ADOPTION OF INTERNET OF THINGS IN ENHANCING KNOWLEDGE MANAGEMENT IN UNIVERSITY LIBRARIES: A CASE STUDY OF CATHOLIC UNIVERSITY OF EASTERN AFRICA, KENYA

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A Thesis Submitted to the School of Science and Technology in Partial Fulfillment for the Requirements of the Conferment of Degree of Masters of Science in Information Science of Kenya Methodist University

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented for a degree or any other award in any other University.

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Recommendation

I/We confirm that the work reported in this thesis was carried out by the candidate under my/our supervision.

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DEDICATION

I dedicate this work to Meru University of Science and Technology and Catholic University of Eastern Africa libraries as well as to my supportive family.

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I would like to express my heartfelt gratitude for the support and guidance I received throughout this academic endeavour. First and foremost, I acknowledge the blessings and grace bestowed upon me by the Almighty. Secondly, I am incredibly grateful to my family and friends who have been a constant source of encouragement and mentorship. Their unwavering belief in me has been instrumental in my success. Thirdly, I extend my sincere appreciation to my esteemed supervisors, Prof. Paul Maku Gichohi and Dr. Lawrence Mwenda for their valuable advice and guidance, which has greatly contributed to my research achievements. Fourth, I would like to express my heartfelt appreciation to my lecturers whom were so instrumental in this scholarly endeavour. Moreover, I would also like to express my deep gratitude to the library staff at Catholic University of Eastern Africa library, KeMU Library, and Reuben Marambii Library for their assistance and motivation. Lastly, to all those who have played a role in shaping my academic journey, I am truly thankful for your unwavering support.

ABSTRACT

The potential of the Internet of Things (IoT) to improve operational efficiency and effectiveness has been widely acknowledged in various sectors. However, university libraries are yet to fully embrace this technology. The main purpose of this study was to investigate the adoption of Internet of Things (IoT) technology in enhancing knowledge management at Catholic University of Eastern Africa library, with a view to recommend best practices. Specific objectives were to: assess the types of Internets of Things technology adopted at Catholic University of Eastern Africa library, examine factors attributed to successful adoption of the Internet of Things at Catholic University of Eastern Africa library, examine how internet of things technology relate with knowledge management and determine the competency of library staff in using IoT to manage knowledge at Catholic University of Eastern Africa library. The study was guided by the Unified Theory of Technology Acceptance and Use and Adaptive Structural Theory, and was conducted at the Catholic University of Eastern Africa university libraries. Utilizing a descriptive research design, this study focused on a target population of seven decision-making librarians and five hundred library patrons. Employing a qualitative approach, data was collected through interviews with a purposively selected university librarian, five section head librarians, and six focus group discussions (7 each), involving simple randomly sampled library patrons. Document analysis was also conducted. Content analysis and thematic categorization were used for data analysis. The study found out that there was limited IoT adoption for knowledge management in libraries at CUEA. This is attributed to challenges in infrastructure, training, and organizational barriers. Key success factors identified include robust infrastructure, user acceptance, library staff training, and organizational support. The study also found varying competency levels among library staff in using IoT technology. Additionally, a positive relationship between IoT and knowledge management was observed, particularly in terms of information access, resource management, and collaboration. The study concluded that the IoT adoption for knowledge management in libraries at CUEA were limited to infrastructure, training, competency, user acceptance, support and organizational barriers. Additionally, a positive relationship between IoT and knowledge management was observed. Based on the findings, the study recommends that libraries should develop a comprehensive strategy for integrating IoT technology into knowledge management practices. Libraries should establish partnerships with technology providers and industry experts to access suitable IoT solutions. Libraries should conduct regular assessments and evaluations to monitor the progress and measure the impact of IoT implementation. Additionally, the government should foster a culture of innovation and continuous learning within university libraries. Furthermore, the study encourages further research and studies to expand the knowledge base and contribute to the advancement of best practices in the field of IoT adoption for knowledge management in university libraries. By implementing these recommendations, university libraries will leverage IoT technology effectively, enhance their knowledge management capabilities, and make significant contributions to academic excellence in research and learning environments.

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ABBREVIATIONS AND ACRONYMS

AI	– Artificial Intelligence
CUEA	– Catholic University of Eastern Africa
ICT	– Information Communication Technology
IoT	– Internet of Things
KM	– Knowledge Management
EDMS	– Electronic Document Management Systems
Ebook	– Electronic Book
Ejournal	– Electronic Journal

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

This section elaborates on the background of knowledge management in university libraries, the concept of internet of things and the background of knowledge management at Catholic University of Eastern Africa library.

1.1.1 Managing Knowledge in University Libraries

During the last decade of the twentieth century, the term "Knowledge Management" gained popularity in the commercial sector. In the "global economy" of the "information era," corporations were the first to recognize the importance of knowledge. Owning relevant and strategic information, as well as its continuous renewal, provides a competitive advantage in the modern knowledge economy. Today, organizations across various sectors are implementing knowledge management solutions as knowledge is now considered one of the most critical determinants of success for both organizations and individuals.

Knowledge has become a power source that propels progress and competitive edge, enhancing skills and experiences, accelerating innovative and creative activities, and satisfying customer desires. Libraries, just like the corporate world, are changing dramatically in the digital age, and they must serve as a hub for learning and knowledge. Four critical factors of knowledge management are people, method, content/technology, and strategy. Leaders, sponsors, and facilitators of information exchange are essential, as are precisely articulated procedures for monitoring and quantifying knowledge flows. Automated tools that integrate the appropriate individuals to the appropriate stuff at the appropriate time are also vital. Ultimately,

individuals need a well-defined and validated scheme for leveraging KM to resolve the most pressing and instantaneous stakeholder expectations.

Knowledge Management (KM) processes are crucial in the deployment of various Information Systems (Al-Emran et al., 2018) to capture, manage, store, disseminate, utilize, and dispose of knowledge. A well-designed framework is necessary to support the deployment of knowledge management, and technology should be utilized as a facilitator. IoTs play a significant role in increasing the efficiency and efficacy of the knowledge management process. Other systems used in knowledge management include KOHA, V-smart, Amlib, ABCD, OPALS, and FOLIO (Breeding, 2022), with modules such as acquisition, cataloguing, circulation, patrons, reports, and search engine. MyLOft, Remotex, Ezproxy, Open Athens, and Shibboleth are used to manage on-campus and off-campus access to e-journals and e-books, while Dspace, IR Plus, Greenstone, and Eprint are used to manage institutional repositories that archive institutional publications and grey literature.

After labour, land, and capital, knowledge is the most important factor of production globally (Mohajan, 2017). Therefore, innovative tools and systems are needed to manage knowledge. Countries such as the US, UK, Norway, Sweden, and Denmark have invested in their libraries' infrastructure to manage knowledge efficiently, effectively, and to receive a high level of user satisfaction.

In African countries like South Africa and Nigeria, knowledge management is achieved through group dialogue, apprenticeships, peer support and work groups, seminars, conferences, and workshops (Enakrire & Onyancha, 2020). Libraries in these countries use KM technologies such as decision support systems, database management systems, online portals, electronic document management systems (EDMS), and management

information systems for both general and special tasks. New knowledge has improved KM procedures in academic libraries, and it is critical to constantly share knowledge to increase service delivery quality and meet users' information and knowledge needs.

Although Knowledge Management is still in its nascent stage in several African university libraries, it is not a foreign invention. Library staff use multiple KM modules to oversee KM operations, and insightful approaches to categorizing information and knowledge have been developed to reorganize and disseminate local collections.

1.1.2 The concept of Internet of Things in University Libraries

The Internet of Things (IoT) is revolutionizing how knowledge is controlled and managed towards clients. This has led to the need for a new and creative knowledge management system, one that can adapt to facilitate and track the knowledge management process (Santoro et al., 2018). In recent years, advancements in machine learning, AI, sensors, systems, networks, and software have led to the adoption of IoT in managing and operating organizational tasks (Khan & Javaid, 2021).

IoT is a digital connection of everyday objects, many of which are intelligent in some way. It blends everything with knowledge-holding materials, creating a widespread network of appliances that connect with living beings and other equipment. The primary purpose of IoT is to collect and share data through internet-connected devices. To be considered an IoT system, four components must be integrated: sensors/devices, connectivity, data processing, and user interface (Trivedi, 2022).

The Internet has evolved from a set of interconnected computer devices to a network of connected objects, including household appliances, machinery, transportation, business storage, commodities, workplace devices, and even parcels. Knowledge, generated primarily within the research world and outside of science, is often considered a

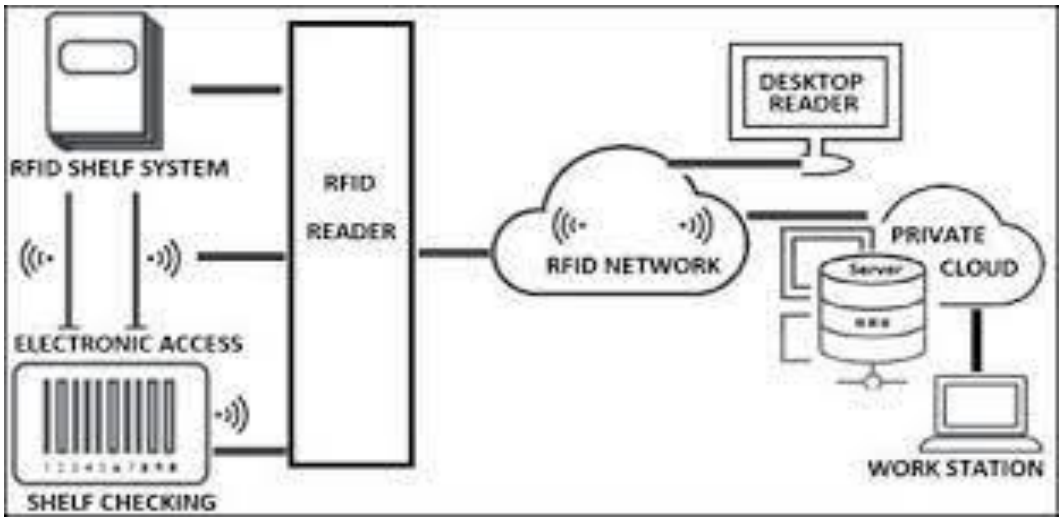
commodity (Stehr, 2020). Developed countries such as the USA, UK, Denmark, Singapore, Norway, and the UAE have witnessed the rapid growth of the internet in our lives. It has changed the way people interact and led to the development of IoT (Fizza et al., 2021). This technology acts as a significant facilitator, providing efficient solutions for all aspects of knowledge management, including knowledge capture, processing, storing, dissemination, and application.

Libraries have also adopted IoT technology, with RFID technology being widely used for real-time detection, scanning, monitoring, recognizing, and modifying a variety of objects, including information and knowledge materials (Kavulya, 2019). RFID is an IoT component used to identify items.

RFID technology has been identified as a viable alternative for managing ICT-driven academic libraries in the 21st century. The Deichman Library in Norway has integrated IoT technology, while in Africa, only a few libraries have adopted this technology. Kavulya (2019) provides a detailed explanation of the RFID system used at the Catholic University of Eastern Africa library in Nairobi, Kenya. The RFID system components in a library include RFID tags, RFID tagging machines, inventory scanners and analysers, access control gates, exit RFID security gates, RFID application server, RFID self-check stations, self-payment stations, library staff workstations, RFID smart cards, and Library Book Drop. An RFID reader detects and locates books with RFID tags in a library. The ultimate goal is to provide seamless library information services using IoT technology.

Figure 1. 1

Network Architecture for RFID

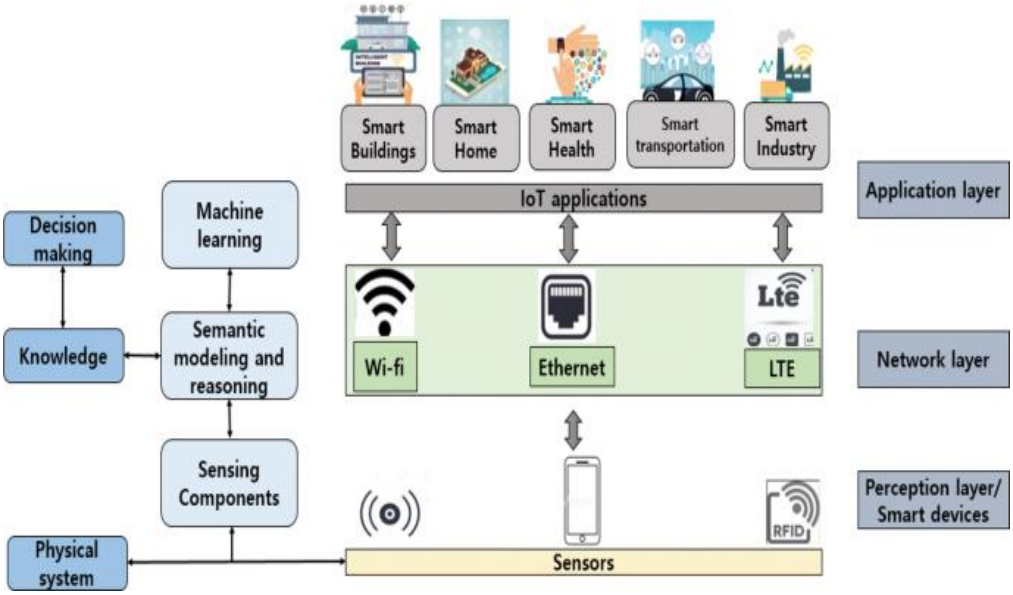


Source: *Bayani et al. (2018)*

IoT technology enables the connection of common objects in the library through the incorporation of sensors. This not only adds to the knowledge in the library, but also supports knowledge services. These sensors possess networking capabilities that allow them to connect with one another, and the data obtained from them can be transferred over a network without the need for human intervention. IoT refers to the use of sensors, processors, cloud computing, wireless networking, and other infrastructure and technology to gather, send, and act on data received from the surrounding knowledge.

Figure 1. 2

Overview of IoT design



Source: *Phuyal et al. (2020)*

The Internet of Things (IoT) operates by connecting to an IoT gateway or edge device, where data can either be transferred to the cloud for analysis or examined locally before providing the user with a response based on the gathered and analyzed information. In libraries, IoT devices can collect user input from a web server, compose an SMS command, and send it to a remote embedded system module through GSM-SMS. This command is then received by the embedded system connected to the GSM receiving module located at a distant station. The embedded system module promptly connects to and controls the library's knowledge appliances and other devices. The GSM module contains IoT software and an embedded system module. The user receives a confirmation when the commands are successfully executed.

1.1.3 The University campus Libraries at Catholic University of Eastern Africa

In the information and knowledge society, information, knowledge, and technology all play crucial roles in modernizing libraries (Ocholla et al., 2022). Information and

communication technology has transformed the operational environment of libraries, with every library inevitably digitizing. A digital library comprises digital content, services, and IT facilities that support teaching, learning, research, and the preservation of information and knowledge. Kenyan university libraries are investing in digital projects to improve access and boost teaching, learning, and research, including CUEA.

These two campus libraries (Lang'ata/Nairobi campus and Eldoret campus libraries) acquire knowledge in various forms, such as textbooks, e-books, print journals, e-journals, CDs, DVDs, magazines, print newspapers, e-newspapers, and past examination papers, and manage this knowledge using systems like Koha, dspace, databases management systems like OJS, editorial manager, and journal one. However, the conventional method of using magnetic strips with barcodes on a sticker to monitor and secure knowledge materials cannot integrate with the system to boost sensing and identification, unlike RFID. With the use of IoT, library systems can be automated to manage knowledge, and the IoT framework can provide best practices for adopting IoT to improve knowledge management.

1.2 Statement of the Problem

The technological revolution in the Internet of Things has uniquely presented its potential to improve effectiveness and efficiency in operations and functioning across various sectors (Thordarson, 2018). Sectors such as education have invested in the infrastructure associated with the Internet of Things and in retooling library staff. University libraries, supporting research, teaching, and learning in higher education, have a significant need to adopt appropriate technology. The Association of Ccollege and Research Libraries (2006) and ISO 30401:2018 (2018) outlined standards for libraries regarding the technological infrastructure that supports information and

knowledge management to enhance effectiveness and efficiency in service delivery. Additionally, Commission for University Education [CUE] (2014) articulated standards and guidelines for university libraries (LIBR/STD/03), directing the adoption and maintenance of ICTs for managing knowledge. These guidelines and standardizations were expected to pave the way for easier adoption of the Internet of Things in enhancing operational efficiency in knowledge management.

Despite the adoption of the Internet of Things in social networking, smart cities, smart homes, health, and the social sphere, its acceptance in the academic environment remained low (Roy et al., 2016). According to the Internet of Things Analytics report of 2021, various Internet of Things use cases were becoming increasingly popular in different sectors (IOT Analytics, 2021). For example, process automation aimed to minimize paperwork, reduce errors, lower labour costs, and provide real-time data access.

There were possibly various reasons responsible for the poor uptake of the Internet of Things in managing knowledge in libraries, such as the lack of integration of information and knowledge systems with library devices, and slow adoption of self-service. This provided evidence that the Internet of Things framework had not been adopted by the majority of university libraries (Igbinovia, 2021). The most conspicuous progress in the majority of university libraries was in systems installations and digitization of information materials. The slow uptake of the Internet of Things in university libraries for managing information and knowledge posed serious drawbacks considering advances and the dynamic technological evolution. This attested to the need for a framework guiding university libraries in implementing the Internet of Things for managing information and knowledge, as the absence of which would render

them obsolete (Makori, 2017). The missing technology adoption of Internet of Things best practices in libraries could make them vulnerable to knowledge management processes and services.

Multiple earlier research, as with Igbinovia (2021), Jumba et al. (2020), Ocholla et al. (2022) and Roy et al. (2016) investigated various aspects like the role of IoT in enhancing learning in universities, emerging issues in IoT adoption in developing countries, knowledge management and technology for developing Africa's education, and a model to facilitate the adoption of IoT-based innovations by urban poor communities. However, none of these studies clarified how university libraries should deal with the adoption of the Internet of Things or recommended specific steps to implement this technology. Recognizing the absence of a dedicated IoT adoption framework for university libraries, this study delved into the critical theme of integrating Internet of Things (IoT) technology to enhance knowledge management within the context of the Catholic University of Eastern Africa, Kenya.

1.3 Purpose of the Study

The main aim was to investigate the adoption and use of Internet of Things (IoT) technology in enhancing knowledge management at Catholic University of Eastern Africa library, with a view to recommending best practice.

1.4 Objectives

The objectives of this study were to:

i. Assess the types of Internets of Things technology adopted at Catholic University of Eastern Africa library.

ii. Examine factors attributed to the successful adoption of the Internet of Things at Catholic University of Eastern Africa library.
iii. Examine how Internet of Things technology relates to knowledge.
iv. Determine the competency of library staff in using IoT to manage knowledge at Catholic University of Eastern Africa library.

1.5 Research questions

i. What types of Internets of Things (IoT) technology were adopted at Catholic University of Eastern Africa library?
ii. What factors contributed to the successful implementation of IoT technology at Catholic University of Eastern Africa library?
iii. How did Internet of Things technology relate to knowledge management in the university library?
iv. What competency did library staff of the Catholic University of Eastern Africa library have in using IoT technology?

1.6 Justification of the Study

The researchers benefited from the knowledge added to IoT adoption in university libraries, as well as the factors contributing to the efficiency and effectiveness of technologies in libraries to advance knowledge management.

Library staff gained from the adopted best practices while acquiring and implementing IoT in the library for knowledge management. Additionally, they learned about the potential benefits of the proper adoption of IoTs.

Stakeholders who provided funds to libraries for technology acquisition learned about the best pre- and post-requisites for effective IoT implementation in knowledge management within libraries.

With the developed best practices, knowledge managers had smoother management of IoTs and patrons enjoyed the ease of finding and using knowledge.

Through the optimal implementation of IoT in libraries, this evolution progressed from being either a conventional library or a smart library to becoming a hybrid library.

1.7 Scope of the Study

This research project placed more emphasis on IoT uptake in university library at Catholic University of Eastern Africa for knowledge management. The research focused on the role of IoTs in enhancing knowledge management in academic libraries. The research was confined to universities within Catholic University of Eastern Africa. Library patrons and library staff were sampled to provide feedback during interviews regarding the adoption of IoT and its potential to support knowledge and service delivery in the library.

1.8 Significance of the study

The prominence of a research project was judged by how it applied to scholarly research and literature in the subject, enhanced practice in the field of interest, and advanced policy.

This work offered valuable lessons to the library field as a whole on the necessity of effectively and efficiently managing knowledge and information. This, in turn, improved how service was delivered to patrons, library operations, and the functioning

of the library. The proposed best practices from this study were useful to library professionals seeking to enhance their operations.

Secondly, this research assisted policymakers by sensitizing them to the need for aligning IoT policies with knowledge management for hybrid service delivery and library operations. This was particularly important since knowledge management was one of the core functions of the library, making knowledge and information available and usable, thus benefiting patrons.

Furthermore, the research corresponded to knowledge advancement among scholars and knowledge managers regarding best practices in knowledge management and IoT usage to enhance operations and service delivery. This not only benefited the library field but also other related areas of research.

Lastly, the research generated new knowledge and stimulated further research in the areas of IoTs and knowledge management. This contributed to the advancement of the field and the development of innovative solutions for the challenges faced by libraries and other organizations.

1.9 Limitation of the Study

These were unanticipated events that had implications for the research outcome, and the researcher's control over them was limited (White & McBurney, 2013). One of the major limitations was the use of a qualitative research approach that heavily relied on the researcher's own perceptions of the data. This subjectivity could introduce bias and limit the reliability of the findings. To mitigate this limitation, the researcher employed various strategies, such as the use of supplemental sources of evidence, expert reviews, and peer-reviewed publications, to validate the accuracy of their data interpretation.

Another limitation of the study was the lack of a longitudinal approach due to budget and time constraints. As implementing an IoT system was costly, and the technology was in constant evolution, the survey was unable to capture the long-term impacts of IoT on knowledge management in libraries. This limitation could affect the generalizability of the study's findings to other contexts or over a longer timeframe.

Furthermore, unforeseen events beyond the researcher's control, such as changes in policies or regulations related to IoT and knowledge management, could also impact the study's outcome. To address this limitation, the researcher remained vigilant and monitored any external factors that could affect the study's findings, adjusting the research design and methodology accordingly.

1.10 Assumptions of the study

The reviews were shaped by the following assumptions:

i. A relationship existed between knowledge management and IoTs, which was significant in enhancing the effectiveness and efficiency of service delivery in academic libraries.
ii. In every academic library, knowledge management practices were involved.
iii. Despite the significant role of knowledge management in enhancing academic library operations, institutions of higher learning did not perceive IoTs as crucial for improving effectiveness and efficiency.
iv. University libraries had not fully embraced IoTs, resulting in low IoT adoption and a subsequent negative impact on achieving enhanced knowledge management and sufficient service delivery.

v. There were no established best practices for IoT adoption that linked knowledge management modules and service delivery, serving as success factors in library operations and functioning.

1.11 Operational Definition of Terms

Internet of Things (IoT) – refer to a network of interconnected devices and sensors that are deployed within the library environment to collect, exchange, and utilize data to improve various aspects of library operations and services. These IoT devices can include sensors, RFID tags, smart shelves, environmental monitoring systems, and other hardware that are equipped with internet connectivity and the ability to communicate with each other and with library management systems (Patel et al., 2016).

Library - is a specialized institution within the university campus dedicated to the acquisition, organization, preservation, and dissemination of knowledge and information resources. It serves as a central hub for supporting the academic and research needs of students, faculty, and researchers affiliated with the university (American Library Association [A.L.A], 2019).

Knowledge Management – refers to the systematic process of creating, organizing, storing, accessing, sharing, and utilizing the vast body of information, data, and intellectual resources available within the library to support the academic and research needs of the university community (Mphidi & Snyman, 2004).

Radio Frequency Identification (RFID) - It is a technology that uses radio waves to automatically identify and track items, such as library books, through RFID tags or labels attached to them (Al-Khater et al., 2017).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers empirical reviews, theoretical and conceptual framework of the study. The empirical review is based on all variables of the study, that is, Technology for Knowledge Management adopted technology frameworks of knowledge management, success factors attributed to the adoption of internet of things in university libraries, Relationship between IoTs and KM and IoTs adoption framework for KM in university libraries. The summary of the research gap, theoretical review and conceptual framework are then presented.

2.2 Types of Internets of Things technology adopted in university libraries

The adoption of Internet of Things (IoT) technology in university libraries has revolutionized knowledge management practices, enabling libraries to enhance their services and streamline operations. With the aim of providing seamless access to information and resources, university libraries have embraced various types of IoT technology. These advancements have not only transformed the way knowledge is curated and shared but also improved the overall functioning of libraries. This section presents an empirical study examining the types of Internets of Things (IoT) technology that have been adopted in university libraries. The study involved comprehensive research and analysis of multiple university libraries across different geographical locations. The aim was to identify the prevalent types of IoT technology utilized and understand their impact on knowledge management practices.

The Internet of Things (IoT) encompasses a network of interconnected devices and objects that communicate and share data through embedded applications. This

technology revolutionizes the way ordinary items function by integrating them with intelligent features. In the context of university libraries, IoT technology has been adopted to enhance knowledge management processes and improve efficiency.

To qualify as an IoT system, four key components must be integrated seamlessly: sensors and devices, connectivity, data processing, and the user interface (Trivedi, 2022). Sensors and devices serve as the foundational elements, capturing and collecting data from the library environment. These devices range from smart shelves with embedded sensors to environmental monitoring devices that track factors like temperature and humidity. Connectivity plays a vital role in facilitating data transfer between devices. Through internet connectivity, these IoT devices can communicate and share data without the need for human intervention. This enables real-time monitoring and analysis of library resources, occupancy levels, and environmental conditions. Data processing is another critical component of an IoT system. Once data is collected from sensors and devices, it is processed and analyzed to extract meaningful insights. In university libraries, data processing algorithms can be used to generate reports on resource utilization, optimize space management, and provide personalized recommendations to library users. The user interface component of an IoT system enables interaction between users and the IoT devices. It encompasses interfaces such as mobile applications or web-based portals that allow users to access and control IoT-enabled features in the library. For example, users can use a mobile app to locate a specific book on a smart shelf or receive notifications about available study spaces.

The study discovered that Pakistani university libraries applied Internet - of - things gadgets such as intelligent air conditioners, auto smoke detectors, high-tech hand sanitizer servers, and intelligent security gates using data gathered from 122 academic

library staff all over Pakistan (Asim et al., 2022). Besides that, the university libraries used constrained Internet of Things solutions such as auto alerts for check-out and check-in, self-borrowing and self-returning systems, card acceptance, and the deployment of Radio Frequency Identification (RFID) metadata for security. The lack of a hyperconnected and incorporated eco system, financial concerns, the lack of a policy and planning process, and a shortage of technical manpower were the major challenges to implementing IoT applications. This novel research discusses the scope of IoT applications along with the difficulties related to adoption IoT components and utilizing the idea of the Internet of Things in Pakistani universities.

Based on field investigations conducted at eight libraries in Wuhan, China,Xie et al. (2019) explored the implementation of Internet of Things (IoT) tools for intelligent evacuation protocols in library disaster responses. Their study focused on utilizing IoT technology to enhance crowd evacuation during fire emergencies. By creating an application trail and employing software like Tracker, the researchers successfully modelled and simulated the evacuation process. The findings of Xie et al. (2019) identified four key criteria that distinguish IoT-based emergency procedures: situation correlation, accurate emergency response, dynamic adjustment, and logical decision-making. The study's successful implementation of the suggested IoT-based procedure demonstrates its practicality and highlights the significant potential of smart applications in library risk control. These intelligent emergency procedures, based on IoT technology, hold promise for widespread adoption, particularly in building architecture. Implementing IoT in library infrastructure can greatly contribute to group safety and effective emergency planning. By integrating IoT devices and applications, libraries can enhance their ability to respond to emergencies and ensure the well-being of library patrons and library staff.

In developing nations, such as South Africa, some university libraries have embraced various IoT tools to enhance their operations and support research governance. These IoT tools encompass a range of technologies designed to improve efficiency, accessibility, and data management within library settings (Igbinovia, 2021). For instance, RFID (Radio Frequency Identification) technology has gained popularity in South African university libraries. RFID tags are attached to library resources, enabling automated tracking, inventory management, and self-checkout systems. This technology streamlines the borrowing and return processes, reduces manual labor, and enhances the overall user experience (Maepa & Moeti, 2021). Smart lighting systems are another IoT technology implemented in South African university libraries. These systems utilize sensors and connectivity to optimize energy consumption based on occupancy levels. By automatically adjusting lighting levels and turning off lights in unoccupied areas, these systems contribute to energy conservation efforts while ensuring a conducive environment for library users (Masenya & Chisita, 2022).

Additionally, IoT-based environmental monitoring systems are being deployed in South African university libraries. These systems use sensors to measure factors such as temperature, humidity, and air quality, ensuring optimal conditions for preserving sensitive library materials and providing a comfortable environment for library users (Owolabi et al., 2022).

Furthermore, South African university libraries have adopted IoT-based surveillance and security systems. These systems utilize cameras, motion sensors, and access control mechanisms to enhance the safety and security of library premises. Real-time monitoring and alerts enable prompt response to potential threats or incidents, ensuring the protection of library resources and the well-being of library users (Bharti & Verma,

2021). The implementation of these IoT tools in South African university libraries reflects a commitment to leveraging technology for efficient knowledge management, resource utilization, and user satisfaction. By embracing such IoT technologies, university libraries in South Africa are enhancing their capabilities and providing an innovative and digitally enabled environment for their academic communities.

In Kenya, a leading innovation hub in sub-Saharan Africa, university libraries have embraced various types of Internets of Things (IoT) technologies to enhance their services and operations. These IoT solutions contribute to the digital transformation of library environments, offering new possibilities for information management and user engagement (Ashioya, 2018; Jumba et al., 2020). One notable IoT technology adopted by Kenyan university libraries is smart sensors. These sensors are deployed throughout the library premises to monitor environmental conditions such as temperature, humidity, and air quality. By collecting real-time data, libraries can ensure optimal conditions for preserving valuable collections and creating a comfortable study environment for users (Kavulya, 2019).

Another IoT technology utilized in Kenyan university libraries is RFID (Radio Frequency Identification) technology. RFID tags are attached to library materials, allowing for efficient inventory management, self-checkout systems, and automated book return processes (Nyabuto, 2019). This technology simplifies the borrowing and returning process for users, reduces human error, and improves overall library efficiency.

Furthermore, Kenyan university libraries have implemented IoT-based security systems. These systems may include surveillance cameras, access control mechanisms, and alarm systems integrated with IoT platforms. Such technologies enhance the safety

and security of library spaces, protecting valuable resources and ensuring a secure environment for library users (Nzioki, 2021). The adoption of these IoT technologies in Kenyan university libraries reflects their commitment to leveraging innovation and technology to provide enhanced services to their users. By incorporating smart sensors, RFID technology, security systems, and location tracking solutions, libraries can optimize their operations, streamline processes, and deliver a seamless and user-centric library experience.

2.3 Factors determining the successful adoption of IoT in university libraries

In the ever-evolving landscape of university libraries, the successful adoption of Internet of Things (IoT) technology plays a pivotal role in meeting the changing needs of patrons and enhancing the overall library experience. While libraries must continue to invest in technology-related offerings and innovate their services and programs, it is essential to recognize that these advancements do not undermine the value of traditional library services, such as in-person reference consultation and material circulation. Rather, the integration of IoT in university libraries can complement and enhance these traditional services, creating a harmonious blend of innovation and established practices (Kim, 2020). To ensure the effective adoption of IoT, it is crucial to identify the key factors that contribute to its success in university libraries. By understanding and addressing these factors, libraries can harness the full potential of IoT technology and provide a seamless and comprehensive range of services to their patrons.

Planning process, training at the moment of need, and creating a strategy for continuous support are all essential to achieving Internet of Things adoption success. Coming to terms with internal objections to change is one of the most prevalent roadblocks in technological transformation (Koul & Eydgahi, 2017). Employees must comprehend

what technology changes are taking place in the corporate world, why such advancements have been made, and how adopting these adjustments will make their tasks convenient. Developing a culture of transformation affirmation through preparatory work and education will consequence in an ambience of enthusiasm rather than afraid. Effective digital transformation presupposes the adoption of innovative learning strategies and software solutions capable of meeting the training requirements of advanced software and services (Ruiz et al., 2022).

Trainers' Digital Adoption Platform or Training course Patrons and library staff necessitate notifications and sufficient support to maintain a current understanding on the software implemented and succeeding upgrades. This implies that whenever a newer version is added, you can launch a second in-app user guide to adapt existing how to apply the extra capabilities. Understanding user progress entails tracking it in its entirety. Usage data analysis will reveal which functionalities are pretty obvious and well utilized by library staff, as well as which functionalities are underexploited or bypassed. It is simple to identify challenges, enhance success of the program, and increase user experience when internal training personnel have this data available to them. Instructors can also monitor student learning' advancement in real time, allowing them to better comprehend what inspires users and devise ways to actually encourage them to gain knowledge and using the system (Whatfix, 2020).

Dawar et al. (2021) research into the factors influencing IoT adoption intentions in libraries resulted in a research study of universities open to everyone in Nanjing, China. A total of 389 library staff comments in response and literature on technology adoption are then used to develop quantitative theories. Dawar et al. (2021) concluded that Internet of Things services in university libraries require strong management

procedures and efficient use of technological resources. To meet patron demands, several more libraries are testifying significant adjustments to their framework in terms of technological and architectural. Library staff can assist comprehend the fundamental rationale for tech innovation decision in libraries, principally IoT facilities, which may result in advancements in the libraries' ability to offer information access services.

Hakim et al. (2022) highlights four crucial factors for IoT deployment based on a study conducted by five panels of Indonesian experts with skill and knowledge in the field of IoT application. This is described as resources, operations, people, and management. IoT applicability entails numerous resources, including sensors, devices, and tools, and accomplishments is largely dependent on the functionalities of these resource structures. The primary function of IoT is to record and communicate data, which must be accomplished as intended using cloud equipment and gadgets. In the context of IoT, "relationship" generally refers to interfaces that permit people to monitor or initialize IoT devices. Lastly, the collaboration of management with relevant parties in the IoT ecosphere ensures that plan of action requirements is embraced and delivered.

The Internet of Things (IoT) is widely used in developed countries but not so in countries in transition such as Saudi Arabia, Malaysia, Pakistan, and Bangladesh. Madni et al. (2022) investigated the use of IoT in digital learning in these transitioning nations. As notable factors collected from a sample on IoT adoption, privacy (27%), groundwork capacity (24%), budgetary concerns (24%), versatility of use (20%), academic library staff support (18%), participation (15%), attitude (14%), and access and data confidentiality (14%) (Madni et al., 2022). According to the (Madni et al., 2022) findings, domestic culture plays a vital role in emerging economies' independent, institutional, innovation, and ecologic attitude against latest tech.

The major IoT enabler in Africa is then analysed, as well as its general situation of implementation and device connectivity in Africa. Specific examples of the development of the proposed system are furnished, as are business forecasts for emerging developments (Amaizu & Okereafor, 2015b). Following that, the challenges to the phenomenon's development are highlighted. Scalability, synchronization, principles, database administration, and software complexity are among the challenges. Others include electricity supply, cost over user experience, internet backbone resource constraints, low literacy rates and a shortage of local content, trust, security, and privacy concerns. Answers to these issues are also proposed. Due to limited available bandwidth, many successful organizations have also built systems that leverage unregulated bandwidth innovations such as whitespace and boost the use of Internet access to unload smartphones for wireless consumption. Some rechargeable cordless sensors capable of transmitting data via wireless, such as RFID systems, get their power either remotely or from the measuring process itself, such as by using piezoelectric or pyroelectric materials for pressure and temperature measurements.

In comparison to other continents, Africa as of now has a slower rate of IoT adoption. Nigeria, as the world's largest smartphone market and the most populous African country, has immense potential in IoT, which, if applied effectively, has the potential to increase productivity across all economic sectors and improve people's standards of living. One of several success determinants for IoT rollout in Nigeria is the relatively inexpensive of automated capabilities and services. Sensor prices have fallen to an average of 60 cents from USD 1.30 over the last decade, while the cost of bandwidth has dropped by nearly 40 times of 60 cents from USD 1.30 over the last decade (Amaizu & Okereafor, 2015), while the cost of bandwidth has dropped by a factor of nearly 40 times. Similarly, the cost of processing has dropped nearly 60 times in the last decade,

allowing more gadgets to intelligently handle all of the new data they generate or receive.

Kenyan institutions can capitalize on the prospects of IoT and big data for long-term development. Key practices such as providing funding for small systems and building trust are required. Data strategy must be maximized for use in addressing business needs for organizational plans or generating value through insights (Machii et al., 2020). Organizations are responsible not only for documenting usage patterns, but also for encouraging the presence of items on the internet and in situations to learn more about them. This interplay enables the development of an ecosphere capable of learning and responding to demands, as well as driving change and making people's lives easier. As a result, Ikeda (2019) proposed a model that demonstrates how knowledge management processes and their accomplices can collaborate with IoT elements and supplementary technologies such as IA to create smart IoT ecologies for users and organizations. All components of the IoT network can collaborate to produce greater interconnection and competence, with people, devices, and other items conversing via a learning circular pattern in a system of data, details, and equipment.

2.4 How IoT relates to knowledge management

The effective management of knowledge is crucial in today's rapidly evolving digital landscape, and the integration of Internet of Things (IoT) technology holds significant promise for enhancing knowledge management practices. IoT's impact extends throughout the entire knowledge management cycle, from knowledge creation to capture, organization, storage, retrieval, dissemination, and ultimately utilization. By leveraging IoT, organizations, including university libraries, can optimize each stage of the knowledge management cycle, leading to improved knowledge accessibility,

enhanced collaboration, more efficient workflows, and informed decision-making. In this subtopic, we will explore the multifaceted relationship between IoT and knowledge management, highlighting how IoT technology transforms the way knowledge is generated, shared, and utilized in the context of university libraries.

2.4.1 Knowledge management in university libraries

In developed nations, knowledge management in university libraries has been a focus of extensive research and implementation. For instance, in the United States, universities such as Harvard and Stanford have adopted sophisticated knowledge management systems to enhance information access, collaboration, and research outcomes (Sharma, 2019). These systems leverage technologies such as data analytics, artificial intelligence, and semantic search algorithms to facilitate knowledge discovery and dissemination. Critics argue that while knowledge management systems in developed nations have achieved notable advancements, there are challenges related to information overload and the need for continuous system updates. Additionally, the implementation of these systems requires substantial financial investment, skilled personnel, and comprehensive training programs for library staff.

In developing nations, including various countries in Africa, knowledge management in university libraries is gaining recognition as a crucial factor for academic development. For example, the University of Cape Town in South Africa has implemented knowledge management initiatives to improve the accessibility and utilization of research outputs (Martins et al., 2019). These initiatives involve the establishment of institutional repositories and the development of policies that encourage knowledge sharing and collaboration. However, critics highlight that developing nations face unique challenges in knowledge management implementation.

Limited financial resources, inadequate infrastructure, and a scarcity of skilled personnel pose significant obstacles. Additionally, there is a need for stronger government support and investment in developing sustainable knowledge management strategies in university libraries.

In Kenya, knowledge management practices in university libraries have witnessed significant growth in recent years. Universities such as the University of Nairobi and Kenyatta University have embraced digital repositories, virtual learning environments, and collaborative platforms to enhance knowledge sharing and facilitate research collaboration (Mwangi et al., 2021). Critics argue that while there have been notable advancements, challenges persist. Limited internet connectivity, inconsistent funding, and a lack of comprehensive policies hinder the full integration of knowledge management systems. There is a need for improved infrastructure, capacity building programs, and increased collaboration between universities and government agencies to address these challenges effectively.

Knowledge management in university libraries is a critical area of focus worldwide. Developed nations have made significant progress in implementing sophisticated knowledge management systems, although challenges related to information overload and system maintenance persist. Developing nations in Africa are recognizing the importance of knowledge management but face unique challenges such as limited resources and infrastructure. Kenya has shown promising advancements in knowledge management practices, but further investment and collaboration are required for sustainable growth.

Moving forward, it is crucial for universities and governments to prioritize knowledge management in university libraries by addressing the identified challenges, fostering

collaboration, and investing in the necessary resources. By doing so, university libraries can effectively harness knowledge, support research and innovation, and contribute to the overall academic development of their respective nations.

2.4.2 How IoT relates to knowledge management

How Internet of Things (IoT) and knowledge management (KM) in university libraries is of paramount importance in today's evolving educational landscape. As the focus shifts from traditional teaching and learning approaches to a more dynamic cycle of research, learning, innovation, and teaching, efficient knowledge management has become critical for students and faculty. IoT technology plays a pivotal role in supporting knowledge management processes within university libraries. By facilitating the acquisition, processing, storage, dissemination, and application of knowledge, IoT enhances the curation of intellectual resources to meet the diverse needs of users.

In the context of university libraries, IoT serves as a valuable tool for improving knowledge management practices. It acts as an assistive technology, benefiting all library users (Ocholla et al., 2022). Whether it is user identification, searching, detection, location tracking, navigation, self-borrowing, disaster management, or even real-time updates for library staff, IoT enables seamless operations and enhances user experiences. Additionally, IoT empowers automated decision-making processes, such as blocking users, controlling lights, or managing environmental factors.

The utilization of IoT tools in university libraries not only lays a strong foundation for the implementation of IoT applications but also establishes a symbiotic relationship between these tools and knowledge management (KM) practices. These versatile tools encompass a wide range of features and functionalities that can be effectively harnessed

to deploy IoT systems and seamlessly integrate sensor-equipped devices within library settings. By embracing IoT tools, university libraries can unlock their full potential to enhance knowledge management processes. Through the strategic utilization of IoT tools, libraries can revolutionize their KM practices, leading to significant improvements in services and operations. These tools enable libraries to collect and analyze real-time data, facilitating the acquisition, organization, and dissemination of knowledge resources. By harnessing IoT-enabled capabilities, libraries can optimize resource allocation, enhance information access, and promote collaborative learning experiences.

The integration of IoT tools in library settings fosters an interconnected ecosystem where knowledge becomes more accessible and available to library patrons. These tools can automate various tasks, such as identifying users, locating specific resources, and streamlining self-borrowing processes. Additionally, IoT applications facilitate proactive management of potential risks and emergencies, allowing libraries to implement robust disaster management protocols and ensure the safety of both physical and digital assets. The relationship between IoT tools and KM in libraries goes beyond mere technological advancements. By leveraging these tools, libraries can create a more efficient and effective learning environment for their patrons. They empower library staff to gain valuable insights into user behaviors, preferences, and needs, enabling them to tailor their services and resources accordingly. This personalized approach to KM cultivates a culture of continuous learning and supports the diverse research and learning needs of the university community.

Modern systems enable knowledge managers to concentrate on more pressing functions, thereby enhancing KM reliability, streamlining processes, and saving

university libraries funding (Sieron & Gromko, 2018). Library staff are the knowledge managers in university libraries because they are tasked with the important functions of knowledge management, hence the delivery of knowledge services and knowledge management. This can result in the satisfaction of knowledge users. It has resulted in relief for other functions by using advanced technology to perform knowledge management functions in the library.

Libraries can become more versatile in managing knowledge for the university by leveraging the power of Web 4.0 technologies. These systems' technology includes automatic, assertive, content-exploring, self-learning, collaborative, and content-generating agents that are based on fully matured semantic and reasoning technologies as well as AI (Garcia et al., 2022). They enable responsive content presentation with an appropriate algorithm and a Web repository. Examples include services that engage with sensors and augmentations, natural-language utilities, and interactive virtual services. (Huang & Vedantham, 2019).

The transition from the "Internet of Communication" to the "Internet of Things," or IoT, is among the most notable innovations. By embedding sensors in ordinary items that are not computers, this fascinating and trendy tech allows them to be connected (Lapointe, 2019). This means that the IoT can be used to integrate anything in the library, including books, cards, desktops, theses, tags, bulbs, doors, windows, shelves, washrooms, reprographics, the circulation desk, the helpdesk, periodicals, audio-visuals, security machines, and switches.

Globally**,** several new tools are being used to improve knowledge management. Each IoT tool or technology has unique capabilities for accelerating, simplifying, and improving knowledge management. By integrating these tools in knowledge

management processes, libraries have made acquiring, organizing, storing, and disseminating knowledge easier than ever before while still facilitating other operations.

The advanced management of knowledge in university libraries Alagappa University in India IoT has come in handy to support this functionality. Stock control of library items, information provision through websites and blogs, live communication, tagging of items using RFID, people counting using sensor machines, wireless connectivity, and use of text-to-speech, lifts for the disabled, and security management (Pandiyan et al., 2021). The Internet of Things will significantly assist libraries and their users. The latest technological solutions based on IoT could very well help university libraries maintain their competitive edge. By investing in appropriate technology, libraries will be capable of boosting productivity levels while reducing expenses, enabling library services to achieve increased functioning and deliver a better patron experience.

The Mohammed bin Rashid Library in the UAE and the Middle Eastern will be using artificial intelligence (AI) in its functions, sending code to robots to find books and deliver them to users(Mansoor, 2022). The Internet of Things has modified the operation of the library. IoTs are being used by university libraries to enhance the efficacy and efficiency of their day-to-day library work and services. Allocation, cataloguing, distribution, transaction, and communication.

Xie et al. (2019) examined crowd gathering patterns in libraries as well as dilemmas with the libraries' established safety procedures during site observations at eight libraries in Wuhan, China. The case study reveals that the suggested procedure is practicable, specifying that IoT technologies have a good prospect of being applied effectively to library safety management. An intelligent emergency model can detect,

trigger an alarm, notify relevant library staff, handle crowds, implement options, and direct people to fire exits with the help of IoT. RFID ID tags, CCTV cameras, and image recognition are used to track patrons and library staff in the library.

Based on the observation that insufficient tech innovation groundwork and facilities have always hindered knowledge management in the learning sphere, as examined the use of Information and Communication Technologies for knowledge management among scholars at the National University of Science and Technology (NUST) in Zimbabwe (Dewah & Sibanda, 2022). How IoTs are used to improve knowledge management in NUST it is paralysed due to university legal system and insecurities. Additionally, Dewah and Sibanda (2022) highlights from the study that internet connection and hesitance in knowledge dissemination is an amongst barriers to knowledge management in NUST university.

According to the findings of the study by Jumba et al. (2020), universities in Kenya have retooled in innovation rooting and strictures to aid knowledge management protocol. Regrettably, due to underuse, users haven't quite gained the complete value. Institutions can realize competitiveness, efficiency, and effectiveness, as well as informed decision, by leveraging these Infrastructure technologies and tools. It is critical to implement a knowledge management policy that defines the standards and procedures and the incentive programs for knowledge development, use, and sharing. Furthermore, inclusive of all interested individuals (decision maker, scholars, and operational library staff) of the institutions must be included in the knowledge management processes.

2.5 Library staff Competency in using IoT to manage Knowledge

In the rapidly evolving landscape of knowledge management, library staff' competency in utilizing Internet of Things (IoT) technology is of paramount importance in university libraries. Knowledge management forms the backbone of library operations, encompassing the acquisition, organization, and dissemination of information and knowledge resources to support the academic pursuits of the university community. As guardians of knowledge, library staff play a pivotal role in enhancing the quality and effectiveness of library services, positioning the library as a central hub for learning and knowledge creation. Library staff leverage their expertise to curate and manage collections of scholarly materials, ensuring their accessibility and availability to library patrons. By adeptly organizing and maintaining these resources, library staff enable seamless navigation through vast amounts of information. They also provide invaluable training and support, empowering library users to hone their research and information-seeking skills. By facilitating the acquisition and utilization of knowledge, library staff contribute to the success of the university community and foster intellectual growth in diverse fields.

In the context of IoT, library staff need to develop proficiency in leveraging IoT tools and technologies to optimize knowledge management processes. Embracing IoT opens up new avenues for data collection, analysis, and utilization, enabling library staff to gain deeper insights into user preferences and needs. By harnessing IoT capabilities, library staff can enhance the efficiency of knowledge acquisition, organization, and dissemination, leading to more personalized and tailored services for library patrons. As we delve into the discussion on library staff' competency in using IoT for knowledge management, it is evident that their role extends beyond traditional library practices.

By embracing IoT, library staff have the opportunity to become dynamic facilitators of knowledge, actively contributing to the advancement of scholarship within the university community and beyond. Their expertise and adaptability in utilizing IoT tools will ultimately shape the future of knowledge management in university libraries.

The importance of library staff' competence in using Internet of Things (IoT) in knowledge management in university libraries lies in its skills, knowledge and ability to improve the efficiency and effectiveness of library operations, enhance user experiences, and promote innovation in library services. IoT technologies, such as sensors, smart devices, and data analytics tools, leveraging library staff' competency can help library staff to manage resources, services, and facilities more effectively, and to provide personalized and seamless experiences to library patrons.

Library staff play a critical role in this process by leveraging their knowledge and skills to identify, evaluate, and implement appropriate IoT solutions to support their specific library operations and user needs. This includes understanding the capabilities and limitations of different IoT technologies, as well as being able to effectively manage and analyse the vast amounts of data generated by these technologies. Furthermore, library staff also need to develop competencies in areas such as cybersecurity, privacy, and data ethics to ensure that IoT technologies are used in a responsible and ethical manner, and that user data is protected and secure. Overall, the competence of library staff in using IoT in knowledge management in university libraries is essential for providing high-quality library services, improving user experiences, and promoting innovation and creativity in the library field. Through their efforts, library staff can contribute to the success of their libraries and support the advancement of knowledge and learning in their respective institutions.

IoTs are being used to manage knowledge in developed countries such as the United States, Canada, Australia, and several European countries. Subaveerapandiyan and Sindhu (2022) conducted a survey of library staff in developed countries regarding their level of competency in using IoT technologies for knowledge management. The survey included questions on library staff' knowledge of IoT technologies and their use of these technologies in knowledge management, as well as their attitudes toward IoT and their perceptions of the challenges and opportunities of IoT for knowledge management. The study found that library staff in developed countries had varying levels of competency in using IoT technologies for knowledge management. While many library staff had a good understanding of IoT technologies, few were fully proficient in using these technologies to enhance knowledge management in their libraries. The study identified several factors that were associated with higher levels of competency, including access to training and support, organizational culture, and individual motivation. The study concluded that while library staff in developed countries were generally aware of the potential of IoT for knowledge management, there was a need for more targeted training and education programs to support library staff in developing the skills and competencies necessary to fully leverage these technologies. The study also suggested that library staff could benefit from increased collaboration and knowledge sharing around IoT-based knowledge management, both within their own institutions and across different countries and regions. The study highlights the need for ongoing research and support for library staff in developing their competencies in IoT-based knowledge management. It suggests that library staff can benefit from access to training and education programs as well as increased collaboration and knowledge sharing across institutions and countries. By developing these competencies, library staff can

play a vital role in enhancing knowledge management in their institutions and contributing to broader efforts to promote innovation and creativity in the digital age.

While there is limited empirical research on the level of competency of library staff in Africa in using the Internet of Things (IoT) to manage knowledge, some studies suggest that there are challenges in this area. Specifically, university libraries in Africa face a number of constraints related to infrastructure, technology, and training that limit the ability of library staff to use IoT tools effectively for knowledge management. One study by Ukamaka and Kakiri (2021) explored the challenges and prospects of IoT adoption in academic libraries in Nigeria. The authors found that the low level of ICT literacy and training among library staff, coupled with inadequate funding for technology and infrastructure, are major barriers to the effective use of IoT for knowledge management. Additionally, the study identified a lack of awareness among library staff about the potential benefits of IoT, which further hinders their adoption of IoT tools. Another study by Aina and Afolabi (2020) examined the readiness of Nigerian university libraries for IoT adoption. The study found that while library staff were generally aware of IoT and its potential benefits, there were significant challenges in terms of infrastructure, funding, and technical support that hindered their ability to use IoT effectively for knowledge management. Specifically, the study highlighted the need for investment in reliable network connectivity, power supply, and training and support for library staff to improve their competencies in IoT.

Despite these challenges, some university libraries in Africa have successfully adopted IoT tools for knowledge management. For example, a study by Van Biljon and Ehlers (2019) examined the use of IoT sensors in the University of Pretoria Library in South Africa. The study found that the IoT sensors improved the efficiency of library

operations, reduced costs, and enhanced the user experience. However, the study also noted the need for ongoing training and support for library staff to ensure that they can effectively use the IoT tools. Overall, while there are some success stories of IoT adoption in university libraries in Africa, there are also significant challenges that need to be addressed to improve the level of competency of library staff in using IoT for knowledge management. These challenges include infrastructure constraints, funding limitations, and the need for training and support to improve the ICT literacy and technical competencies of library staff.

There is limited empirical research specifically focused on the level of competency of library staff in Kenya in using the Internet of Things (IoT) to manage knowledge in university libraries. However, some studies suggest that there are challenges in this area, and that more training and support is needed for library staff to effectively use IoT tools for knowledge management. A study by Karanja and Kiarie (2019) investigated the challenges facing the adoption of IoT in academic libraries in Kenya. The study found that the major challenges were inadequate ICT infrastructure, lack of financial resources, and insufficient training and awareness among library staff. In addition, the study found that the majority of library staff lacked the necessary skills and knowledge to effectively use IoT tools for knowledge management. Another study by Karimi and Muthee (2018) examined the adoption of IoT in Kenyan university libraries. The study found that while library staff were generally aware of IoT and its potential benefits, there were challenges related to the cost of implementation, lack of infrastructure, and the need for training and support to improve the competencies of library staff in using IoT for knowledge management.

Despite these challenges, some university libraries in Kenya have successfully adopted IoT tools for knowledge management. For example, the Technical University of Kenya has implemented an IoT-based library management system that includes features such as automated book borrowing and return, real-time monitoring of book usage, and analysis of user behaviour (Njoroge & Wanjohi, 2021). The implementation of this system has improved the efficiency of library operations and enhanced the user experience. Overall, the level of competency of library staff in Kenya in using IoT for knowledge management varies depending on the specific university library and its resources. While some university libraries have successfully adopted IoT tools, many face challenges related to infrastructure, funding, and training that limit their ability to use IoT effectively. Addressing these challenges will require investment in ICT infrastructure, financial resources, and training and support for library staff to improve their competencies in IoT.

2.6 Summary of Research Gaps

The relationship between IoT and KM literature review focused on the status quo of ICT tools and technology use in universities for student information and knowledge management in order to achieve institutional sustainability; it does not describe the adoption best practices for managing knowledge in the university library. The researchers talked about how academic corporations have retooled in tech innovations and strictures for student information coaching but not in libraries, where more knowledge is managed, negatively impacting knowledge management and library sustainability. The findings led to the development of a framework to assist university stakeholders in integrating ICT tools and technologies into knowledge management in order to achieve institutional sustainability. The proposed model directs the creation of knowledge management guidelines and procedures for both employee and student data

and information but does not provide a model to guide the adoption of IoTs in managing knowledge in the library, hence the gap.

Moreover, the literature on IoT adoption best practices for KM in university libraries is scarce and limited to adoption best practices used in the business niche and disaster management niche. There is a need for literature specifically focused on the success factors attributed to the adoption of IoT in university libraries to enhance their services, functions, and operations. While some studies suggest that there are challenges in using IoT tools for knowledge management in university libraries, there is little empirical research on the level of competency of library staff in Kenya in this area.

There is limited empirical research specifically focusing on the level of competency of library staff in Kenya in using the Internet of Things (IoT) to manage knowledge in university libraries. However, some studies suggest that there are challenges in this area, and that more training and support is needed for library staff to effectively use IoT tools for knowledge management. These challenges include infrastructure constraints, funding limitations, and the need for training and support to improve the ICT literacy and technical competencies of library staff.

2.7 Theoretical Framework

Multiple theories reinforce the adoption of IoT application in managing knowledge. This research is guided by two theories: the unified theory of technology acceptance and use, and adaptive structural theory.

2.7.1 Unified Theory of Technology Acceptance and Use

The Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. Developed this model in 2003 as a user acceptance which is critical to the development of any information system

including IoT. The most widely used theory to evaluate technology use is the Unified Theory of Acceptance and Use of Technology (UTAUT)(Venkatesh et al., 2012). The UTAUT model was used to examine the IoT adoption framework for simplifying tasks and enhance efficiency in managing knowledge in university libraries in Catholic University of Eastern Africa. This theory employs four main factors: performance expectancy; effort expectancy; social influence; and facilitating conditions. Gender, age, experttise, and readiness to use are mediating factors believed to affect the four main factors of utilization intention and behaviour. The structured format and mediating factors of UTAUT will be used to examine the effectiveness of the use of IoT in managing knowledge.

Therefore, this study used the UTAUT model to examine the adoption of IoT in university libraries in Catholic University of Eastern Africa to simplify tasks and enhance efficiency in managing knowledge. The UTAUT model employs four main factors: performance expectancy, effort expectancy, social influence, and facilitating conditions, with gender, age, expertise, and readiness to use as mediating factors that can affect utilization intention and behaviour.

The aim of this study was to investigate how the four main factors of UTAUT influence the success of IoT adoption in university libraries for managing knowledge, using the adopted knowledge management technology frameworks. Performance expectancy relates to how library staff and patrons perceive that using an IoT system will support them in achieving better management of knowledge, service delivery, and user satisfaction. Effort expectancy relates to the level of convenience and user-friendliness that library staff will experience after adopting and using an IoT system. Social influence refers to the concept that library staff in the developed world are largely inspired by the actions and views of other IoT-enabled libraries. Facilitating conditions

refer to the degree to which a librarian believes that the existing operational and technological infrastructure can endorse the application of technology.

Although various theories on knowledge management exist, the theoretical foundation for an IoT adoption best practice to improve knowledge management in university libraries is currently inadequate, resulting in knowledge gaps. This study aims to recommend best practices to overcome these challenges and bridge the knowledge gaps.

2.7.2 Adaptive Structural Theory

Based on Anthony Giddens' structuration theory, Adaptive Structuration Theory (AST) identifies questions of human behaviour in the light of innovation utilizing social structure (Barrett, 2018). AST posits that the adoption of new technology by an institution is influenced by various factors, including the innovation itself, the institution's environment, the activity, and the way systems emerge and evolve during the acquisition phase.

AST was used to understand how the appropriation of innovation, organizational culture, and responsibilities impact the use of technology and its outcomes. This framework aided in assessing the effects of using IoT tools in knowledge management processes. The transformation of connected systems can bring numerous benefits through quality utilization of data from these devices. However, institutions must consider the impact on overall organizational growth strategy, infrastructural facilities, and security mechanisms before implementing IoT tools. Despite the strong impact of individual constructs on IoT, adoption rates have been slow due to factors such as cost and data protection.

The rapid advancement of technology has led to significant changes in library and information services, as well as the roles and expectations of library staff and information professionals. To maintain their relevance and provide quality services to users, library staff must adapt to new technology tools that are being used globally to provide library services. Failure to keep up with technology trends and adopt cutting-edge tools can result in library staff and information professionals being left behind.

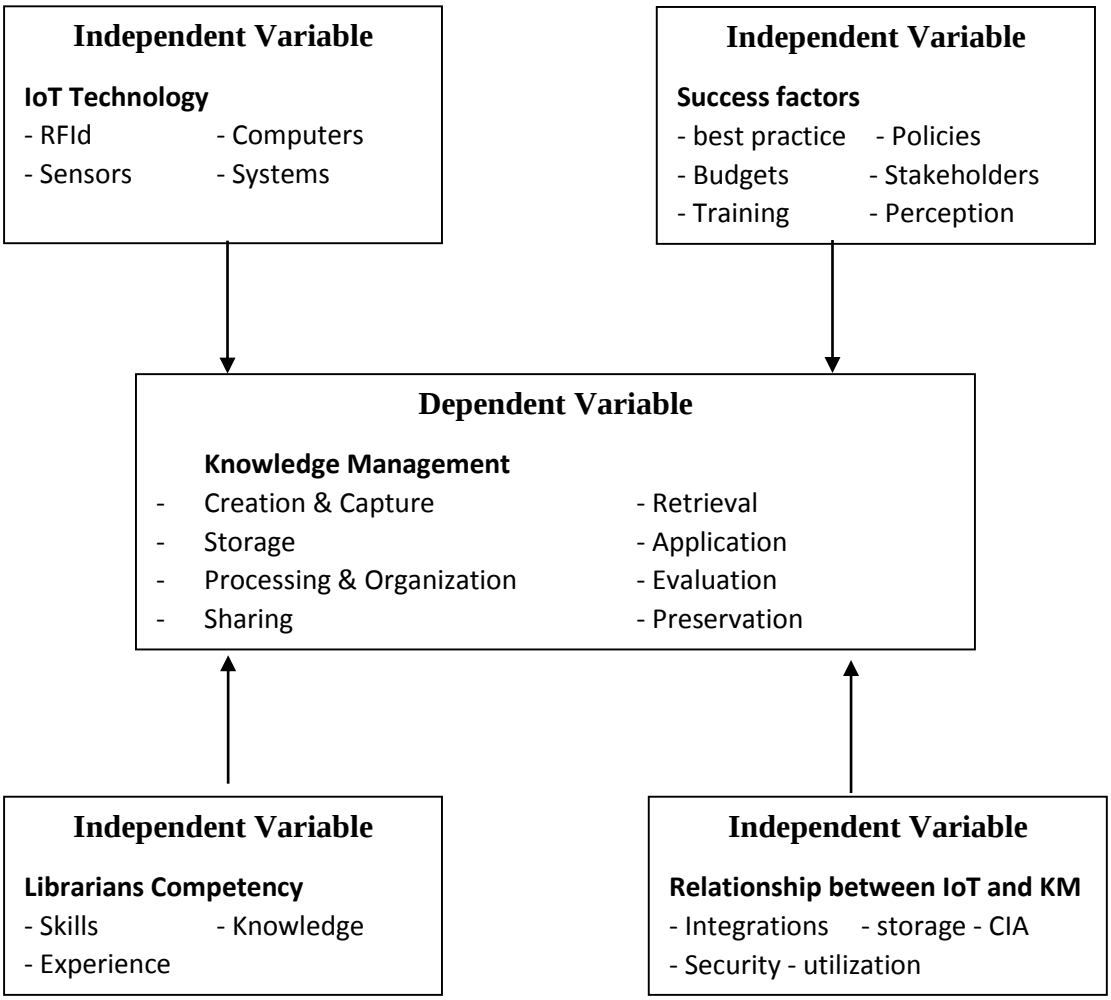
Therefore, it is important for library staff and information professionals to evolve with the structure by keeping their knowledge and skills up to date and incorporating emerging technology tools into library service delivery. This is both significant and relevant in the domain of information science.

2.8 Conceptual Framework

This is a graphic illustration of the variables used in the study. Figure 3 depicts the study's conceptual framework. On the right side, the dependent variable is IoT Adoption (Integration of systems, User satisfaction, Ease of use, Automated notification, Improved Identification of items, Auto support of users, Advanced user management, and Self service). Success factors (best practices, policies, budgets, stakeholder involvement, training, and perception), the IoT technology (RFID, computers, sensors, systems), librarian competencies (skills, knowledge, ability, use), and the relationship between IoT and knowledge management (integrations, storage, confidentiality, integrity, availability, and security) are among the independent variables shown on the left

Figure 2. 1

Conceptual Framework



The success of IoT adoption in libraries were measured through various factors including best practices, policies, budgets, stakeholder involvement, training, and perception. The independent variables that influenced IoT adoption include the IoT technology itself (RFID, computers, sensors, systems), librarian competencies (skills, knowledge, and experience), and the relationship between IoT and knowledge management (integrations, storage, confidentiality, integrity, availability, and security). The IoT infrastructure consisted of various components such as RFID, devices, sensors, the internet, systems, servers, and interfaces, which helped to transform non-electronic

library resources into system-identifiable items. In this process, knowledge management processes are leveraged, including capture, storage, organization, verification, security, distribution, and use.

The focus of this study revolved around the knowledge management cycle as the dependent variable (Creation & Capture, Retrieval, Storage, Application, Processing & Organization, Evaluation, Sharing, and Preservation), with IoT adoption serving as one of the contributing factors. The successful adoption and implementation of IoT infrastructure in the library have a direct impact on knowledge management processes. By leveraging IoT technologies, libraries can make knowledge readily available to users anytime and anywhere. Through the auto-support of users using sensors and bots, libraries can provide immediate assistance and facilitate the seamless access to knowledge resources. The integration of self-service functionalities further enhances knowledge delivery to users. Automated self-check-in/out, fine payments, renewals, and other self-service features empower users to independently manage their knowledge-related activities. This streamlined approach not only improves efficiency but also increases user satisfaction and engagement with library services. Moreover, the utilization of AI and machine learning algorithms within the IoT system enables a deeper understanding of users' knowledge needs. By analyzing user behavior and preferences, the system can proactively recommend relevant knowledge resources, thereby facilitating personalized knowledge delivery and enhancing knowledge utilization among library patrons. In summary, the dependent variable in this study focuses on the knowledge management cycle, with IoT adoption being a critical factor. Successful adoption and implementation of IoT infrastructure in the library enhance knowledge management by providing auto-support to users, enabling self-service functionalities, and leveraging AI to optimize knowledge delivery. By integrating IoT

technologies into the library environment, libraries can revolutionize their knowledge management processes and improve the overall user experience.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

Creswell (2014) defines research methodology as a method for systematically solving a research problem. According to Kothari (2004), research methodology can be defined as a science that studies how scientific research is conducted. The methodology outlines the measures adopted by a researcher to examine a study's objectives. This chapter explains the location of the study, the research approach and design, the study population, the target population, sampling and sample size, data collection, the validity and reliability of the research instruments, and the research instruments themselves. Analysis of data, as well as ethical considerations

3.2 Location of Study

The study was conducted at two university campus libraries, specifically at the main campus and at the Eldoret campus of Catholic University of Eastern Africa, both located in Kenya. The main campus library is situated on Lang'ata Bogani Eastern Road, off Magadi Road, adjacent to Galleria Mall, which is approximately 23 km from the Jomo Kenyatta International Airport in Nairobi, Kenya. The Gaba Campus (Eldoret) library is located on Kisumu Road, next to Eldoret Polytechnic, and is approximately 12 km from the Eldoret International Airport in Eldoret, Kenya. This research was carried out in two university libraries (case studies), although it emphasized on one phenomenon, namely the process of IoT adoption, a multiple case study approach was used. This will allow the study to examine a variety of cases. This allowed the researcher to examine various cases and understand the common features in their

technology adoption processes in the university library, with the purpose of drawing conclusions.

3.3 Research Design and approaches

The research design of this study was a descriptive survey research design. Descriptive survey research allowed for the description of a phenomenon, which was the process of implementing IoT in the setting of the university campus libraries at the Catholic University of Eastern Africa, Kenya. Among the goals of this research was to investigate the determinants of IoT adoption accomplishment in university libraries for knowledge management. As a result, the descriptive survey research design was deemed appropriate for describing how university campus libraries handled the process of IoT adoption. The research was carried out in two university campus libraries (case studies), although it emphasized one phenomenon, namely the process of IoT adoption. Therefore, a multiple case study approach was used. This allowed the study to examine a variety of cases. Furthermore, it enabled the researcher to examine various cases and understand the common features in their technology adoption processes in the university library, with the purpose of drawing conclusions.

A qualitative research approach was used in this study. Qualitative research helped to clarify the perceptions and mindsets of the sampled participants (Bricki & Green, 2007). To comprehend the respondents' experiences and attitudes, this approach aimed to respond to concerns about the "what," "how," or "why" of a phenomenon, instead of "how many." This approach sought to answer questions about a phenomenon's "what," "how," or "why," rather than "how many" or "how much," which were addressed by a quantitative approach. The purpose of this research was to examine the process of IoT adoption by university campus libraries. Realizing the peculiarity of the process as

pursued by the two university campus libraries in their setting, as well as their experiences, attitudes, and degree of engagement in technology adoption, was needed. Furthermore, because the research questions were about comprehension rather than just trying to measure the process, qualitative research was the preferred technique. Numerous different studies had employed the survey research design in their investigations Sovacool et al. (2018), it was used in energy sector research. It was also applied in a research project focused on controlling supply chains by Flynn et al. (2018). Garvey et al. (2019) used the research design in teaching and learning to investigate gender and sex concerns in postsecondary education. Employing this research design, all of these surveys yielded significant findings.

3.4 Target Population

According to Asiamah et al. (2017), the "target population" is a set of participants or parties involved who share specific traits of interest and relevance. Consequently, the target population for this study comprised six (6) librarians responsible for making decisions about library technology adoption. These individuals were expected to provide relevant information about the processes and technologies adopted, as well as the success factors associated with IoT technology adoption. Additionally, feedback was sought from five hundred (500) library patrons (users who utilized the library services) to gauge their satisfaction with knowledge and information provision, as well as the efficiency and effectiveness of knowledge service delivery.

The population under consideration was drawn from the Catholic University of Eastern Africa's comprehensive university environment, specifically the CUEA campus Libraries. This included both a main campus (Lang'ata - Nairobi) and Gaba university campus library (Eldoret). The both university campus library's context could offer

insights into IoT adoption in a main campus setting, whereas funding and decision-making regarding new technologies.

3.5 Sampling procedure

Purposive sampling was adopted to select a representative sample from both Lang'ata and Eldoret University campus libraries to ensure a satisfactory representation of cases. The aim was to obtain an ideal population representation from different segments of the university. Purposive sampling (librarians), a simple random (patrons) technique, was employed, wherein the investigator selected information-rich cases for investigation. This approach aimed to analyse cases that provided significant details related to the study's motives.

The study sample consisted of one university librarian (purposively selected) drawn from the selected university library. Additionally, all five (5) library staff members (purposively selected) responsible for various sections were included from the chosen university campus libraries. In this study, a total of six (6) focus group discussions (FGDs), each comprising 7 members, were conducted to gather valuable insights from library patrons concerning the utilization of IoT tools for enhancing knowledge management. Library staff played a crucial role in facilitating the recruitment of focus group representatives. Representatives of library patrons were randomly sampled to provide insights.

The active involvement of library staff in recruiting focus group representatives and creating a conducive dialogue environment demonstrated their commitment to supporting research and amplifying the voices of library patrons. By collaborating with library staff, the researcher ensured the successful execution of the FGDs and collected valuable insights contributing to the exploration of IoT tools' impact on knowledge

management in the library context. For a summary of the target population, refer to Table 3.1.

Table 3. 1

Target population

University	Head Librarian		Head sections		Library patron (Focus Group)	
	Target	Sampled	Target	Sampled	Target	Sampled
Nairobi Campus	1	1	3	3	3	3
Eldoret Campus	0	0	2	2	3	3
Total	1	1	5	5	6	6

3.6 Data collection instruments

The research instruments for this study included interview schedules for library staff, analysis of library documents, and focus group discussions (FGDs) involving library patrons.

3.6.1 Interview Schedule

Data was gathered through interviews conducted with library staff, including those responsible for various library sections, as well as through focus group interviews with library patrons. Library staff often served as key informants, contributing data based on their specialized knowledge and perspectives regarding technology adoption. The

researcher carried out semi-structured interviews with these key informants, utilizing pre-planned essential questions printed on paper to guide the interview schedules (Pulla & Carter, 2018); one for the policy maker (head librarian) while the other is for the implementers (section heads).

The data was gathered by recording the interviews, with prior authorization obtained to serve as a contingency plan and for verification purposes. The voice recording was entirely voluntary, and all interviews were pre-recorded for the sake of backup and verification. Every interview was captured through audio recording, with participants' voluntary consent. In instances where necessary, the researcher took notes to ensure additional backup. The interviews typically lasted between approximately 30 and 40 minutes, and they were conducted within the participants' office spaces.

3.6.2 Document Analysis

Document analysis involved examining the content, structure, and form of the document to understand how it was created and used. This research method was valuable for comprehending the historical context of an event, exploring diverse interpretations of the same material, and uncovering concealed meanings within texts (Oliveira et al., 2018). The university library's ICT procurement procedures, policy frameworks, subscription details for the systems, communication systems, and the library's strategic plan for the previous 12 months were assessed. The guide for document analysis in this study is provided in Appendix III.

3.6.3 Focus Group Discussions

Focus group discussions allowed the researcher to observe the topic with a selected set of participants and gain a more comprehensive understanding of how the group

considered and experienced the subject matter, according to Prasad and Garcia (2017). This study held focus group discussions with library users at each of the campus libraries under consideration. The guide for the six focus group discussions involving patrons is provided in Appendix IV, as described in Appendix III.

Each focus group had five to ten participants, and the researcher conducted three to four focus groups on the university's campus. Additionally, the libraries' key informants were interviewed individually. Key informants were individuals with expert knowledge or experience in a specific subject, offering valuable insights during interviews. Library section heads were considered key informants due to their expertise in knowledge management, understanding of library systems and infrastructure, awareness of user needs and behaviours, experience in implementing technology solutions, and institutional perspective. Their knowledge and insights played a crucial role in advancing research on IoT technology adoption for knowledge management in the university context.

3.7 Pre-testing of research instruments

A pre-test was considered by the researcher because it could highlight key structural flaws and provide insights into necessary adjustments before progressing further. Pre-testing helped refine the instruments before the final assessment, preventing issues during the study's implementation. The timing of pre-tests was chosen to minimize the impact of environmental factors on respondent sensitivity to independent variable s (Buschle et al., 2021). The pre-testing sample size was recommended to be 5-10% of the study population (Singh & Masuku, 2004; Singh & Masuku, 2014). Consequently, the researcher conducted a pre-test involving one university librarian, three section heads, and two focus groups, each consisting of six users from Umma University

library. Umma University served as an ideal pre-test location due to its knowledge management practices, including the use of RFID—an element of IoT technology systems—similar to libraries at Catholic University of Eastern Africa.

Umma University served as a representative case study for universities in Kenya due to its adoption of RFID, an element of IoT. Before distributing the survey to participants, a pre-test was carried out to gather valuable insights. This pre-test enabled the researcher to fine-tune, adjust, or potentially revise survey questions to maximize the extraction of data. The use of effective data collection tools was vital for achieving this objective.

3.8 Data collection procedures

The data was collected in person by the researcher at both university campuses, involving visits to the university's campus libraries. An appointment was arranged with the university librarian, with the interview's scheduled date communicated to the head of the section to ensure that library staff were not taken by surprise. During the interviews, the researcher introduced the research and then proceeded with the interview. The university librarian was also informed to help organize the venue for the focus group discussion and to inform patrons about their participation. Appointments were made with the patrons to gather their perspectives.

3.9 Validity of research Instruments

Data was gathered from multiple sources using a triangulation of data sources. In a contemporary context, consistent questions were posed to all three categories of participants. Each university conducted interviews with the university librarian, library staff responsible for different library segments, and scholars, employing standardized

questions to elicit similar responses. Method triangulation was also employed, entailing the utilization of diverse data collection techniques. For instance, alongside the interviews, data collection methods like observation and document analysis were used to corroborate some of the feedback received.

3.10 Reliability of research instruments

The consistency shown by the research, which could potentially lead to strong correlations, was referred to as reliability (Gephart, 2004). Throughout the research project, external auditing was employed to ensure the dependability of the collected data. Supervisors acted as examiners, evaluating the study's process and outcomes to assess the accuracy of the results and ascertain whether explanations and inferences were supported by data. This approach signified the objectivity with which the obtained data was evaluated (Brink, 1993). As per Lincoln and Guba (1985), confirmability indicated the extent to which the outcomes of the research study were shaped by the respondents, rather than influenced by interviewer bias, determination, or curiosity.

To ensure content validity in the study results, audio recordings were made and notes were taken to aid in reporting the outcomes from the respondents' perspective. Moreover, rationale was presented in all aspects of the study to minimize bias in the selection of cases, phenomena, and study designs.

3.11 Data analysis

Individuals and focus group interviews were recorded and transcribed. The responses were analysed, compared, and the data from the focus group interviews was encoded, corroborated, and inferred to form opinions. This study employed the conceptual model analytical method developed by Ritchie and Spencer for qualitative data analysis.

Framework analysis was defined as an "analytical process that consists of several distinct but highly interconnected stages."

Familiarization: In the familiarization stage of framework analysis, the aim was to thoroughly understand the data. The researcher became familiar with the scope and variety of the data to create a summary of the gathered information.

Finding a thematic framework: This stage aimed to organize the data in a meaningful and manageable way. Using notes taken during the familiarization stage, the researcher identified sub-themes, key issues, and concepts.

Indexing: Data segments related to specific subjects or threads were identified. Since the data flow was organized based on research questions, each meta-tagged data was indexed to a thread, corresponding to the major themes.

Charting: The data indexed was organized into a chart with themes and sub-themes. Data was extracted from its original context and reorganized according to thematic references. Charts were organized by theme and by case. Even though data was extracted from its context, it was clear which case it represented.

3.12 Ethical considerations

The researcher sought a letter of approval from the National Commission for Science, Technology, and Innovation (NACOSTI) to collect data. Additionally, consent to conduct research was requested from each individual university, along with permission to proceed with research from the university library.

Every individual participating in the research study possessed a fundamental right to privacy. Therefore, no personally identifiable information about individuals or groups

was revealed in written or other forms of communication. Prior to commencing interviews, participants were informed about their privacy and the assurance that no information would be disclosed. Personal-identifiable data was excluded from the recorded and presented information.

Participants were assured that their involvement in the research was entirely voluntary, and no one was coerced into providing information. They were informed about the research's purpose and how the data would be utilized. Additionally, the researcher sent requests to the selected sample universities to obtain permission to conduct studies at their institutions.

This study employed and will continue to employ insights from consulted literature to provide support, inform, or critique concepts. All non-researcher information was properly acknowledged using the APA 7th edition citation style. To prevent unintentional plagiarism and prevent future occurrences, the researcher used Turnitin software to check for plagiarism.

The researcher analysed data in a manner that avoided deliberate falsehoods, misinterpretations, or falsified analyses. Consequently, risks of overinterpreting or misinterpreting results were carefully considered to avoid presenting views not supported by research and evidence. This was achieved by analysing results in the context of the study objectives.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

Chapter Four of this thesis presents the results of the data collected through interviews with library staff, focus group discussions with students, and analysis of library documents, and is structured around key thematic areas guided by the research objectives. The manual approach of thematic analysis was employed using coding to represent universities while identifying key themes informed by the research objectives. The chapter is organized based on the following research objectives: (i) assessing the adopted IoT technology for knowledge management in university libraries at CUEA, (ii) examining the success factors attributed to the adoption of IoT in university libraries, (iii) investigating the competency of library staff in using IoT, and (iv) evaluating the relationship between IoT and knowledge management.

Beginning with respondent's background. Thereafter, the chapter presents the data analysis and findings related to the adopted IoT technology for knowledge management in university libraries at CUEA. Additionally, the chapter presents the success factors attributed to the adoption of IoT in university libraries, including operational efficiency, improved user experience, library staff training and support, integration with existing systems, and cost considerations. Then, the chapter presents the findings related to the competency of library staff in using IoT, including their knowledge and skills in using the new technology. Moreover, the chapter evaluates the relationship between IoT and knowledge management, including how the adoption of IoT technology impacts the management of knowledge in university libraries. This chapter provides a comprehensive analysis of the data collected and offers insights into the success factors

and challenges associated with the adoption of IoT technology in university libraries. The findings of this study have implications for university libraries seeking to adopt IoT technology to enhance their knowledge management capabilities.

4.2 Respondents Background

The background of the respondents in this study, as shown in Table 4.1, provides valuable insights into the diversity and representation within the participant groups. The table presents information on the target and sampled individuals from various university campuses, including the head library staff, head sections, and library patrons who participated in the focus groups. By examining the demographics of the respondents, we can better understand the perspectives and experiences shared throughout the study.

Table 4. 1

Respondents Background

University	Head Librarian		Head sections		Library patron (Focus Group)	
	Target	Sampled	Target	Sampled	Target	Sampled
Nairobi Campus	1	1	3	3	3	3
Eldoret Campus	0	0	2	2	3	3
Total	1	1	5	5	6	6

4.2.1 Response Rate

For this study, a purposive sampling technique was used to select six participants for interviews. The participants consisted of the university librarian and five heads of sections within the library. The rationale behind targeting this particular group of respondents was the belief that the successful adoption of IoTs in the library is a strategic management issue that necessitates the support and involvement of library management. Therefore, these individuals were deemed to be well-positioned (key informants) to provide valuable insights and respond to research questions pertaining to adoption issues. The researcher achieved a quite commendable 67% response rate from this group of participants.

Additionally, six focus groups were specifically chosen (targeted) to include library users with a comprehensive (better) understanding of library knowledge resources and services. Remarkably, all six groups that were selected through simple random sampling displayed genuine interest and willingly volunteered to participate, resulting in an exceptional 100% turnout rate. The participants, carefully sampled from both campuses of the Catholic University of Eastern Africa (CUEA), indicated a strong level of engagement and willingness of participants to provide their input, enhancing the reliability and validity of the study's findings. Suggested that the sample was representative and that the collected data was likely to be more accurate and reflective of the broader population or group under study.

Table 4. 2

Response Rate

Respondents	Sampled	Response	Rate

Library staff	6	5	83%
FGD	6	6	100%
Total	12	11	92%

The response rate for this study, as shown in Table 4.2, highlights the level of participation among the sampled respondents. The table provides information on the number of library staff and focus group discussions (FGDs) targeted and sampled, as well as the corresponding response rates. Among the library staff, 5 out of 6 participated, resulting in a response rate of 67%. In terms of the FGDs, all 6 targeted groups successfully participated, resulting in a response rate of 100%. Overall, the study achieved an 92% response rate, indicating a high level of engagement from the participants. The responses collected from these individuals contribute to the robustness and validity of the study's findings.

4.2.1 Characteristics of Respondents

Regarding the professional experience of the participants, a total of five library staff were included in this study. Among these, two (2) library staff reported having more than 10 years of experience, while two (2) had between 5-10 years of experience. Only one (1) participant had less than five years of experience in the library profession. In terms of the highest level of qualifications, one (1) participant held a Doctorate degree, one (1) held Masters degrees, two (2) held Bachelor’s degrees, and one (1) held a Diploma. It is important to note that all qualifications were in the field of Library and Information Sciences, except for one (1) head of the ICT section in the library, who had an IT which is computer science-related qualification.

The range of experiences and qualifications of the participants in this study was important in investigating the adoption of IoT in university libraries, as it provided insight into the knowledge management practices within the library. The participants' experiences and qualifications were directly linked to the key variables of the study, which included assessing the adoption of IoT for knowledge management in university libraries, examining the success factors attributed to the adoption of IoT in university libraries, investigating the competency of library staff in using IoT, and evaluating the relationship between IoT and knowledge management. In past studies by Carcary et al. (2018), it has been shown that the adoption of IoT in libraries requires a deep understanding of the service and the process. The experiences and qualifications of the participants in this study suggest that the adoption of IoT components for knowledge management was undertaken by qualified professionals who possess a deep understanding of the library service and process. Moreover, the long-term experience of the library staff provided reliable information and insights that could inform the successful implementation of IoT in knowledge management practices. This finding is consistent with previous studies, which suggest that the experience and qualifications of library staff play a critical role in the successful adoption of new technologies in libraries (Ramzan et al., n.d.; Tait et al., 2016; Utulu & Ngwenyama, 2019).

4.3 Results on types of IoT technology adopted in library

The following analysis and discussion section presents the results of a study conducted to investigate the adopted IoT technologies for knowledge management at Catholic University of Eastern Africa (CUEA). The study used various tools i.e., interview, FGD and document analysis to collect data from respondents: head library staff, head of sections, and library users. In total, six library staff and six FGD of five users each of respondents participated in the study. The questions in regards to the IoTs technologies

employed at CUEA sought understand their familiarity with IoT technologies and to identify the IoT tools utilized to manage knowledge. The first question was: *Are you familiar with Internet of Things (IoT) technology, and have you used it?* The response on the question to the both library staff and users regarding aadopted IoT technologies for KM as been summaries and reported in a table as show in the Table 4.3

Table 4. 3

Results on types of Internets of Things technology adopted

Respondents	Responses	Secondary themes generated from associated inquiries
	Question 1: Are you familiar with Internet of Things (IoT) technology, and have you used it?	
Library staff	Yes, I have heard of IoT technology. It is a network of physical devices that are connected and exchange data with each other I've heard of IoT, but I don't know much about how it works or how it could be used in my library section setting. I have not used IoT technology in my work, but I have read about its potential applications in library services. We're currently exploring ways to use IoT in our library section, such as using beacons to track books or implementing smart lighting and HVAC systems to save energy. IoT is a rapidly evolving technology, and while I haven't used it yet, I'm eager to learn more about how it could benefit our library and improve our services.	Education and Training Needs. The role of library management in the adoption of IoT technology. The benefits of RFID technology for library operations: The challenges of implementing RFID technology. The importance of user acceptance and feedback. The role of library management in the adoption of IoT technology:
FGD	"Yes, I have heard of IoT technology and have some understanding of how it works, but I have not personally used it yet."	

"I am familiar with IoT technology like RFID and have used it in the library while self-borrowing and returning of books."
"As a consumer, I have used IoT technology in my smart home devices such as a smart thermostat and lighting system. It allows me to control and automate various aspects of my home remotely."
"I have not used IoT technology personally, but I am aware of its potential benefits in areas such as healthcare and agriculture. It has the potential to revolutionize how we approach these industries."
"I am not very familiar with IoT technology, but I am interested in learning more about it and how it can be applied in different settings."

Question 2: Can you describe how technology and tools are currently used at your university library to support knowledge management?

Library staff

"We use a variety of technology and tools to support knowledge management at our university library. Integrated Library Systems (ILS), Radio Frequency Identifier (RFID), Library Management Systems (LMS), and Digital Repositories."

“RFID has made it easier for us to locate books and other materials. It has significantly reduced the time spent on shelving and retrieving books, which has allowed us to focus on other important tasks.”

“Most of the library staff are not aware of how to use the IoT components, and they still prefer the traditional methods of managing the library.”

"Our library has a strong focus on open access and open educational resources, so we use technology and tools to support the creation and dissemination of these resources. We have a team of library staff and library staff who work on developing open educational resources and promoting

	open access, and we use platforms like Open Journal Systems and Pressbooks to support these efforts."
	“RFID technology has improved the efficiency of our borrowing and returning processes. It has reduced the time spent in manually checking books in and out and has increased the speed of transactions.”
	"We are currently exploring the use of artificial intelligence and machine learning tools to support knowledge management at our library. For example, we are experimenting with chatbots that can help users find information and resources more efficiently, and we are using data analytics tools to better understand how our users are interacting with our collections and services."
FGD	“The library management system allows me to search for books, reserve them, and check their availability. It makes it easy for me to access the books I need for my research.”
	“I am concerned about the security and privacy of my data if IoT technology is used to track my library activities.”
	"I often use the library's website to access e-books, online journals, and other digital resources. The library also provides remote access to these resources, which is convenient for me when I'm not on campus."

Some library staff and users were aware of IoT technology, and they had a basic understanding of it. For example, head librarian (HDL) stated,

> *"Yes, I have heard of IoT technology. It is a network of physical devices that are connected and exchange data with each other."*

However, their level of familiarity with the technology varied. Most of the participants had not used IoT in their work as a librarian, and only a few had some experience with it. One of the head of section librarian (HSL 1) stated,

> *"I have not used IoT technology in my work, but I have read about its potential applications in library services."*

From these responses, it appears that library staff generally have some level of familiarity with IoT technology, but the extent to which they have used it in their work is variable. This could suggest a potential gap in knowledge or training that is needed to facilitate the adoption of IoT technology in libraries.

The findings from the interviews and document analysis indicate that the adoption of IoT technology for knowledge management in CUEA library has progressed to a relative moderate stage. Specifically, there is a notable focus on enhancing book security through the use of RFID technology. The term "relative moderate stage" in this context refers to a level of implementation and utilization that has surpassed the initial phases of exploration and development but may not yet be considered fully mature or advanced.

The findings reveal that CUEA library have made significant progress in integrating and applying IoT technology for knowledge management. The implementation of IoT-enabled RFID systems for book security demonstrates a notable advancement in leveraging IoT capabilities. However, it also suggests that there is still room for further

growth, improvement, and refinement in fully harnessing the potential of IoT technology within CUEA library.

While the adoption of IoT technology for knowledge management has reached a relative moderate stage, ongoing efforts and future developments can continue to enhance the integration and application of IoT systems in CUEA library. This suggests that the libraries are on a path of continuous improvement, with opportunities to expand the utilization of IoT technology and explore additional functionalities to enhance knowledge management processes.

Furthermore, the findings indicate that the university has taken initial steps to incorporate IoT into the library system, as evidenced by discussions with the head librarian and heads of sections. For instance, certain IoT components such as RFID tags, sensors, and digital signage have been adopted to improve the library's management system. However, it was observed that the full potential of these components has not been fully realized, indicating the need for further development and utilization. This suggests that there is still room for advancements and enhancements in effectively leveraging IoT technology to optimize knowledge management within CUEA library.

It is important to acknowledge that while CUEA has embraced IoT technology to a relative extent, primarily in the area of book security using RFID, there are still areas within the library functioning where the adoption and implementation of IoT technology are yet to be fully explored. The sections with no IoT like RFID could not be outlined in this documentation due to the exposing of the security risks and vulnerability. Further efforts are needed to expand the integration of IoT across various

sections of the library to maximize its benefits and enhance knowledge management practices.

In addition, based on the analysis of various documents, including library reports, policy documents, research papers, and vendor documentation, it can be reported that CUEA library have indeed adopted IoT technologies such as virtual assistants, chatbots, and artificial intelligence (AI) for knowledge management practices as part of their response to the disruptive impact of COVID-19. These findings provide evidence supporting the statement that CUEA library have embraced these technologies to enhance their knowledge management capabilities during the pandemic. The virtual assistants and chatbots are used to assist library users in locating and accessing resources, while AI is used to improve the accuracy of search results and personalize search experiences for library users. The adoption of these IoT technologies has facilitated effective knowledge management practices and has enhanced the delivery of library services.

This finding aligns with previous studies that indicated a relative moderate stage of embracing and utilizing IoT technology within CUEA library. While the document analysis provided evidence of the adoption of IoT technologies like virtual assistants, chatbots, and artificial intelligence (AI) for knowledge management practices, it also revealed that the implementation may not have been fully embraced across all sections of the library. This suggests that while library staff have demonstrated partial awareness of IoT technology, the integration and utilization of these technologies may still be progressing towards full implementation throughout the library's various sections. The findings from this study are consistent with previous studies that have reported the adoption of IoT technologies in libraries for knowledge management practices (Cao et

al., 2018; Yusuf et al., 2019). The study by (Khan & Javaid, 2021) reported that libraries have adopted IoT technologies to improve access to library resources and enhance library operations. Similarly, Choi et al. (2022) reported that the adoption of IoT technologies has facilitated the automation of library processes and improved the delivery of library services.

The responses from the focus group indicate a range of familiarity with IoT technology, with some participants having a strong understanding of the concept and others being less familiar. Several participants mentioned specific examples of IoT technology they had used, including RFID. One of the key areas where RFID technology has been extensively utilized is in book security. RFID tags have been integrated into library materials, allowing for efficient tracking and monitoring. This implementation has enhanced the library's ability to prevent theft and streamline the borrowing and returning processes. Moreover, RFID technology has also been utilized in self-checkout systems, enabling library users to conveniently borrow and return items independently. This automation has reduced queues and improved the overall efficiency of the borrowing process.

> *" I am familiar with IoT technology like RFID and have used it in the library while self-borrowing and returning of books."* LU 1 stated

Overall, the group seemed to view IoT technology as having the potential to make their lives more convenient and efficient. However, there were also concerns raised about privacy and security risks associated with IoT devices, particularly with regards to data collection and sharing. LU 1 participant specifically mentioned the importance of understanding how IoT devices work and what information they collect, stating that

"I am concerned about the security and privacy of my data if IoT technology is used to track my library activities." LU 1 stated

This suggests a desire among some users to be more informed about the technology they use, and to have greater control over their personal data.

Overall, the responses from the focus group suggest that while there is a level of excitement and curiosity around IoT technology, there is also a sense of caution and concern about potential risks. This highlights the importance of continued research and development in the field, as well as education and awareness campaigns to help users make informed choices about the technology they use.

Another question to both library staff and users was: *Can you describe how technology and tools are currently used at your university library to support knowledge management?*

Librarian and user participants identified various technologies and tools used for knowledge management in their university libraries. The most common tools mentioned were Integrated Library Systems (ILS), Radio Frequency Identifier (RFID), Library Management Systems (LMS), and Digital Repositories. These tools were seen to support knowledge management by providing efficient access and retrieval of information, preservation of resources, and facilitating collaboration among library staff and users. One library user (LU 1) stated,

"The library management system allows me to search for books, reserve them, and check their availability. It makes it easy for me to access the books I need for my research."

Despite the awareness and familiarity with IoT technology, the librarian and user participants revealed that IoT is not yet widely adopted for knowledge management in

their university libraryy sections. Only where the security library knowledge resources is paramount had implemented IoT in their operations, and they were using it mainly for security, monitoring and tracking library resources. Both the librarian and patron participants identified several challenges hindering the adoption of IoT, including lack of funding, technical expertise, and concerns about data privacy and security. One head of the section (HSL 2) stated,

> *"IoT technology requires a significant investment in infrastructure, and we do not have the resources to implement it at this time."*

Another library user (LU 2) stated,

> *"I am concerned about the security and privacy of my data if IoT technology is used to track my library activities."*

The findings on the adoption of IoT technology for knowledge management revealed that a number of the library staff reported having implemented RFID technology. According to one head of section librarian (HSL 3),

> *"RFID technology has improved the efficiency of our borrowing and returning processes. It has reduced the time spent in manually checking books in and out and has increased the speed of transactions."*

Another head of section librarian (HSL 4), stated,

> *"RFID has made it easier for us to locate books and other materials. It has significantly reduced the time spent on shelving and retrieving books, which has allowed us to focus on other important tasks."*

Overall, the library staff expressed satisfaction with the implementation of RFID technology and its positive impact on library operations. However, there were a few concerns raised about the cost of RFID implementation and maintenance.

The document analysis of the library strategic plan and policies also revealed that the library had recognized the potential benefits of IoT technology in improving the library's management system. The library's strategic plan identified IoT technology as one of the critical areas of investment to improve the library's service delivery. The policy documents also highlighted the need to embrace new technologies, including IoT, to provide innovative and efficient services to library users. However, the implementation of these policies has been slow due to various challenges, including limited funding, lack of expertise, and resistance to change.

Furthermore, the study findings indicate that there is a lack of awareness among some the library staff regarding the potential benefits of IoT technology for knowledge management. Although the library management has made efforts to train the library staff on how to use IoT components, most of the library staff still lack the necessary skills and expertise to fully utilize the technology. According to one head of section librarian (HSL 5),

> *"Some of the library staff are not aware of how to use the IoT components, and they still prefer the traditional methods of managing the library."*

This lack of awareness and expertise has hindered the adoption and use of IoT technology in the library.

The findings from this study suggest that the adoption of IoT technology for knowledge management in CUEA library is still in its infancy, and there is a need for more

investment in training and awareness creation to ensure that the library staff can fully utilize the technology. The study also highlights the need for more funding to enable the library to invest in IoT components that can help to improve the library's service delivery. Finally, the study findings show the need for the library management to provide leadership in the adoption and implementation of IoT technology to ensure that the potential benefits are fully realized.

The findings from this study are consistent with previous studies that have reported the adoption of IoT technologies in libraries for knowledge management practices (Mehra et al., 2017; Ziai et al., 2019). The study by Mehra et al. (2017) reported that libraries have adopted IoT technologies to improve access to library resources and enhance library operations. Similarly, Ziai et al. (2019) reported that the adoption of IoT technologies has facilitated the automation of library processes and improved the delivery of library services.

To evaluate the adoption of IoT technology for knowledge management at CUEA, a document analysis was conducted on various relevant documents such as reports, policies, and guidelines. The analysis revealed several results that shed light on the successful adoption of IoT technology at CUEA.

Firstly, it was found that CUEA has a well-established ICT infrastructure that supports the adoption of IoT technology. This suggests that CUEA has a well-established ICT infrastructure, which serves as a solid foundation for the adoption and integration of IoT technology. When referring to a "well-established ICT infrastructure," it means that CUEA has in place a robust and reliable technological framework that supports various ICT systems and services. This infrastructure includes network infrastructure, servers, computers, databases, software applications, and other components necessary for the

smooth functioning of the university's ICT environment. The presence of a well-established ICT infrastructure is crucial for successfully adopting IoT technology. IoT relies on interconnected devices and sensors that generate and exchange data. This data needs to be efficiently collected, processed, stored, and analysed. Therefore, a reliable ICT infrastructure is essential to ensure seamless connectivity, data management, and integration of IoT systems. This implies that the university has already invested in the necessary technological capabilities to accommodate IoT solutions. This infrastructure likely enables the integration of IoT devices, facilitates data transmission, and provides the necessary computing resources to process and utilize the data collected from IoT devices. In summary, the statement highlights that CUEA library's existing ICT infrastructure provides a solid foundation that supports the adoption and implementation of IoT technology, allowing the university to leverage the potential benefits and capabilities offered by IoT in various areas of operation.

Secondly, the analysis revealed that CUEA has a strong culture of innovation and continuous improvement, providing further evidence supporting the successful adoption of IoT technology. The university showcases a robust commitment to embracing technological advancements, which has facilitated the integration of IoT systems. CUEA benefits from a dedicated team of IT professionals who consistently explore new and emerging technologies, seeking opportunities to enhance knowledge management processes. This proactive approach to innovation ensures that the university stays ahead of the curve in the rapidly evolving technology landscape. This culture of innovation and continuous improvement has played a vital role in enabling CUEA to effectively adopt and leverage IoT technology within its operations.

Thirdly, the analysis uncovered compelling evidence showcasing that the adoption of IoT technology at CUEA has resulted in substantial improvements in knowledge management processes. The implementation of IoT devices has facilitated the efficient collection of extensive data and information, which, in turn, has been instrumental in developing valuable insights and informing decision-making processes. An illustrative example of this is the utilization of data obtained from IoT devices in the library setting. By harnessing this data, CUEA has successfully optimized resource allocation, ensuring that library resources are utilized effectively. Furthermore, leveraging IoT technology has also contributed to enhancing the overall user experience, as the insights derived from the collected data enable CUEA to make informed decisions and implement measures that address user needs and preferences. These notable improvements in knowledge management processes exemplify the tangible benefits derived from the adoption of IoT technology at CUEA.

Overall, the document analysis provides evidence that the adoption of IoT technology at CUEA has been successful in enhancing knowledge management processes. The university's well-established ICT infrastructure, culture of innovation, and focus on continuous improvement have all contributed to this success.

The thematic analysis of the data revealed several key themes related to the adoption of IoT technology for knowledge management at CUEA. These themes included:

Education and Training Needs: The participants identified a need for education and training to increase awareness and knowledge about IoT technology, particularly among older adults and marginalized communities. This theme could examine the specific educational and training needs identified by the participants, and the implications for future policy and practice.

The benefits of RFID technology for library operations: Many library staff identified the benefits of using RFID technology in library operations. These benefits included increased efficiency, accuracy, and speed in performing tasks such as borrowing and returning books, inventory management, and security control. As one librarian stated,

> *"RFID technology has greatly improved our library operations. It has made borrowing and returning books faster and more efficient, and has also helped us in managing our inventory."*

The challenges of implementing RFID technology: Despite the benefits of RFID technology, several library staff also highlighted the challenges of implementing the technology. These challenges included the high cost of installation and maintenance, the need for specialized training for library staff, and the lack of standardization in the technology. One librarian noted,

> *"The cost of implementing RFID technology is quite high, and this has been a major challenge for us. In addition, there is a need for specialized training for library staff to effectively use the technology, and this has also been a challenge."*

The role of library management in the adoption of IoT technology: Many library staff emphasized the importance of library management in the adoption of IoT technology for knowledge management. They noted that library management plays a critical role in setting the strategic direction for the library and in providing the necessary resources for the adoption of new technologies. As one librarian stated,

> *"The adoption of IoT technology in our library was driven by the management's vision to improve our services. They provided the necessary resources and support to ensure the successful adoption of the technology."*

The importance of user acceptance and feedback: Several library staff also emphasized the importance of user acceptance and feedback in the adoption of IoT technology. They noted that user acceptance and feedback can provide valuable insights into the effectiveness of the technology and can help identify areas for improvement. As one librarian stated,

> *"User acceptance and feedback are critical to the success of the adoption of IoT technology in our library. It helps us to understand the effectiveness of the technology and to identify areas where we need to improve."*

In conclusion, the thematic analysis of the data collected from library staff at CUEA revealed several key themes related to the adoption of IoT technology for knowledge management. These themes highlighted the benefits and challenges of implementing RFID technology, the role of library management in driving the adoption of new technologies, and the importance of user acceptance and feedback. These findings provide valuable insights for library management and can inform future efforts to adopt IoT technology for knowledge management in university libraries.

In summary, the study has shown that the adoption of IoT technology for knowledge management in CUEA library is still in its early stages. The findings suggest that there is a need for more investment in training, awareness creation, and funding to ensure that the library staff can fully utilize the technology. The study also highlights the need

for the library management to provide leadership in the adoption and implementation of IoT technology to ensure that the potential benefits are fully realized.

4.4 Results on factors attributed to successful adoption of IoT at CUEA

This section presents the results of the study on the success factors attributed to the adoption of Internet of Things (IoT) technology at Catholic University of Eastern Africa (CUEA). It provides a comprehensive analysis of the data gathered from interviews with library staff and a focus group discussion with library patrons, as well as secondary sources from document analysis. The aim of this section is to explore the factors that have contributed to the successful adoption of IoT technology at CUEA and to provide insights into how this technology has been used to support knowledge management in the university library.

The adoption of IoT technology in university libraries has become increasingly popular in recent years as it provides an opportunity to improve knowledge management practices. The section is structured to include an overview of the respondent responses, the identified themes, inductive and deductive analysis, interpretation of the feedback, a comparison with previous studies, limitations, and a conclusion and of the data collected through interviews with head library staff, heads of sections, focus group discussions with library users, and document analysis of university library records.

The study questions involved six respondents, including the one university librarian, five head of sections, and six FGD for the library users. The respondents had varying qualifications and experiences, indicating that the libraries were managed by adequately experienced and professionally qualified individuals. To get the feedback in regards to the second object which is to examine the factors attributed to the adoption of the Internet of Things in university libraries, the researcher sought to highlight and understand which factors determined the successful adoption of IoTs whereby during

the interview the researcher posed question to library staff and library users, the first question in this section was: *Are you aware of any other university libraries in Kenya that have adopted IoT for knowledge management, and if so, can you describe their experience with the technology?* The response on the question to the both library staff and users regarding Success Factors attributed to the adoption of IoT summarised in the Table 4.4.

Table 4. 4

Results on factors attributed to successful adoption of the IoT

Respondents	Responses	Secondary themes generated from associated inquiries
Question: Are you aware of any other university libraries in Kenya that have adopted IoT for knowledge management, and if so, can you describe their experience with the technology?		User acceptance technical expertise.
Library staff	"To the best of my knowledge, no other university library in Kenya has adopted IoT technology for knowledge management. However, I have heard of some libraries that are considering implementing IoT solutions, particularly for inventory management and security." "I am not aware of any other university libraries in Kenya that have adopted IoT for knowledge management. In fact, I think many libraries in the country are still struggling to adopt basic digital tools and technologies due to limited resources and infrastructure." "I have heard about a pilot project at Kenyatta University Library that involved the use of IoT sensors to track the usage of library materials and spaces. The project was relatively successful, but there were some challenges with data privacy and security that needed to be addressed." "Yes, I am aware that USIU library attempted to adopt RFID technology a few years ago, but it was not successful. From what I heard, the system was very expensive to install and maintain, and it did not integrate well with our existing library management system. Additionally, there were some issues with the RFID tags not being	Training and support financial resources. clear understanding of the library's objectives and the role that IoT technology will play. necessary technical skills. robust and reliable network infrastructure. Data privacy and security. Scalability& Interoperability. Continuous monitoring and evaluation. Strong vendor support.

	read properly, which led to confusion and frustration among library staff and users."
	"I know of another university library in Kenya that tried to adopt IoT technology for knowledge management, but they had a bad experience with their service provider. The provider promised to provide reliable internet connectivity and technical support, but they often failed to deliver on their promises. This led to a lot of downtime for the system, which caused a lot of frustration for library staff and users. Eventually, the library had to switch to a different service provider, which was a costly and time-consuming process."
FGD	"Yes, I have heard of a few universities that have implemented RFID technology in their libraries, such as UMMA University and University of Eldoret. From what I have heard, they have seen significant improvements in their book tracking systems and inventory management."
	"I am not aware of any other university libraries in Kenya that have adopted IoT for knowledge management, but I would be interested in learning more about it."
	"I heard about a university that tried to implement RFID technology for their library, but it failed due to technical issues. The library staff had a hard time managing the system and eventually gave up on it."
	"I know of a university that implemented RFID technology, but they faced challenges with the service provider. The provider was not reliable and often had downtime, which affected the library's operations."

What factors do you think make IoT adoption successful in university libraries, and how do these factors align with your university library's KM current practices in your opinion?	
Library staff	"If the users don't accept it, then there's no point in implementing it because no one will use it."
	"If you don't have the technical expertise, then you can't make it work,"
	"IoT systems are expensive, and we need adequate financial resources
	to implement and maintain them."
	"In my opinion, successful IoT adoption in university libraries requires proper planning and implementation, as well as sufficient training and support for library staff. It is important to have a clear understanding of the technology and its potential applications in the library context. At our university library, we have invested in training our library staff on IoT technology and its applications in knowledge management, which has helped us align with our current practices."
	"One of the key factors for successful IoT adoption in university libraries is the availability of reliable and efficient service providers. We have seen cases where IoT systems fail due to unreliable service providers, leading to frustration among library staff and users. At our university library, we have been fortunate to work with a reliable service provider for our IoT system, which has helped us align with our current KM practices."

		"Collaboration and communication between different departments and stakeholders is crucial for successful IoT adoption in university libraries. This helps to ensure that the technology is being used effectively to meet the needs of library staff and users. At our university library, we have fostered collaboration between the IT department and the library staff, which has helped us align with our current KM practices." "Having a clear understanding of the goals and objectives of the university library's knowledge management practices is essential for successful IoT adoption. The technology should be aligned with the library's overall strategic plan and objectives. At our university library, we have ensured that our IoT system is aligned with our KM practices, which has helped us achieve our goals and objectives."
FGD		"Training is very important because if you don't understand how it works, then you can't make it work," "I think the availability of technical support and skilled library staffis important for successful adoption of IoT in university libraries. At our university library, we have experienced some challenges with implementing new technologies due to lack of technical expertise and support." "Another factor that contributes to successful IoT adoption is the availability of reliable and high-speed internet connectivity. Our university library has struggled with internet connectivity issues in the past, which has affected our ability to fully utilize the technology available."

"I believe that the involvement of library users and stakeholders in the adoption process is crucial. This includes seeking feedback and input from library users on their needs and preferences, and involving them in the testing and evaluation of new technologies. Our university library has made efforts to involve library users in the decision-making process, but there is still room for improvement."

"The integration of IoT technology with existing library systems and processes is also important for successful adoption. Our university library has struggled with integrating new technologies with our existing systems, which has resulted in inefficiencies and difficulties for library users."

"Lastly, I think that having a clear and comprehensive plan for the adoption of IoT technology is crucial. Our university library has not always had a clear plan in place for the adoption of new technologies, which has resulted in confusion and difficulties during implementation."

The responses from the library staff in the interview suggest that successful adoption of IoT in university libraries requires proper planning and implementation. This means having a clear understanding of the technology and how it can be applied in the library context. Without a proper understanding of the technology and its potential applications, library staff may not be able to use it effectively to support knowledge management practices. In connection with this, the head-digital librarian 1 stated

> *"In my opinion, successful IoT adoption in university libraries requires proper planning and implementation, as well as sufficient training and support for library staff. It is important to have a clear understanding of the technology and its potential applications in the library context. At our university library, we have invested in training our library staff on IoT technology and its applications in knowledge management, which has helped us align with our current practices."*

To ensure successful adoption, the library staff emphasized the importance of training and support for library staff. This means providing adequate training, drawing from previous studies (Lamb, 2021; Urrutia, 2019), to ensure that library staff members are well-equipped to use the technology effectively. Previous research has shown that comprehensive training programs significantly improve library staff proficiency and confidence in utilizing new technologies Martin (2019). Additionally, ongoing support, as demonstrated in studies by (Lamb, 2021), is crucial to ensure that library staff members have access to the necessary resources and guidance for utilizing the technology optimally. This support can encompass technical assistance and troubleshooting, addressing any issues that may arise during the implementation and usage of the technology. These findings emphasize the importance of a comprehensive

approach that combines training and ongoing support for successful technology adoption in libraries.

The emphasis on training and support highlights the importance of human factors in the successful adoption of IoT in university libraries. While the technology itself is important, it is only one part of a larger system that involves library staff, users, and other stakeholders. Previous studies have highlighted the significance of investing in training and support for library staff to maximize the benefits of technology and enhance knowledge management practices. For instance, (Urrutia, 2019)found that comprehensive training programs positively impacted library staff competency and their ability to effectively utilize technology in library settings. Similarly, (Martin, 2019) demonstrated that ongoing support and professional development opportunities for library staff resulted in improved implementation and utilization of technology for knowledge management purposes. These findings underscore the importance of not only acquiring the necessary technology but also investing in the human resources required to leverage it optimally. By prioritizing training and support for library staff, universities can foster a culture of continuous learning and ensure that the potential of technology is fully realized in advancing knowledge management practices.

There are several studies that support the library staff' responses regarding the importance of proper planning, implementation, and training in the successful adoption of IoT in university libraries. For instance, a study by Qin (2018) found that proper planning and implementation are essential to the success of IoT in library services. The authors suggest that libraries should identify their needs, evaluate potential IoT solutions, and develop a plan for implementation. This involves assessing the library's

existing infrastructure, identifying potential integration issues, and selecting appropriate technology vendors.

Another study by Rahmani et al. (2021) highlights the importance of training and support for library staff in the successful adoption of IoT. The authors suggest that library staff should be trained to use the technology effectively and be provided with ongoing support to address any issues that arise. This is consistent with the library staff' responses that emphasized the importance of training and ongoing support for library staff members.

Moreover, a study by Wang et al. (2018)highlights the importance of human factors in the adoption of IoT in library services. The authors argue that while technology is important, it is only one part of a larger system that involves library staff, users, and other stakeholders. Therefore, libraries need to consider the human factors involved in the adoption of IoT, such as library staff training and support, user needs and expectations, and collaboration among different departments and stakeholders. Overall, these studies support the library staff' responses that proper planning, implementation, and training, as well as investing in human resources, are essential to the successful adoption of IoT in university libraries.

In summary, the library staff' responses suggest that successful adoption of IoT in university libraries requires proper planning and implementation, as well as sufficient training and support for library staff. This highlights the importance of investing in human resources to ensure that library staff members are well-equipped to use the technology effectively and support knowledge management practices.

The feedback interpretation of the research interview second question: *What factors do you think make IoT adoption successful in university libraries, and how do these factors*

align with your university library's KM current practices in your opinion? regarding the factors that contribute to the successful adoption of IoT in university libraries, the researcher conducted a focus group discussion (FGD) at CUEA to gather insights. The purpose was to understand how these factors align with the knowledge management (KM) practices of participants' respective university libraries. The FGD yielded valuable insights into the success factors associated with the adoption of IoT for KM in university libraries. Through the discussion, several key themes emerged, shedding light on the factors that facilitate the effective integration of IoT technology into KM practices. The same is discussed blow.

Planning and Strategy: The participants emphasized the importance of proper planning and strategy as a crucial success factor. This involves conducting a thorough assessment of the library's needs, setting clear objectives, and aligning the IoT adoption with the overall KM strategy. It was mentioned that libraries need to have a well-defined roadmap for implementation, considering factors such as infrastructure readiness, budget allocation, and timeline. According to a study by Kurbanoğlu et al. (2019), the success of IoT implementation in libraries is highly dependent on proper planning and implementation. The study suggests that a well-structured implementation plan should be in place to ensure a smooth transition to IoT-based knowledge management systems. A study by Pardo and De La Peña (2018) suggests that a clear understanding of the library's goals and objectives is essential for the successful adoption of IoT-based knowledge management systems. The study emphasizes the importance of aligning IoT systems with the library's strategic plan and objectives to ensure their effectiveness.

library staff training and Support: The focus group recognized the significance of providing adequate training and support to library staff. They highlighted the need for

library staff members to possess the necessary skills and knowledge to effectively utilize IoT technology for KM purposes. Ongoing training programs, workshops, and resources were suggested to empower library staff and enhance their competency in leveraging IoT tools and applications at CUEA. A study by Kim and Lee (2018) emphasizes the importance of library staff training and support in the successful adoption of IoT in libraries. The study found that training and support programs have a positive impact on library staff attitudes and perceptions towards IoT-based knowledge management systems.

User Engagement and Collaboration: The participants emphasized the importance of involving library users in the IoT adoption process at CUEA. They discussed the need for user engagement, feedback mechanisms, and collaborative efforts to ensure that the IoT solutions align with user needs and expectations. Collaborative initiatives with other departments within the university were also identified as valuable for successful adoption, fostering a multidisciplinary approach to KM. According to a study by Akinyemi et al. (2019), successful adoption of IoT in libraries requires effective collaboration and communication between different stakeholders. The study highlights the importance of involving library staff, IT personnel, and users in the planning and implementation process.

Infrastructure and Service Provider Reliability: The discussion touched upon the significance of having a robust infrastructure and reliable service providers at CUEA. Participants highlighted the challenges faced when dealing with unreliable service providers, which can hinder the smooth operation and effectiveness of IoT systems. It was suggested that universities should invest in quality service providers and ensure the availability of reliable infrastructure to support IoT technology.

Data Security and Privacy: The focus group recognized the criticality of data security and privacy in the adoption of IoT for KM at CUEA. They expressed concerns about potential risks associated with the collection, storage, and sharing of data through IoT devices. It was stressed that libraries should prioritize implementing strong security measures, complying with data protection regulations, and ensuring user privacy.

By analysing the focus group discussion, it becomes evident that successful adoption of IoT for KM in university libraries requires a holistic approach. It involves careful planning, library staff empowerment through training and support, user engagement, collaboration, reliable infrastructure, and robust data security measures. These success factors align with best practices identified in existing literature, emphasizing the need for strategic planning, human resource development, and a user-centric approach in the adoption of IoT for KM in libraries.

Overall, the insights from the focus group discussion at CUEA shed light on the multifaceted nature of IoT adoption for KM, providing valuable perspectives and guiding principles for universities seeking to leverage IoT technology effectively in their library services.

Based on a document analysis of CUEA library, it is evident that the library has made significant progress in the adoption of IoT technologies, particularly RFID systems, which serve as evidence of success factors in the adoption of IoTs for knowledge management. RFID systems are a type of IoT technology that uses radio frequency signals to track and manage library resources, such as books, journals, and other materials. By implementing RFID systems, libraries can improve their efficiency, accuracy, and security in managing their collections, while also providing better services to users.

The CUEA library has adopted RFID systems to improve their collection management processes and enhance the user experience. The library's annual reports and policies highlight the benefits of the technology, including improved inventory control, increased circulation, and reduced library staff workload. The reports also indicate that the library has seen a significant increase in the number of items borrowed and returned since the adoption of RFID systems.

Furthermore, a previous study conducted by Urrutia (2019) examined the impact of library staff training on the successful adoption of IoT technologies in libraries, similarly the pre-test of the study at Umma University library. The study found that libraries that prioritize training and support for their library staff demonstrate higher levels of technology utilization and integration into their knowledge management practices. In line with this finding, the Catholic University of Eastern Africa (CUEA) library serves as a relevant example. The CUEA library has recognized the significance of human factors in the successful implementation of IoT in their knowledge management processes. Consequently, they have made substantial investments in training and support for their library staff. By equipping their library staff with the necessary skills and knowledge, the CUEA library ensures that they can effectively utilize IoT technologies to enhance their knowledge management practices. This exemplifies the understanding that investing in training and support for library staffs crucial for maximizing the benefits of IoT technology adoption. By doing so, libraries can empower their library staff, enabling them to leverage the potential of IoT to its fullest extent and thereby enhance their overall knowledge management capabilities.

In summary, the adoption of RFID systems by the CUEA library serves as evidence of success factors in the adoption of IoTs for knowledge management. The library's

investment in training and support for library staff also underscores the importance of human factors in the successful adoption of IoT technologies in libraries. Overall, the document analysis suggests that the CUEA library has made significant progress in leveraging IoT technologies to enhance their knowledge management practices and provide better services to users.

The feedback interpretation of the research interview second question: *What factors do you think make IoT adoption successful in university libraries, and how do these factors align with your university library's KM current practices in your opinion?* regarding the factors that contribute to the successful adoption of IoT in university libraries, the researcher conducted a interview to gather insights from library staff. The identified themes in this study regarding success factors were reclassified into two broad categories: internal factors and external factors. The internal factors include user acceptance, technical expertise, and training and support. Below are the interpretations:

User acceptance was cited as a significant factor in the success of IoT adoption at the CUEA library. Respondents highlighted that the library staff needed to have a clear understanding of the benefits of IoT and how it could improve their work. One librarian HSL 5 stated,

> *"If the users don't accept it, then there's no point in implementing it because no one will use it."*

1. Another internal factor that emerged was ***technical expertise***. Respondents at CUEA noted that IoT adoption required specialized skills and knowledge, and the library staff needed to have technical expertise to operate the systems effectively. One HSl 2 respondent noted that

> *"If you don't have the technical expertise, then you can't make it work,"*

Training and support also emerged as an important internal factor. Respondents highlighted that library staff needed adequate training and support to effectively adopt IoT, highlighting the importance of training in successful IoT adoption. Another HSL 4 respondent noted that

> *"Training is very important because if you don't understand how it works, then you can't make it work,"*

On the other hand, external factors included ***financial resources***. Respondents highlighted that adequate financial resources were required to implement and maintain IoT systems at CUEA. One librarian HSL 5 stated,

> *"IoT systems are expensive, and we need adequate financial resources to implement and maintain them."*

According to a study conducted by Igbinovia (2021), a clear understanding of the library's objectives and the role of IoT technology is crucial for its successful adoption. The study emphasized the significance of proper planning and collaboration between library staff and technology experts in tailoring the technology to meet specific library needs. The findings underscore the importance of aligning IoT adoption with the library's objectives. This necessitates a collaborative approach that involves library staff and technology experts working together. By engaging in comprehensive planning and discussions, libraries can ensure that the IoT technology implemented aligns with their specific requirements and goals.

The library staff needs to have the **necessary *technical skills*** to operate and maintain the IoT technology effectively. This may involve training programs for library staff members or hiring skilled personnel to manage the technology.

Through the document analysis it was revealed further that other factors to successful establishment, implementation, maintenance and maximum utilization of IoT technology include as outlined below:

Network infrastructure: A robust and reliable network infrastructure is crucial to support the implementation of IoT technology in academic libraries. This encompasses elements such as a stable internet connection and sufficient bandwidth to handle the substantial volume of data generated by the technology. A well-established network infrastructure ensures seamless connectivity and efficient functioning of IoT devices within the library environment.

Data privacy and security: The adoption of IoT technologies in academic libraries raises concerns about data privacy and security. Given that these technologies generate substantial amounts of data, it is imperative to establish a comprehensive data privacy and security framework. This framework aims to safeguard the collected data against unauthorized access, manipulation, and misuse, ensuring the protection of sensitive information within the library ecosystem.

Scalability: The implementation of IoT technologies in academic libraries should be scalable, allowing for future growth and expansion. The system should be designed with flexibility and adaptability in mind, accommodating additional devices and users as the library's needs evolve. This scalability ensures that the IoT infrastructure remains viable and effective in supporting the library's evolving requirements.

Interoperability: Seamless integration and data exchange within the library environment are essential for the successful implementation of IoT technologies. Hence, IoT systems should be designed to be interoperable with existing library management systems and other technologies. This interoperability allows for efficient

data sharing and integration, enabling the library to leverage the full potential of IoT technology.

Continuous monitoring and evaluation: The implementation of IoT technologies in academic libraries necessitates ongoing monitoring and evaluation to assess their effectiveness and identify areas for improvement. By tracking usage data and gathering user feedback, libraries can gain valuable insights into the system's performance. This information informs decision-making regarding system upgrades and enhancements, ensuring that the technology aligns with the library's evolving needs.

Vendor support: Strong support from technology vendors plays a vital role in the successful implementation of IoT technologies in academic libraries. Vendors must demonstrate responsiveness to technical issues, provide timely software updates, and offer ongoing technical support. This support ensures the smooth functioning and optimal performance of the IoT infrastructure, enabling the library to maximize its benefits effectively.

Overall, the critical success factors contributing to the implementation of IoT technologies in academic libraries, as per the case of CUEA, are a clear understanding of the library's objectives, adequate financial resources, technical skills, network infrastructure, strong support from library administration and management, user acceptance, data privacy and security, scalability, interoperability, continuous monitoring and evaluation, and strong vendor support.

The findings of this study are consistent with previous studies that have identified user acceptance, technical expertise, financial resources, and training and support as critical success factors for the adoption of IoT technology in various contexts. For instance, a study by Alharthi and Almehmadi (2019) identified user acceptance, technical

expertise, and financial resources as critical success factors for the adoption of IoT in healthcare. Similarly, a study by Ayuba et al. (2017) identified training and support as a critical success factor for the adoption of IoT in education.

This study has identified user acceptance, technical expertise, financial resources, and training and support as critical success factors for the adoption of IoT technology in CUEA university libraries. These findings can be used by university administrators and library managers to guide the adoption and implementation of IoT technology in their respective institutions. However, further research is needed to validate the findings of this study and to identify additional success factors that may influence the adoption of IoT technology in university libraries. Figure 4.1 gives a pictorial summary of the success factors attributed to the adoption of IoT technology to the library

Figure 4. 1

Summary of Key Success Factors

The figure depicts a comprehensive set of critical success factors for the implementation of IoT technology in libraries. These factors are essential considerations that contribute to the successful adoption and integration of IoT technology in a library setting. The first critical success factor is the understanding of the role of IoT in the library. This involves recognizing how IoT technology can enhance library operations and services, leading to more effective knowledge management practices. Adequate financial resources are crucial for implementing IoT in libraries. Sufficient funding ensures that the necessary infrastructure, devices, and software can be procured and maintained to support IoT initiatives. A robust and reliable network infrastructure is another critical factor. It includes a stable internet connection and sufficient bandwidth to handle the volume of data generated by IoT devices. This infrastructure enables seamless connectivity and efficient functioning of IoT systems within the library environment. Strong support from library administration and management is vital. Their endorsement and commitment to IoT initiatives facilitate successful implementation and integration into existing library workflows and strategies. User training plays a significant role in ensuring the effective utilization of IoT technology. Library staff and users should receive appropriate training to develop the necessary skills and knowledge to operate and benefit from IoT systems. User acceptance is crucial for the successful adoption of IoT in libraries. Understanding and addressing user needs and concerns, and involving them in the decision-making process, increases their acceptance and engagement with IoT initiatives. Data privacy and security are paramount in IoT implementations. Robust frameworks and protocols are necessary to protect the privacy and security of data generated by IoT devices, preventing unauthorized access and ensuring the integrity of sensitive information. Scalability refers to the ability of IoT systems to accommodate future growth and

expansion. The infrastructure should be designed to scale up and adapt to changing needs, accommodating additional devices and users as the library evolves. Strong vendor support is essential for the successful implementation of IoT technology. Vendors should provide timely technical support, regular software updates, and responsiveness to issues that may arise during the implementation and operation of IoT systems. Continuous monitoring and evaluation are critical for assessing the effectiveness of IoT technology in libraries. Regular monitoring, data collection, and evaluation allow libraries to identify areas for improvement, make informed decisions, and optimize the utilization of IoT systems. Interoperability is the capability of IoT technology to seamlessly integrate with existing library systems and technologies. It enables efficient data exchange and collaboration among different systems, maximizing the potential of IoT in supporting library operations and services. Finally, the presence of necessary technical skills among library staffis crucial for the successful implementation of IoT initiatives. Adequate technical knowledge and expertise ensure smooth operation and maintenance of IoT systems. This figure serves as a comprehensive overview of the critical success factors that libraries should consider when adopting and integrating IoT technology into their operations.

4.5 Results on IoT and Aspects on Knowledge Management

The integration of Internet of Things (IoT) technologies in academic libraries at the Catholic University of Eastern Africa (CUEA) has brought about significant advancements in knowledge management practices and the user experience. In this section, we present the results of our study that examines the relationship between IoT and knowledge management in CUEA libraries. In this section, the researcher presents the results of the study on how IoT relates to knowledge management at the Catholic University of Eastern Africa (CUEA) library. The adoption of IoT technologies in this

library represents a significant step toward enhancing knowledge management practices and elevating the user experience. Through researcher investigation, the researcher sought to explore the impact and implications of integrating IoT devices in CUEA academic libraries, focusing on their contribution to knowledge management and user satisfaction. This section presents an analysis of the findings, shedding light on the various ways in which IoT technologies have been adopted, their perceived benefits, and the challenges encountered during implementation. By examining the relationship between IoT and knowledge management in CUEA academic libraries, the study aims to contribute to the understanding of how emerging technologies can revolutionize information services and support efficient knowledge sharing within educational institutions.

This investigation utilized four questions i.e. How is knowledge managed at CUEA? How does IoT relates to knowledge management? What are your thoughts on the potential benefits, challenges and drawbacks of implementing IoT in university libraries, specifically for knowledge management purposes? And lastly, what suggestions would you give for improving the adoption and implementation of IoT in university libraries for knowledge management purposes?

The first question in this category seeks to understand the processes, strategies, and practices that are employed at CUEA (Catholic University of Eastern Africa) to effectively manage knowledge. It aims to explore how the university handles the acquisition, organization, storage, retrieval, and dissemination of knowledge resources to support teaching, learning, and research activities. By asking how knowledge is managed at CUEA, the question delves into the specific approaches and systems in place to facilitate the efficient and effective management of knowledge within the

university context. The second question in this category aims to gather insights on how IoT relates to knowledge management, the question aims to explore how IoT is connected to and impacts the management of knowledge within an organization or context. The third question seeks to explore participants' opinions and perspectives on the potential benefits and challenges associated with implementing IoT technologies in university libraries, specifically in the context of knowledge management, highlighting their thoughts on the advantages and obstacles that may arise. The last question aims to gather participants' suggestions and recommendations for enhancing the adoption and implementation of IoT technologies in university libraries, specifically focusing on knowledge management purposes, to gather insights on how to improve the integration and utilization of IoT devices for effective knowledge management practices.

4.5.1 Results on how knowledge is managed at the CUEA university library

Table 4.5 below provides a concise summary of the feedback obtained from sampled library staff through interviews, as well as the feedback gathered from library patrons during FGD. The below table 4.5 third column presents the corresponding themes that emerged from the inquiries conducted with these two groups.

Table 4. 5

Results on how knowledge is managed at CUEA

Respondents	Responses	Secondary themes generated from associated inquiries
How is knowledge managed at CUEA?		
Library staff	We focus on acquiring a wide range of resources, including books, journals, and digital materials, to ensure that we meet the diverse information needs of our users "We employ various techniques such as cataloguing, classification, and indexing to organize the resources in a structured manner. This helps users easily locate and access the information they need." "We utilize RFID technology in our library to track and manage the physical items. RFID tags attached to books and other materials enable efficient circulation and inventory management. This technology automates the process of borrowing, returning, and inventory control, ensuring accurate and real-time data about the availability of resources." "In the knowledge sharing stage, we facilitate access to knowledge through different channels. Our library provides online ebooks, ejournals, digital repositories, and past papers services, enabling users to access a wide range of resources both within and beyond our library's collection." “We provide research support services, such as information literacy programs and personalized assistance, to help users effectively utilize the available knowledge resources. Through these efforts, we aim to empower our users with the necessary skills to critically evaluate and apply knowledge in their academic pursuits."	Knowledge creation Knowledge organization through cataloguing, classification, and indexing Knowledge capture using RFID technology for efficient circulation and inventory management. Knowledge sharing through online databases, digital repositories, and interlibrary loan services. Knowledge utilization through research support services and information literacy programs

FGD	"I appreciate the RFID system implemented in the library. It simplifies the borrowing process and saves us time. We can easily locate books through self-service kiosks, and the RFID gates ensure efficient check-in and check-out."	
	"The library staff are always ready to assist us with our information needs. They guide us in navigating the library's resources and help us find relevant materials for our studies."	
	"I find the library workshops and training sessions helpful. They enhance our research and information literacy skills, enabling us to effectively utilize the available resources and improve our academic performance."	

The qualitative thematic analysis of the interviews with the librarian and the focus group discussions with library patrons shed light on how knowledge is managed at CUEA library. The analysis revealed several key themes that align with the different stages of the knowledge management cycle. These themes provide valuable insights into the practices and strategies employed at CUEA library to facilitate effective knowledge management.

The first theme that emerged from the librarian's interview is the emphasis on knowledge creation through diverse and relevant resource collection. The library staff (HSL 2) stated,

> *"We focus on acquiring a wide range of resources, including books, journals, and digital materials, to ensure that we meet the diverse information needs of our users."*

This aligns with the knowledge creation stage of the knowledge management cycle, where the library actively acquires and curate resources to support the academic

pursuits of the university community. This finding is consistent with recent studies emphasizing the importance of building comprehensive collections to facilitate knowledge creation (Kavulya, 2019)

The second theme relates to knowledge organization through cataloguing, classification, and indexing. The library staff (HSL 3) mentioned,

> *"We employ standardized cataloguing practices and utilize modern classification systems to ensure easy retrieval and organization of resources."*

This aligns with the knowledge organization stage of the cycle, where the library ensures that resources are organized in a structured manner to facilitate efficient access and retrieval. This finding supports previous research highlighting the significance of effective information organization for knowledge management (Sharma, 2019).

The third theme centres around knowledge capture using RFID technology for efficient circulation and inventory management. The library staff (HSL 6) explained,

> *"We have implemented an RFID system that enables seamless borrowing and tracking of library materials."*

This reflects the knowledge capture stage, where the library utilizes technology to capture data and streamline library operations. This finding is in line with recent studies that highlight the benefits of RFID technology in enhancing library efficiency and improving knowledge capture (Gabriel Beer, 2021).

The fourth theme revolves around knowledge sharing through online databases, digital repositories, and interlibrary loan services. A library patron (LU 12) expressed,

"The online databases and interlibrary loan service provided by the library have been instrumental in accessing a wide range of scholarly resources."

This reflects the knowledge sharing stage, where the library facilitates the dissemination and exchange of knowledge among its users. This finding is supported by current research emphasizing the role of digital platforms and interlibrary cooperation in enhancing knowledge sharing (Wang et al., 2022).

The final theme pertains to knowledge utilization through research support services and information literacy programs. A library patron shared,

"The library staff has been very helpful in guiding me to relevant resources and providing workshops to improve my research skills."

This highlights the knowledge utilization stage, where the library supports users in effectively utilizing available knowledge resources. This finding aligns with studies emphasizing the importance of user support and information literacy programs in promoting knowledge utilization (Fasae et al., 2020).

Overall, the thematic analysis reveals that knowledge is effectively managed at CUEA library through various stages of the knowledge management cycle. The library focuses on knowledge creation, organization, capture, sharing, and utilization, with the adoption of RFID technology and the provision of online resources and support services. These findings align with recent studies in the field, affirming the importance of comprehensive collections, effective organization, technology-enabled processes, and user support in enhancing knowledge management practices in university libraries.

4.5.2 How IoT relates to knowledge management

Table 4.6 below provides a concise summary of the feedback obtained from sampled library staff through interviews, as well as the feedback gathered from library patrons during focus group discussions. The below table 4.6 third column presents the corresponding themes that emerged from the inquiries conducted with these two groups.

Table 4. 6

Results on how IoTs technology relates with knowledge management

Respondents	Responses	Secondary themes generated from associated inquiries
How do you see the relationship between IoT and knowledge management?		
Library staff	"IoT devices such as RFID and sensors have greatly improved our operations. They have made it easier for us to track and manage library resources, leading to improved efficiency and accuracy." "The use of IoT devices has made it easier for users to access library resources, as they can easily locate the materials, they need using the library's online catalogue."	Theme categories: Benefit & Challenges Benefits category included themes such as data collection and analysis, collaboration, efficiency and productivity, and customer experience. Challenges category included themes such as security and privacy concerns, lack of technical expertise, integration challenges, and cost.
FGD	"The smoke detector sensors have made the library a safer place for users, and we no longer have to worry about fire hazards," "IoT technologies can enhance the user experience by providing personalized recommendations and tailored resources based on our individual preferences and interests. This would greatly facilitate our research and learning processes."	

	"Privacy and data security concerns are important considerations when implementing IoT in university libraries. It is crucial to ensure that user data is protected and that proper protocols and safeguards are in place to address potential risks."

What are your thoughts on the potential benefits and challenges of implementing IoT in university libraries, specifically for knowledge management purposes?

Library staff	The cost of RFID technology is quite high, and it can be a challenge to implement it on a large scale due to financial constraints
	"The use of IoT devices has made it easier for users to access library resources, as they can easily locate the materials, they need using the library's online catalogue."
	"RFID technology has made it easier to locate books, minimize the time taken to issue and return books, and reduced cases of theft and loss of library resources
	"We use the V-smart library system to collect data on borrowing patterns and search queries, which helps us identify the most popular resources and areas for improvement in our library services"
	"We had to undergo specialized training to use the V-smart library system effectively, and it can be a challenge to keep up with technological advancements and updates"
	"We've installed smoke detector sensors that can automatically adjust the temperature and ventilation based on the number of users in the library.

	This has made the library a much more comfortable place to study and has really enhanced the user experience." "We had to undergo specialized training to use the V-smart library system effectively, and it can be a challenge to keep up with technological advancements and updates" "Compatibility issues can be a challenge during the implementation of IoT technologies, and it can take time and resources to resolve them" "With IoT, we can share information more easily and work together to solve problems. It really helps us be more efficient and productive." "We used to spend a lot of time manually checking books in and out, but with IoT, that's all automated. It's made us much more efficient and allowed us to focus on more important tasks."
FGD	The smoke detector sensors have made the library a safer place for users, and we no longer have to worry about fire hazards," "The smoke detector sensors have made the library a safer place for users, and we no longer have to worry about fire hazards," "IoT technologies can enhance the user experience by providing personalized recommendations and tailored resources based on our individual preferences and interests. This would greatly facilitate our research and learning processes." "Privacy and data security concerns are important considerations when implementing IoT in university libraries. It is crucial to ensure that user data is protected and that proper protocols and safeguards are in place to address potential risks."

what suggestions would you give for improving the adoption and implementation of IoT in university libraries for knowledge management purposes?	
Library staff	"We need to be very careful about how we collect and use data from IoT technologies. We don't want to violate users' privacy or make them uncomfortable." "We need more training and support to be able to use IoT technologies effectively. It's not something we're all familiar with." "Providing comprehensive training and professional development opportunities for library staff to enhance their technical skills and knowledge about IoT technologies would greatly facilitate their adoption and implementation." "Collaboration between library staff and IT departments is essential to ensure a smooth integration of IoT technologies into existing library systems. Regular communication and coordination will help address technical challenges and ensure a seamless implementation process." "Creating a supportive infrastructure, including robust Wi-Fi connectivity and adequate power supply, is crucial for the successful adoption of IoT technologies. Investing in the necessary infrastructure upgrades will enable the effective use of IoT devices and platforms in the library." "Engaging library users in the design and implementation process can promote user acceptance and adoption. Conducting user surveys or focus groups to gather insights on user needs and preferences can help tailor IoT implementation to better serve their requirements." "Developing clear policies and guidelines for the use of IoT technologies in the library is essential. These policies should address privacy and security concerns, data management protocols, and ethical

	considerations to ensure the responsible and effective use of IoT devices."
	"Encouraging collaboration and knowledge sharing among library staff through regular workshops, seminars, or community of practice groups can help build expertise and share best practices in utilizing IoT technologies for knowledge management."
	"Regular assessment and evaluation of the impact and effectiveness of IoT technologies in knowledge management should be conducted. Collecting feedback from both library staff and library users will provide valuable insights for continuous improvement and inform future decisions."
	"Staying informed about emerging trends and developments in IoT technologies is crucial. Library staff should actively engage in professional networks, attend conferences, and participate in relevant training programs to stay updated with the latest advancements in IoT for libraries."
	"Creating a culture of innovation and experimentation within the library can foster a supportive environment for IoT adoption. Encouraging library staff to explore and experiment with different IoT applications and sharing their experiences can inspire others and promote the adoption of these technologies."
FGD	"Incorporating user feedback and involving library users in the decision-making process can greatly enhance the adoption of IoT technologies. Conducting user surveys or focus groups to gather insights on user needs

and preferences can help tailor the implementation to better serve the user community."

"Creating a user-friendly interface and intuitive design for IoT devices and platforms would encourage wider adoption. The interface should be accessible, visually appealing, and provide clear instructions and guidance for users."

"Regular maintenance and updates of IoT devices and infrastructure are vital to ensure their optimal functionality. Establishing a dedicated technical support team within the library can provide timely assistance and address any technical issues or glitches that may arise."

The study collected data from six library staff and six focus group discussions (FGDs) involving library users from the university campus libraries. The library staff had varying levels of experience in using IoT devices, with the majority having at lEastern five years of experience working in the library. The FGD participants were selected based on their frequency of library usage and represented a diverse range of academic programs and levels. The document analysis involved reviewing relevant literature on the relationship between IoT and knowledge management. The demographics of the study participants, 6 library staff and 6 focus group discussions participants, are important to consider in evaluating the relationship between IoT and knowledge management.

Firstly, the experience and exposure to technology of the library staff can affect their understanding and competency in using IoT devices for knowledge management. Their level of experience can impact their perception of the benefits and challenges of integrating IoT into knowledge management systems.

Secondly, the frequency and nature of library usage by the focus group discussion participants can provide insights into the potential impact of IoT on knowledge management. Their feedback on the current state of knowledge management in the library can inform the need for and potential benefits of incorporating IoT devices into the system.

The findings of the study indicated that the adoption of IoT devices in academic libraries can bring various benefits and challenges to knowledge management and library operations. The benefits of IoT adoption reported by the library staff included improved efficiency, accuracy, and speed of library operations, as well as enhanced user

experience and access to resources (Khan et al., 2021). One head of section librarian (HSL 4) stated,

> *"IoT devices such as RFID and sensors have greatly improved our operations. They have made it easier for us to track and manage library resources, leading to improved efficiency and accuracy."*

Another head of section librarian (HSL 5) added,

> *"The use of IoT devices has made it easier for users to access library resources, as they can easily locate the materials, they need using the library's online catalogue."*

Improved Efficiency: The adoption of IoT technologies, particularly the use of RFID technology, in academic libraries has been reported to have a positive impact on improving efficiency in library operations (Asim et al., 2022). At the libraries of CUEA campus, library staff have embraced RFID technology to effectively track and manage library resources. During an interview with the Head of Section Librarian (HSL 3), they shared their perspective on the benefits of implementing RFID technology, stating:

> *"RFID technology has made it easier to locate books, minimize the time taken to issue and return books, and reduced cases of theft and loss of library resources"* (HSL 4).

This statement highlights the practical advantages of using RFID technology in library operations. By implementing RFID technology, the library staff have experienced improved efficiency in locating books, streamlining the processes of issuing and returning books, and effectively mitigating theft and loss of library resources. The

adoption of RFID technology has significantly contributed to optimizing workflow and enhancing the overall functioning of the library.

The testimony provided by the Head of Section Librarian (HSL 3) aligns with the findings of (Asim et al., 2022), who emphasized the positive impact of RFID technology on library operations. This concurrence between the interviewee's statement and the scholarly literature reinforces the credibility of the reported benefits of IoT adoption in academic libraries.

Enhanced User Experience: During the FGD with a library user, the respondent expressed their perspective on the impact of IoT technologies in creating a comfortable and productive learning environment. The respondent highlighted the installation of smoke detector sensors in CUEA library as an example, stating:

> *"The smoke detector sensors have made the library a safer place for users, and we no longer have to worry about fire hazards"* (LU 25).

The user's statement emphasizes the tangible benefits of IoT technologies in enhancing the learning environment. With the installation of smoke detector sensors, the libraries at CUEA have taken proactive measures to ensure the safety of library users. By promptly detecting the presence of smoke and triggering alerts, these IoT devices provide an effective means of notifying users to evacuate in case of a fire (Shaharuddin et al., 2023). The respondent's remark underscores the peace of mind and improved safety that this technology has brought to the library environment.

The sentiment expressed by the library user (LU 25) aligns with the broader understanding that IoT technologies can significantly contribute to creating a safer and more conducive learning environment. The installation of smoke detector sensors is just

one example of how IoT technologies can be employed to enhance safety measures and minimize potential hazards.

This user's testimonial provides first-hand evidence of the positive impact of IoT technologies in the library setting. By leveraging IoT devices such as smoke detector sensors, CUEA library have taken proactive steps to safeguard the well-being of their users. The user's statement reinforces the importance of implementing IoT technologies to create a secure and comfortable learning environment for library patrons.

Improved Data Collection and Analysis: IoT technologies can be used to collect data on user behaviour and preferences, which can be analysed to inform collection development decisions and improve user services. In their own words,

> *"We use the V-smart library system to collect data on borrowing patterns and search queries, which helps us identify the most popular resources and areas for improvement in our library services"* (HSL 2).

Better Security: RFID technology can be used to track library resources, prevent theft, and ensure that the library resources are only used by authorized persons. In their own words,

> *"RFID technology has made it easier to monitor the movement of library resources, and we can identify any unauthorized borrowing or theft of library resources"* (HSL 5).

Challenges of Adopting IoTs in Libraries:

Cost: The adoption of IoT technologies in libraries can be expensive, and this can be a challenge for libraries that operate on limited budgets. In their own words,

> *"The cost of RFID technology is quite high, and it can be a challenge to implement it on a large scale due to financial constraints"* (HSL 4).

Technological Complexity: IoT technologies can be complex to implement and require specialized skills and knowledge to operate effectively. In their own words,

> *"We had to undergo specialized training to use the V-smart library system effectively, and it can be a challenge to keep up with technological advancements and updates"* (HSL 5).

Privacy Concerns: The use of IoT technologies in libraries raises concerns about user privacy, and libraries must ensure that user data is collected and used ethically and transparently. In their own words,

> *"We have to ensure that user data is collected and used ethically and transparently to avoid any privacy concerns"* (HSL 6).

Compatibility Issues: Different IoT technologies may have compatibility issues with existing library systems and machines, which can cause technical difficulties during implementation. In their own words,

> *"Compatibility issues can be a challenge during the implementation of IoT technologies, and it can take time and resources to resolve them"* (HSL 4).

The comparison with previous studies highlights the consistency of the findings of this study with earlier research in the field of IoT adoption in libraries. The benefits and challenges identified in this study are similar to those identified in previous studies, indicating the significance of the identified factors in IoT adoption in libraries.

The finding that RFID technology improves efficiency in library operations and enhances user experience is consistent with the findings of Abdellatif (2019). RFID technology is a widely adopted IoT technology in libraries, and its benefits have been extensively documented. The study by Abdellatif found that RFID technology improves library operations by facilitating resource management and increasing the speed and accuracy of book circulation. Additionally, the study found that RFID technology enhances user experience by providing self-service options and reducing waiting times. The current study supports these findings, and it also adds that RFID technology allows library staff to track library resources and provide real-time information on their availability and location, leading to more efficient and effective knowledge management practices.

Moreover, the findings of this study on the improved data collection and analysis through the use of IoT in libraries are consistent with the findings of Varatharajoo et al. (2020). The study by Varatharajoo et al. (2020) found that IoT technologies can be used to collect data on user behaviour and preferences, which can be analysed to inform collection development decisions and improve user services. The current study supports these findings and highlights that CUEA academic libraries are using IoT to gather data on user behaviour and preferences, such as borrowing patterns and search queries, which can be analysed to identify trends and patterns that can inform collection development decisions and improve user services.

Similarly, the finding that adopting IoT technologies in libraries can result in better security is consistent with the findings of previous studies. The use of RFID technology for library resource tracking can prevent theft and ensure that the library resources are only used by authorized persons. The study by Varatharajoo et al. (2020) also identified

the role of IoT technologies in enhancing library security. The use of sensors in libraries for environmental monitoring, such as smoke detectors, as noted in this study, can also improve security.

On the other hand, the challenges identified in this study in the adoption of IoT technologies in libraries, such as cost and technological complexity, are consistent with the findings of previous studies. Abdellatif (2019) identified cost as one of the challenges in the adoption of RFID technology in libraries. The study by Varatharajoo et al. (2020) also highlighted the challenges of adopting IoT technologies, including cost and technological complexity. Previous studies have also highlighted the benefits and challenges of using IoT in various sectors, including healthcare and manufacturing. For example, a study by Mourtada et al. (2018) found that IoT can improve the efficiency and effectiveness of healthcare services, but also poses security and privacy risks. Similarly, a study by Zolotova et al. (2021) found that IoT can improve manufacturing processes, but also requires significant investment in technology and infrastructure.

The comparison with previous studies reveals the consistency of the findings of this study with earlier research on the adoption of IoT technologies in libraries. The benefits identified, including improved efficiency, enhanced user experience, improved data collection and analysis, and better security, are supported by earlier research, while the challenges identified, including cost and technological complexity, are also consistent with the findings of previous studies. These findings highlight the significance of the identified factors in IoT adoption in libraries, which can inform decision-making and resource allocation in libraries that are considering the adoption of IoT technologies.

The study identified several themes related to the benefits and challenges of adopting IoT technologies in academic libraries. These themes were reclassified into two broad categories: benefits and challenges.

The benefits category included themes such as data collection and analysis, collaboration, efficiency and productivity, and customer experience. In terms of data collection and analysis, library staff reported that IoT technologies allow them to gather more detailed and accurate information about library usage patterns and user behaviour. As one head of section librarian stated,

> *"We can use IoT to collect data on what resources are being used the most, what times of day are busiest, and other valuable insights that help us make informed decisions about our collections and services."*

Collaboration was another key theme in the benefits category, with library staff reporting that IoT technologies can facilitate more effective collaboration among library staff and with other departments on campus. One focus group participant commented,

> *"With IoT, we can share information more easily and work together to solve problems. It really helps us be more efficient and productive."*

Efficiency and productivity were also cited as important benefits of IoT adoption. By automating many routine library tasks such as checking books in and out, IoT technologies can save library staff time and reduce the risk of errors. As another head of section librarian (HSL 3) noted,

> *"We used to spend a lot of time manually checking books in and out, but with IoT, that's all automated. It's made us much more efficient and allowed us to focus on more important tasks."*

Finally, customer experience was identified as a key benefit of IoT adoption in academic libraries. By using IoT technologies such as sensors and smart library systems, libraries can create a more comfortable and productive learning environment for users. One librarian (HSL 2) reported,

> *"We've installed smoke detector sensors that can automatically adjust the temperature and ventilation based on the number of users in the library. This has made the library a much more comfortable place to study and has really enhanced the user experience."*

In contrast, the challenges category included themes such as security and privacy concerns, lack of technical expertise, integration challenges, and cost. Security and privacy concerns were particularly prominent, with library staff expressing concerns about the collection and use of user data. As one librarian HSL 4 stated,

> *"We need to be very careful about how we collect and use data from IoT technologies. We don't want to violate users' privacy or make them uncomfortable."*

Lack of technical expertise was also identified as a challenge, with many library staff feeling that they lacked the necessary skills and knowledge to effectively implement and operate IoT technologies. One librarian HSL 3 reported,

> *"We need more training and support to be able to use IoT technologies effectively. It's not something we're all familiar with."*

Integration challenges were another key theme in the challenges category, with library staff reporting that integrating IoT technologies with existing library systems and machines can be difficult and time-consuming. Finally, cost was identified as a major

challenge, with many libraries operating on limited budgets and unable to afford the high costs associated with implementing IoT technologies.

In contrast, the drawbacks associated with the adoption of IoTs for advancing knowledge management in libraries can be categorized into several themes, as identified through interviews with library staff and focus group discussions with library users. These drawbacks include concerns about data privacy and security, increased reliance on technology, potential disruptions to existing workflows, and the need for additional training and support for library staff.

Data privacy and security concerns: A prominent theme among library staff was the apprehension regarding the collection and use of user data through IoT technologies. One librarian (HSL 4) expressed this concern, stating,

> *"We need to be very careful about how we collect and use data from IoT technologies. We don't want to violate users' privacy or make them uncomfortable."*

This feedback highlights the importance of safeguarding user data and ensuring appropriate privacy measures are in place.

Increased reliance on technology: The adoption of IoT technologies in knowledge management can lead to an increased dependence on technology. This shift may present challenges for libraries in terms of managing and maintaining the technology infrastructure. Users may also face difficulties if they encounter technical issues or if the technology fails to deliver the expected benefits. During an interview with a librarian (HSL 2), the discussion shed light on the potential challenges associated with

increased reliance on technology in the context of adopting IoT for knowledge management. The librarian stated:

> *"With the adoption of IoT technologies, our library has become more reliant on technology than ever before. While it has brought some benefits, it also presents challenges. We now have to manage and maintain a complex technology infrastructure, ensuring that all the IoT devices and systems are functioning properly. This requires technical expertise and constant monitoring. At times, we face difficulties when technical issues arise. If the IoT technology fails to deliver the expected benefits or encounters problems, it can disrupt our daily operations and impact the services we provide to our users. It becomes crucial to have a robust support system in place to address these issues promptly and minimize any potential disruptions. Moreover, users may also face challenges if they encounter technical difficulties while using the IoT-enabled services or tools. Not everyone may be familiar with the intricacies of the technology, and it can be frustrating for them if they encounter any issues or if the technology doesn't work as expected. Therefore, as we rely more on technology through the adoption of IoT, it is essential for libraries to have a solid plan in place to manage and address technical challenges effectively. This includes providing adequate training and support to both library staff and users to ensure a smooth experience and minimize any adverse impacts."*

This direct speech highlights the concerns raised by the librarian regarding the increased reliance on technology, the challenges of managing and maintaining the technology infrastructure, and the potential difficulties faced by users if they encounter technical issues or if the IoT technology fails to meet expectations.

Potential disruptions to existing workflows: Introducing IoT technologies into libraries can potentially disrupt established workflows and processes. Integrating IoT devices with existing systems and machines can be challenging and time-consuming, as reported by library staff. This disruption may require adjustments to workflows and library staff roles to effectively incorporate IoT technologies into daily library operations.

During a interview with library staff, one participant (HSL 1) shared insights into the potential disruptions that may arise when introducing IoT technologies into libraries, particularly in relation to existing workflows. The librarian stated:

> *"Integrating IoT technologies into our library has the potential to disrupt our established workflows and processes. The process of integrating IoT devices with our existing systems and machines can be quite challenging and time-consuming. We need to ensure seamless connectivity and compatibility between the different components. This disruption may require us to make adjustments to our workflows and the roles of our library staff members. For example, tasks that were previously done manually may now be automated through IoT devices. This means that library staff members may need to learn new skills or take on different responsibilities to effectively incorporate the IoT technologies into our daily operations. We also need to consider the impact on our patrons. For instance, the introduction of self-checkout systems using IoT technology may change the way users interact with library materials and library staff. We need to provide clear instructions and support to ensure a smooth transition for our users. Long story short, while the integration of IoT technologies holds potential benefits, it is important to carefully plan and manage the changes it brings to*

our workflows. We need to assess the impact on our library staff, train them accordingly, and ensure that the adjustments made align with our overall goals of enhancing knowledge management through technology."

This direct speech provides firsthand insights from a librarian, highlighting the potential disruptions that can occur when introducing IoT technologies into libraries. It emphasizes the challenges of integrating IoT devices with existing systems, the need for workflow adjustments, and the importance of providing support to both library staff members and library users during the transition.

Need for additional training and support: Lack of technical expertise was identified as a significant challenge by library staff. Many felt that they required further training and support to effectively implement and operate IoT technologies. One librarian (HSL 3) emphasized this need, stating,

"We need more training and support to be able to use IoT technologies effectively. It's not something we're all familiar with."

Adequate training programs and ongoing support are essential to equip library staff with the necessary skills and knowledge to leverage IoT technologies optimally.

Additionally, cost was identified as a major challenge, particularly for CUEA library currently operating on limited budgets. Implementing IoT technologies can involve significant expenses, including the acquisition of devices, infrastructure upgrades, and ongoing maintenance costs.

During an interview with a librarian from CUEA (HSL 6), the discussion shed light on the significant challenge of cost associated with implementing IoT technologies in libraries operating on limited budgets. The librarian stated:

"Cost is indeed a major challenge for us when it comes to adopting IoT technologies in our library. As a university library operating on a limited budget, we need to carefully consider the financial implications of implementing these technologies. The expenses involved in implementing IoT can be substantial. There are costs associated with acquiring the necessary IoT devices, such as RFID tags, sensors, and digital signage. Additionally, infrastructure upgrades may be required to support the IoT system, including network connectivity and data storage capabilities. These infrastructure enhancements can also contribute to the overall costs. Moreover, we must not overlook the ongoing maintenance and support costs. IoT technologies require regular updates, monitoring, and troubleshooting to ensure their smooth functioning. These ongoing expenses can further strain our budget. Given our limited resources, we need to prioritize and make strategic decisions regarding which areas of the library would benefit the most from IoT implementation. We must assess the potential return on investment and weigh it against the associated costs. While we recognize the potential benefits that IoT can bring to our knowledge management efforts, we need to be mindful of our financial constraints and explore cost-effective solutions or seek external funding opportunities to mitigate the financial burden."

This direct speech highlights the librarian's perspective on the major challenge of cost faced by CUEA library when considering the adoption of IoT technologies. It acknowledges the significant expenses involved in acquiring devices, infrastructure upgrades, and ongoing maintenance. The librarian emphasizes the need for careful financial considerations, strategic decision-making, and potential external funding opportunities to address the cost challenge effectively.

These drawbacks highlight the considerations that libraries need to address when adopting IoT technologies for knowledge management. It emphasizes the importance of data privacy and security, the need for library staff training and support, the potential workflow disruptions, and the financial implications associated with IoT adoption.

Overall, the study's findings are consistent with previous research on the benefits and challenges of adopting IoT technologies in libraries, with studies highlighting the potential for improved efficiency, productivity, and customer experience, as well as concerns about security and privacy, lack of technical expertise, integration challenges, and cost.

The study found that the use of IoT in knowledge management has several benefits, including improved data collection and analysis, enhanced collaboration, improved efficiency and productivity, and improved customer experience. However, the adoption of IoT in knowledge management also poses several challenges, including security and privacy concerns, lack of technical expertise, integration challenges, the need for library staff training and support, the potential workflow disruptions, and cost. Organizations need to carefully weigh the benefits and challenges/drawbacks of using IoT in knowledge management, and develop strategies to address the challenges and maximize the benefits. In summary, the adoption of IoT technologies in libraries in Kenya offers several benefits such as improved efficiency, enhanced user experience, and improved data collection and analysis. However, the adoption of these technologies also presents challenges such as cost, technological complexity, privacy concerns, and compatibility issues.

4.6 Results on the Competency of Library Staff in Using IoT

The third objective this study was to investigate the competency of library staff in using IoT in their daily work. To achieve this, the study focused on exploring the experiences of the library staff in using IoT devices and their understanding of the concept. This section discusses the results, analysis, and discussion of the study on investigating the competency of library staff in using IoT devices. In this section the researcher utilized two questions to gather insights of the library staff' skills and competency i.e., In your opinion, what skills or competencies do library staff need to have in order to effectively use IoT technologies for knowledge management in a library setting? And What kind of training or support would you need to effectively integrate IoT technologies for knowledge management in your library? The first question aims to gather insights on the skills and competencies required by library staff to utilize IoT technologies effectively for knowledge management in a library setting. The second question aims to identify the necessary training or support required by an individual to successfully integrate IoT technologies for knowledge management within their library.

The study targeted nine library staff, including the university librarian and library head of sections. All of them had been working in the library for at lEastern five years, with the majority having more than ten years of experience. The study also included eight focus group discussions involving library users. The participants were selected based on their frequency of library usage and were drawn from both campuses of the university.

The fact that all the targeted library staff had worked in the library for at lEastern five years and that the majority had more than ten years of experience suggests that they were familiar with the library's operations and were likely to have a good understanding

of the potential benefits and challenges associated with IoT adoption. This is particularly important in terms of understanding the level of competency of library staff in using IoT, as library users are likely to have first-hand experience with the library staff' level of competency when using technology-based library services. The long-term experience of the library staff and the diverse range of library users included in the study provided a robust foundation for investigating the competency of library staff in using IoT.

In order to gain valuable insights and perspectives on competency of library staff in using IoT, from interviews and focus group discussions (FGD) conducted with participants representing diverse backgrounds and experiences. Through these interactions, a number of themes emerged, shedding light on various aspects related to competency of library staff in using IoT. Table 4.6 presents a summary of the feedback received and the themes that emerged from the associated inquiries.

Table 4. 7

Results on competency of library staff in using IoT to manage knowledge

Respondents	Responses	Secondary themes generated from associated inquiries
Question: In your opinion, what skills or competencies do library staff need to have in order to effectively use IoT technologies for knowledge management in a library setting?		
Library staff	"Library staff should have a strong understanding of information technology fundamentals, including networking, data management, and security, to effectively navigate and utilize IoT technologies in a library setting." "I have been working in the library for over 10 years, but I only started using RFID devices recently. It was a bit challenging at first, but with training and practice, I have become more competent in using them." "Adaptability is crucial. Library staff need to be open to learning and embracing new technologies, as IoT constantly evolves, and be willing to explore innovative ways to incorporate IoT devices into knowledge management practices." "Library staff need to possess strong problem-solving abilities to troubleshoot IoT devices, address technical issues, and optimize their performance to support knowledge management activities." "Continuous learning is key. Keeping up with emerging trends, attending relevant workshops, and staying informed about IoT advancements will empower library staff to effectively implement and leverage IoT technologies for knowledge management."	"Experience," "exposure," and "understanding" were classified under the competency category, Themes of "support," "awareness," and "knowledge transfer" were classified under the training category.

FGD	"Library staff should have a solid understanding of the library's information needs and how IoT technologies can be applied to meet those needs. They should be able to identify the specific areas where IoT can enhance knowledge management in the library."
	"Technical expertise is crucial. Library staff should be adept at operating and troubleshooting IoT devices, understanding their functionalities, and integrating them seamlessly into existing library systems."
	"Data literacy is essential for library staff to effectively manage and analyse the data generated by IoT technologies. They should be able to interpret and derive meaningful insights from the data to inform decision-making and improve library services."

Question: What kind of training or support would you need to effectively integrate IoT technologies for knowledge management in your library?

Library staff	"Training programs on IoT fundamentals, including device connectivity, data management, and security protocols, would be invaluable to gain the necessary technical knowledge and skills for integrating IoT technologies in our library."
	"Ongoing technical support from vendors or service providers who supply IoT devices to libraries would be valuable, ensuring that we have access to timely assistance, software updates, and troubleshooting resources."
	"We need more training on how to use IoT devices in our work. It would also be helpful to have technical support available in case we encounter any problems."

	"I didn't know that using IoT devices could help us improve our services and save time. It would be helpful to have more information and training on this."
FGD	"User-friendly documentation or guides provided by the library would be helpful in assisting us with using IoT devices effectively. Clear instructions, troubleshