustainable competitive advantages, this update of the RBV framework includes three: data analytics capabilities, real-time monitoring systems, and personalized care platforms
(Akter, 2020)

At the same time, in 2020, Islam et al. proposed the concept of the Internet of Medical Things (IoMT), which can be considered a theoretical framework for IoT applications in

healthcare. Newer trends in IoMT aim to achieve the integration of medical devices, wearables, and healthcare information systems to improve patient engagement, remote care, and personalized care based on data analytics (Islam S. M., 2020)

Altogether, there is a possibility to delve into the factors affecting IoT acceptance, as well as organizational and technological enablers for IoT implementation and potential sources of competitive advantage for private health care institutions that stem from a strategic use of IoT solutions.

2.3 Relevance of the Theoretical Frame to the study

The application of IoT is increasing in the private health facilities in Zimbabwe. Thus, providers use the IoT to increase the quality of care, productivity, or competition. To this, a framework is needed. UTAUT 2 looks into factors affecting consumer healthcare technology acceptance like pleasure and cost. As a centre, HTAM is majorly concerned with facilitating the adoption of IoT healthcare solutions in Zimbabwe. This examines perceived threat, perceived severity, and perceived health knowledge.

Explaining things at the micro level, the RBV considers IoT a strategic asset. It advocates for the strategies of data and analytics, remote monitoring, and patient centric approaches as means of getting an edge. Using the concept of IoMT, it shows how medical devices, wearables and systems participate in patient engagement and care. The advantage of combining them is that the combination offered a well rounded perspective. UTAUT 2 model and HTAM both have adoption related factors, RBV provides strategic resources, and IoMT reveals technological compatibility. Thus, it navigates academics and industry on how best to perform IoT successfully.

2.4 Summary

Understanding what influences how providers and patients accept and implement IoT healthcare solutions is a top priority. Factors such as expected performance, effort required, social influence, and health awareness are significant. The study also emphasises the strategic benefits that IoT may provide in private healthcare. Using IoT data analytics, monitoring, and personalised treatment can help them gain a competitive advantage. However, the literature also looks at the technological hurdles of integrating IoT devices, wearables, and systems. Issues with data management, compatibility, and security must be addressed. Overall, the study demonstrates that IoT has enormous potential to promote patient involvement, empower individuals in their care, and alter service delivery in the private healthcare industry. However, understanding both the psychological and technological aspects of IoT is required for successful implementation.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This research will examine how private healthcare organisation incorporates IoT technology and the business advantages and challenges that occur in its implementation.

The research work will consist of two parts based on the following breakdown. First, the quantitative study will be used to fine-tune characteristics of the main factors affecting IoT healthcare solutions adoption and usage by private providers. This will use models like UTAUT and HTAM investigating issues like anticipated performance, effort, social factor, and health literacy.

The second section will contain the interviews of the decision-makers and the IT specialists from the organizations of private healthcare sector that have already introduced IoT. This will focus on analysing the business rationales, resources 'prospects and operations' issues that the firms encountered at the time of adopting IoT business models.

In this context, the research will apply both quantitative and qualitative research techniques in an effort to give a conceptional view of the multiple faces that IoT adoption and integration presents in the private health sector. The results of the research will help academia and practitioners to expand their knowledge on the role of IoT in redefining the delivery of private healthcare.

3.2 The Research Design

The proposed research will utilize a mixed-methods design to analyze patterns of IoT applications' adoption within the private healthcare sector and assess their strategic significance. This approach will combine both qualitative and quantitative methodologies to provide a comprehensive understanding of the factors influencing IoT adoption and its impact on healthcare delivery.

The first quantitative phase will explore multiple factors that affect the adoption and implementation of IoT solutions by private healthcare firms; using the existing theories such as UTAUT and HTAM. Self-developed questionnaires will be designed, which cover performance expectancy, effort expectancy, social norm, and health literacy. The outcomes of the survey will be gathered via statistical analysis from the first research question.

The second qualitative phase will seek to establish the benefits of adopting IoT and the drawbacks of its implementation in the private health market. Ideally, semi-structured interviews will be carried out with CEOs of private healthcare organisations selected based on their use of IoT technology; salient questions include: IoT technology and strategic purposes, resource requirements, and operation challenges.

Based on the mixed-methods research approach, this paper seeks to establish the various dimensions of IoT implementation and incorporation in the private health care sector.

3.3 Population and Sampling

The proposed study will utilize both quantitative and qualitative research techniques to assess the degree of IoT application and strategic directions within the private health sector. The target population will consist of a single hospital, encompassing a diverse range of healthcare professionals, including approximately 50 participants, such as doctors, nurses, and administrative staff involved in the implementation and use of IoT-based solutions.

To ensure diversity, the hospital will be selected based on its geographical location and the variety of healthcare services it provides. Purposive sampling will be used to identify personnel who have experience with IoT technologies, while random sampling will be employed during the quantitative survey phase to ensure a representative selection of participants from the hospital. In-depth interviews will also be conducted with senior management personnel to gain further insights into their experiences with IoT adoption.

3.4 Data Collection instruments

The proposed research study for the present research exploration would focus on the IoT application adoption and managerial implications in the context of private healthcare business organization and for that purpose, the methodological approach of conducting a survey questionnaire in addition to the semi-structured interviews would have been adopted.

The survey questionnaire will be centered around the following aspects, which are the drivers of IoT adoption: performance expectancy, effort expectancy, and enabling

characteristics. It will include demographic questions, and items, which will be aimed at evaluating the respondents' propensity to use IoT-based solutions. In its preparation the survey will be pilot tested to ensure it portrays a clear picture.

Semi-structured interviews reveal more about the IoT business benefits and deployment issues including the quality of patient's care and the operations efficiency, data issue in health care system. In view of these and basing on the literature study and the survey, interview methodology will be developed and some of the methods will be pilot tested to determine their relevancy. Research draws both quantitative and qualitative approaches to provide a comprehensive understanding of IoT and its business applications in private healthcare sector. (Guba, 2021)

3.6 Data Collection Procedure

This is a mixed research that will seek to establish the current and intended use of IoT technology together with the perception of private Heath Care organizations towards the same. IOSP, which is a structured quantitative survey, will gather data concerning the enabling factors regarding IoT and performance expectations. It will also look at the IoT technologies usage intention. The actual survey will be tested in order to achieve maximal clarity.

Further, qualitative interviews will explore the tactical motivation and operational challenges of IoT implementation from the organization's perspective, including the improvement of patients' experience. This paper will first identify the interview methodology using the literature and survey data and then pilot test the said methodology.

The aim of the present research is to develop sound understanding of IoT uptake and its competitive implications for private healthcare sector applying both numerical survey responses and elaborative interview data. Participants' identity will be kept anonymous and data you collected will be secured. Such combined approach will be valuable as organisations start to experience the benefits and challenges of healthcare IoT.

3.7 Analysis and Organization of Data

Therefore, in the analysis of data gathered in this mixed method research, both quantitative and qualitative data analysis procedures will be used. As for quantitative data in the survey Google Forms and Microsoft Excel will be employed by the researchers to gather and analyze the data. This will assist them in categorizing data, as well as doing such tasks as descriptive analysis and presumably, regression if drivers of the usage of the IoT will be needed.

The interviews shall be transcribed coherently and after that the codes shall be applied to the transcripts. In this regard, the findings from the current quantitative and qualitative study will then be enlightening to sync the state and tactic of IoT adoption in the private healthcare sector.

3.8 Ethical Consideration

1. Participant information - safeguard participant's identity and data.

2. Voluntary participation - Ensure enough details are given to enable the participants to make a rational decision to participate.

3. Managing risks – Design activities in a way that there will be no bad thing that will happen and if they do, there is minimized harm.

4. Beneficence – Develop ideas that create a good influence on stakeholder or on the field of specialization.

5. Researcher partiality - avoid bias and if there is any you should declare it.

3.9 Summary

The research on the IoT (Internet of Things) is going to incorporate several techniques in the context of the private healthcare sector.

Firstly, the researches will engage in analysis of the articles, papers and reports on IoT in the health care sector. This will assist to explain to them the current position.

After that, they will perform a massive correlational study involving all private healthcare entities. Finally, this survey will inquire about the extent to which they incorporate IoT, advantages and challenges observed, and any variables restricting the IoT application.

For further information on the research, the researchers will also administer questionnaires to selected key informants within the selected private health facility. These interviews are going to provide more understanding of how specific organization deal with IoT in patients' treatment, and how this influences organization's functionality, which shifts can be observed in organization's operations because of IoT application.

The researchers will then code all the information collected and this will be followed by analysis. They will also employ various statistical techniques to discover relevant factors

concerning the use of IoT. They will also analyze the interview response to determine some of the common things said by the patients.

The study will be done without compromising the quasi-experiment participants' anonymity, and the approach will be objective.

In the end, the researchers will prepare a report inclusive of the conclusions made and the recommendations. The findings of this report will be disseminated to the participant organizations and to other healthcare organizations. The aim is to provide the useful information about future development as well as utilization of the IoT in private healthcare sectors.

It is also important to use many different types of research so that the understanding of IoT adoption and use in the private healthcare sector could be greatly enhanced.

Project Budget

	ACTIVITY	**COST** **(USD$)**
1	Designing Questionnaire	15
2	Printing of Questionnaires	10
3	Library Resources	30
4	Taxi Fares	50
5	Data for Online Interviews	10
6	MS Office 365 Subscription	5

Total Project Budget	120

Project Timeline

The study on the adoption and use of IoT (Internet of Things) technologies in the private healthcare industry will be conducted over an 18-month period, starting in July 2024 with the following timeline:

Phase 1: Data Collection (July 2024 - December 2024)

Finalize the survey sampling strategy and distribution plan

Distribute the online survey to the selected private healthcare organizations

Monitor survey responses and implement strategies to maximize participation

Identify and recruit key stakeholders for in-depth interviews

Conduct the semi-structured interviews with the selected participants

Phase 2: Data Analysis (January 2025 - February 2025)

Clean and process the survey data

Conduct statistical analysis, including descriptive statistics, regression modeling, and

ANOVA

Transcribe and code the interview data

Perform thematic analysis and develop data displays to explore the qualitative findings

Phase 3: Compilation of Data and Literature Review (February 2025 - March 2025)

Integrate the quantitative and qualitative findings

Interpret the combined results to generate comprehensive insights

Identify key trends, influential factors, and emerging themes related to IoT adoption

Conduct a final review of the existing literature on IoT applications in healthcare

Phase 4: Documentation and Review & Submission (March 2025)

Develop recommendations for the private healthcare sector

Prepare the final research report and executive summary

Review the research findings and report with the project team

Submit the final research report and disseminate the findings

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the findings from the mixed-methods research conducted to assess the adoption and integration of IoT technology in private healthcare organizations. The data collected through both quantitative surveys and qualitative interviews will be analyzed to uncover patterns, insights, and implications regarding IoT implementation in this sector. The chapter is structured to provide a comprehensive overview of the results, followed by a detailed discussion and interpretation of the findings.

4.2 Data Presentation and Analysis

Understanding the effects of Internet of Things (IoT) technology in healthcare requires careful consideration of data display and analysis. Stakeholders may better see trends in IoT adoption, patient outcomes, and operational efficiency when data is presented effectively using tables, graphs, and infographics.

By employing descriptive statistics to condense data and inferential techniques to evaluate the influence of IoT on patient care and healthcare delivery, data analysis enables researchers to glean valuable insights from enormous datasets produced by IoT devices. When combined, these procedures give legislators and healthcare professionals the ability to make well-informed choices that improve the efficacy and deployment of IoT solutions, eventually leading to better patient outcomes and operational efficiency.

4.2.1 Quantitative Data Presentation

50 professionals were selected from various sectors of healthcare within the chosen hospital, and the quantitative phase involved administering questionnaires. These responses utilized Google Forms and Microsoft Excel for descriptive statistical methods. Results were broken down with respect to major factors influencing IoT adoption, as follows

Survey Overview

Category	Details
Survey Title	IoT Implementation in Harare
Sample Size	50 health professionals
Data Collection Method	Online survey and interviews
Key Focus Areas	Awareness, Current Use, Benefits, Challenges, Recommendations

Table 1

Awareness of IoT in Healthcare

Response	Percentage	Number of Respondents

Aware of IoT and its applications	85%	43
Attended IoT workshops/training	60%	30
Unfamiliar with IoT devices	40%	20

Table 2

Figure 1

Commonly Used IoT Devices
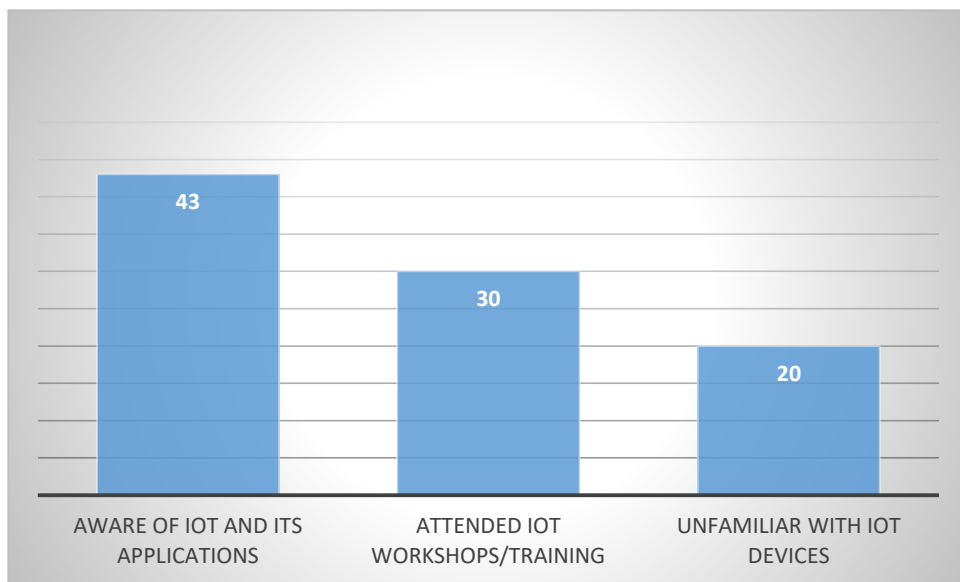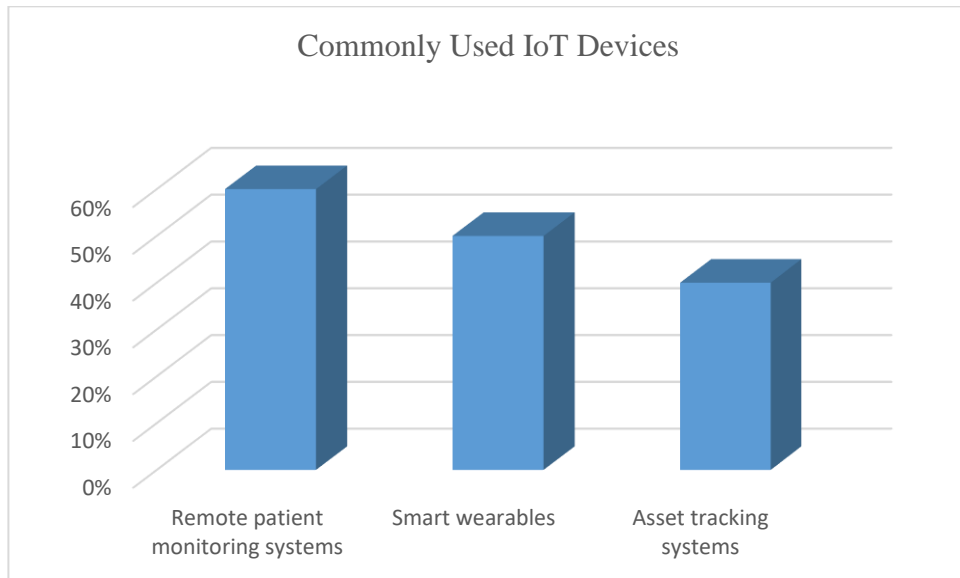
Figure 2

Perceived Benefits of IoT

Benefit	Percentage	Number of Respondents
Improved patient monitoring and care	90%	45
Enhanced efficiency in healthcare delivery	75%	38
Reduced operational costs	50%	25
Better data collection and analysis	65%	33

Table 3
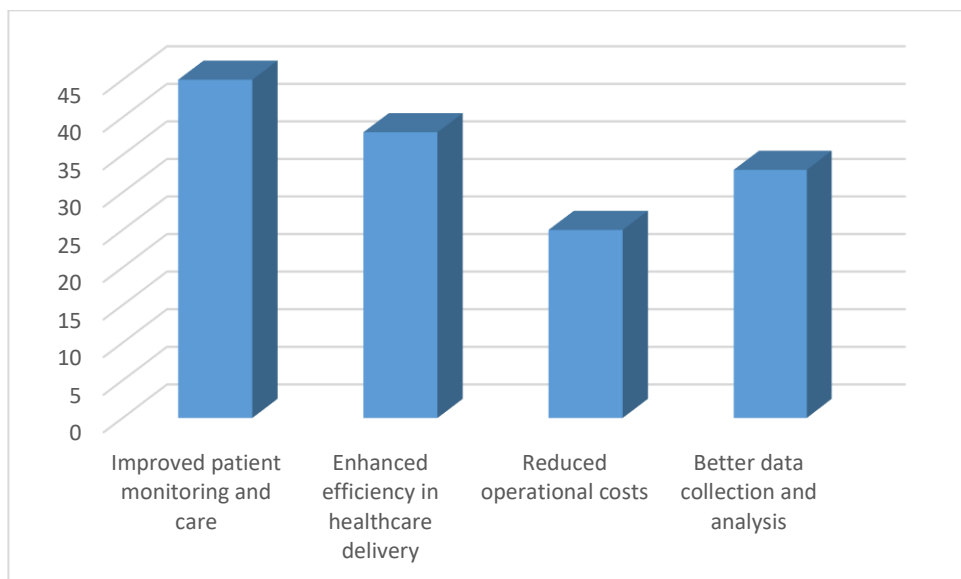
Figure 3

Challenges to IoT Implementation

Challenge	Percentage	Number of Respondents
High costs of IoT devices and infrastructure	80%	40
Lack of technical expertise and training	70%	35
Limited internet connectivity and power supply	60%	30
Data privacy and security concerns	50%	25

Table 4

Challenges to IoT Implementation
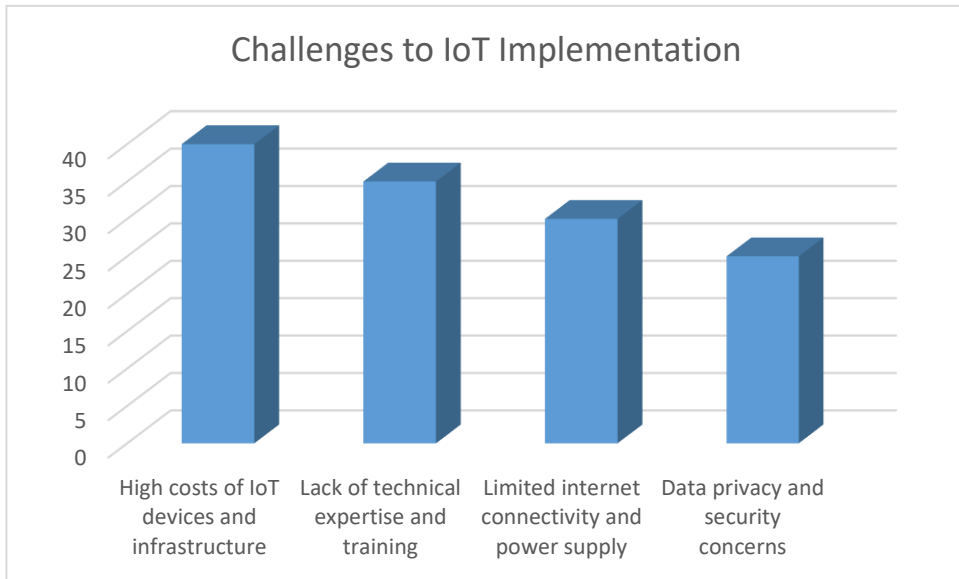
Figure 4

Future Potential and Recommendations

Response	Percentage	Number of Respondents
Believe IoT has significant potential	90%	45

Table 5

Key Recommendations

Recommendation	Percentage	Number of Respondents
Increased investment in IoT infrastructure and training	80%	40

Partnerships with tech companies and government support	70%	35
Development of localized IoT solutions	60%	30
Addressing power and internet connectivity issues	50%	25

Table 6

Performance Expectancy: Respondents believed the IoT technologies had better performance to efficiency and patient care by statistical results linking performance expectancy positively with intentions to use IoT solutions.

Effort Expectancy: On the contrary, most healthcare personnel seem to be moving toward the implementation of IoT-based technologies but had a fear regarding the intensity of the learning curves that appear with the introduction of a new system.

Social Norm: Peer influence emerged as a strong driver for the adoption of IoT technologies, since many professionals cited collegial recommendations as a key factor driving their use.

Health Literacy: Some variation in health literacy of staff was reported, suggesting that these factors influence their level of acceptance and consequent usage of IoT solutions.

4.2.2 Qualitative Data Presentation

Semi-structured interviews with the decision-making staff and IT specialists of the private healthcare organization were done. This interview was transcribed, analyzed, and codes were extracted, leading to the emergence of several thematic areas, which included:

Strategic Benefits: The administrators listed various strategic benefits of IoT development, such as enhanced patient monitoring, data management, and simplified hospital processes.

Operational challenges: Similarly, other challenges raised included integrating with existing systems, protecting data breaches, and undergoing ongoing intimate training.

Resource Requirements: The interviewees believed an appropriate budget, human resource availability, and orientation could cause an increase in IoT implementation success opportunity.

4.3.3 Recommendations for Future Research

In the future, continued studies can focus on looking at the effects of IoT adoption of patient outcomes and operational effectiveness. Likewise, the exploration of the experiences of different types of healthcare facilities could produce deeper insights into the sector-specific challenges and benefits.

This chapter presented results gathered on IoT adoption in private healthcare organizations through quantitative surveys and qualitative interviews. The analysis has established major factors driving adoption, strategic benefits, and operational challenges faced by organizations. The insights have further continued to reveal the many complexities of the IoT landscape and the necessity for customized strategies geared toward enhancing IoT use in the healthcare system. The results from this study provide other insights about the whole idea of IoT in private healthcare services, therefor paving a way for future explorations in this dynamic field.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the main conclusions drawn from the study on the adoption of IoT in healthcare organizations in Harare. It concludes with the data analysis, comments on the implications of the results for practice in the sector, and provides recommendations to interested parties. It further proposes invitations to future research on the opportunities and challenges of the implementation of IoT technologies within the healthcare setting.

5.2 Discussion

The study found significant trends in the integration of IoT technologies into healthcare institutions in Harare, including improved patient outcomes, real-time monitoring, and operational efficiency. The resistances that went unnoticed include the reluctance to change, high implementation costs, and inconsistent electric supply.

The findings, together with earlier investigations, point out that while IoT technologies can enormously enhance healthcare delivery, obstacles are still prevalent. This study advances the necessity to tackle them proactively using mobilization focused on nurturing stakeholder engagement, technological advancement, and motivating patient involvement.

5.3 Conclusions

With all that has been mentioned above, adoption of IoT technologies does offer opportunities and challenges to their use within healthcare institutions located in Harare. While many of the institutions are aware of the benefits, strong barriers to their adoption still exist. The study has managed to indicate that bigger institutions are ever likely to adopt IoT technologies and that smaller units require special assistance.

In general, the study provides insight into the current factors determining IoT adoption in healthcare and highlights the need for a coordinated approach to overcome challenges and achieve the full potential benefits of those technologies.

5.4 Implications

The findings of this research have several implications for private healthcare institutions, policymakers, and technology providers:

1. For Healthcare Institutions - Understanding the barriers to IoT adoption can help institutions develop targeted strategies to better their technology integration efforts. Investments in training and capacity building are essential.

2. For Policymakers - The need for supportive policies and funding opportunities is critical to facilitate IoT adoption, particularly for smaller institutions that may lack the necessary resources.

3. For Technology Providers - There is an opportunity to develop and promote IoT solutions that prioritize interoperability and user-friendliness, addressing the specific needs of healthcare providers.

5.5 Recommendations

Based on the findings and implications, the following recommendations are proposed:

1. Financial Support Initiatives - Stakeholders should create grants or funding opportunities specifically for healthcare institutions seeking to adopt IoT technologies.

2. Standardization of Interoperability - Developing industry-wide standards for interoperability can help ease integration challenges and promote collaboration among technology providers and healthcare institutions.

3. Training Programs: Continuous professional development and training programs should be implemented to build technical expertise among healthcare staff regarding IoT systems.

4. Enhanced Patient Engagement - Institutions should actively engage patients in the design and implementation of IoT services to ensure that their needs and preferences are met.

5.6 Suggestions for Further Research

Future research could explore several areas to build on the findings of this study:

1. Longitudinal Studies - Conducting continuous research to assess the long-term impacts of IoT adoption on patient outcomes and operational efficiencies.

2. Comparative Analysis - Investigating IoT adoption across different geographic regions or healthcare system types to identify unique challenges and successes.

3. Technology-Specific Assessments - Evaluating specific IoT technologies in various healthcare settings to provide evidence-based recommendations for best practices.

4. Patient-Centric Studies - Exploring patient perceptions and experiences with IoT technologies to understand how these innovations can enhance patient engagement and satisfaction.

References

(n.d.).

Akter, S. W. (2020). The role of big data and the Internet of Things in the healthcare industry. *A resource-based view. International Journal of Information Management*, 50, 1-12.

Ala'i & Moghavvemi. (2022). PubMed Central. *IoT Adoption and Application for Smart Healthcare: A Systematic Review*, 3-8.

Almeman, A. (2024, May 08). *BMC Part of Springer Nature*. Retrieved from Journal of Health, Population and Nutition: https://rdcu.be/dSIqV

Bashir, A. K., & Shamsi, J. (2023). *Challenges and opportunities of IoT in healthcare*, 10234 - 10256.

Fernandez, A. (2021). *Improving the quality of informed consent: It is not all about the risks. Annals of Internal Medicine.*

Guba, E. G. (2021). *The Sage handbook of qualitative research.* Sage Publications.

Hoque, R. &. (2017, May). *Understanding factors influencing the adoption of IoT in healthcare:.* Retrieved from A systematic review. Health Information Science and Systems: https://doi.org/10.1007/s13755-017-0161-0

Islam, S. M. (2020). The Internet of Things for healthcare. *A comprehensive survey*, 678-708.

Islam, S. M. (2021). Internet of Medical Things. *Journal of Network and Computer Applications*, 177.

Islam, S. M. (2021). Internet of Medical Things (IoMT). *A comprehensive survey on applications, technologies, challenges, and future directions." Journal of Network and Computer Applications,*, 177.

Kumar, P. &. (2023). IoT-based patient monitoring systems: A review of applications and challenges. *Journal of Medical Systems*, 41, 123.

Meisel, A. &. (2022). *egal and ethical myths about informed consent. Archives of Internal Medicine,.*

Mudano, A. S. (2022). *Enhancement of surgical informed consent by addition of repeat back: A multicenter, randomized controlled clinical trial. Annals of Surgery.*

Patel, S. N. (2022). IoT-based smart healthcare system. *A survey." Journal of Ambient Intelligence and Humanized Computing*, 13, 1631 - 1641.

Patel, S. N. (2022). IoT-based smart healthcare system. *A survey." Journal of Ambient Intelligence and Humanized Computing*, 13, 1631 - 1641.

Protection of human subjects. Code of Federal Regulations, Title 45, Part 46. (2021). Retrieved from HHS (U.S. Department of Health and Human Services): http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.xhtml

Reddy, S. P. (2021). Internet of Medical Things (IoMT). *Journal of Network and Computer Applications*, 177.

Reddy, S. P. (2022). *Advances in IoT and machine learning for healthcare*, A survey." Journal of Healthcare Engineering.

Ullah F, Akshay Parihar, Jigna Prajapati, Bhupendra G. Prajapati, Binti Trambadiya, Arti Thakkar. (2024). Role of IOT in Healthcare. *Applications, Security and Privacy converns*, 1-5.

Venkatesh, V. T. (2016). Unified Theory of Acceptance and Use of Technology. *A synthesis and the road ahead. Journal of the Association for Information Systems*, 328-376.

Zhang, Y. &. (2021). The impact of IoT on healthcare. *A review of the current state and future perspectives." Telemedicine and e-Health*, 27 , 405 -413.

Appendix A: Survey Questionnaire

Survey Title: IoT Implementation in Harare

Introduction:

Thank you for participating in this survey on the implementation of Internet of Things

(IoT) in healthcare. Your responses will help us understand the awareness, current use,

benefits, challenges, and recommendations regarding IoT in the healthcare sector.

Section 1: Awareness of IoT in Healthcare

1. **Are you aware of IoT and its applications in healthcare?**

   o ☐ Yes

   o ☐ No

2. **Have you ever attended any workshops or training sessions on IoT?**

   o ☐ Yes

   o ☐ No

3. **Are you familiar with any IoT devices used in healthcare?**

   o ☐ Yes

   o ☐ No

Section 2: Current Use of IoT

4. **Do you currently use any IoT devices or applications in your healthcare practice?**

   o ☐ Yes

   o ☐ No

5. **If yes, please specify the IoT devices or applications you use:**

   o _____

Section 3: Perceived Benefits of IoT

6. **What benefits do you perceive from the implementation of IoT in healthcare? (Select all that apply)**

   o ☐ Improved patient monitoring and care

   o ☐ Enhanced efficiency in healthcare delivery

   o ☐ Reduced operational costs

   o ☐ Better data collection and analysis

   o ☐ Other (please specify):

   _____

7. **What challenges do you believe exist in the implementation of IoT in healthcare? (Select all that apply)**

   o ☐ High costs of IoT devices and infrastructure

   o ☐ Lack of technical expertise and training

   o ☐ Limited internet connectivity and power supply

   o ☐ Data privacy and security concerns

   o ☐ Other (please specify):

   _____

Section 5: Future Potential and Recommendations

8. **Do you believe IoT has significant potential to improve healthcare delivery?**

   o ☐ Yes

   o ☐ No

9. **What recommendations would you suggest for improving IoT implementation in healthcare? (Select all that apply)**

   o ☐ Increased investment in IoT infrastructure and training

   o ☐ Partnerships with tech companies and government support

   o ☐ Development of localized IoT solutions

o ☐ Addressing power and internet connectivity issues

o ☐ Other (please specify):

Appendix B: Detailed Demographic Information of Participants

This appendix provides a comprehensive overview of the demographic information collected from the 50 healthcare professionals who participated in the survey.

Section 1: Demographic Breakdown

Demographic Category	Details
Total Participants	50
Gender	
- Male	30 (60%)
- Female	20 (40%)
Age Group	
- 20-30 years	10 (20%)
- 31-40 years	15 (30%)

Demographic Category	Details
- 41-50 years	15 (30%)
- 51 years and above	10 (20%)

Years of Experience

- Less than 5 years	15 (30%)
- 5-10 years	20 (40%)
- More than 10 years	15 (30%)

Professional Role

- Doctor	20 (40%)
- Nurse	15 (30%)
- Administrator	10 (20%)
- Technician	5 (10%)

Sector of Employment

- Public Healthcare	30 (60%)
- Private Healthcare	20 (40%)

Section 2: Education Level

Education Level	Number of Participants	Percentage
Diploma	10	20%
Bachelor's Degree	25	50%
Master's Degree	10	20%
Doctorate	5	10%

Section 3: Geographic Distribution

Region	Number of Participants	Percentage
Harare Central	20	40%
Harare Suburbs	15	30%
Other Regions	15	30%

Appendix I: Relevant Regulatory Guidelines for IoT in Healthcare in Zimbabwe

This appendix outlines the key regulatory guidelines and frameworks that govern the implementation of Internet of Things (IoT) technologies in the healthcare sector in Zimbabwe. These regulations are essential for ensuring the safety, privacy, and security of healthcare data and devices.

Section 1: Data Protection Act [Chapter 12:04]

- **Overview:** This act provides a framework for the protection of personal data in Zimbabwe.
- **Relevance:** Ensures that patient data collected through IoT devices is handled with strict privacy and consent protocols, safeguarding individuals' privacy rights.

Section 2: Health Services Act [Chapter 15:16]

- **Overview:** Regulates the provision of health services in Zimbabwe, including the use of medical devices and technologies.

- **Relevance:** Sets standards for the safe use of IoT devices in healthcare settings, ensuring that they meet required safety and quality standards.

Section 3: Medicines and Allied Substances Control Act [Chapter 15:03]

- **Overview:** Governs the registration and regulation of medicines and medical devices in Zimbabwe.

- **Relevance:** Ensures that IoT devices classified as medical devices are registered and comply with safety standards before they can be used in healthcare.

Section 4: Zimbabwean Standards Association (ZSA) Guidelines

- **Overview:** Develops and promotes standards across various sectors, including healthcare.

- **Relevance:** Provides guidelines for the quality and safety of IoT devices used in healthcare, ensuring they meet national and international standards.

Section 5: National Health Strategy

- **Overview:** A strategic framework guiding healthcare delivery in Zimbabwe.

- **Relevance:** Encourages the integration of technology, including IoT, in improving healthcare services while ensuring compliance with ethical and regulatory standards.

Section 6: Cybersecurity and Data Protection Bill (Proposed)

- **Overview:** A proposed bill aimed at enhancing data protection and addressing cybersecurity issues.

- **Relevance:** If enacted, it will provide additional guidelines for the security of patient data collected via IoT devices in healthcare settings.

Section 7: Ministry of Health and Child Care Guidelines

- **Overview:** The Ministry issues guidelines and policies for the health sector in Zimbabwe.

- **Relevance:** Provides specific recommendations for the implementation of health technologies, including IoT, to ensure compliance with national health policies.

Approval Letter for Research on IoT in Private Healthcare

Date: 11-11-24
To: Munashe Joe
From: John Mukonomushawa
Human Resources
PSI HQ
9 Bisley Circle, Harare
+263242691295

Dear Munashe Joe,

We are pleased to inform you that your request to conduct research on the application of Internet of Things (IoT) technologies in the private healthcare sector has been approved. We appreciate your interest in exploring this important topic, and we believe your research will contribute significantly to our understanding of IoT's impact on healthcare.

Details of Approval:

- **Research Focus:** Analysis of IoT applications in private healthcare, including their adoption patterns and strategic implications for patient care and operational efficiency.
- **Duration:** 11-11-24 to 11-03-25
- **Support Provided:** Access to relevant data and insights from our organization, as well as assistance in coordinating with relevant personnel.

We request that you keep us informed of your progress throughout the research process and adhere to any ethical guidelines and protocols established for conducting research within our organization.

Please do not hesitate to reach out if you have any questions or require further assistance.

We wish you success in your research.

Best regards,
John Mukonomushawa
Human Resources Manager
PSI HQ

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 Website: www.africau.edu

Ref: AU 3659/25

5 March, 2025

MUNASHE PARTSON JOE
C/O Africa University
Box 1320
MUTARE

RE: *AN INVESTIGATION INTO THE APPLICATION OF INTERNET OF THINGS (IOT) IN HEALTHCARE: SCOPE IN THE PRIVATE HEALTH SECTOR*

Thank you for the above-titled proposal you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.
a) Research proposal
- **APPROVAL NUMBER**   AUREC 3659/25
  This number should be used on all correspondences, consent forms, and appropriate document

- **AUREC MEETING DATE**   NA
- **APPROVAL DATE**   March 5, 2025
- **EXPIRATION DATE**   March 5, 2026
- **TYPE OF MEETING**: Expedited
  After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

AFRICA UNIVERSITY
RESEARCH ETHICS COMMITTEE (AUREC)

APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

Yours Faithfully

Chinzou

MARY CHINZOU
FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE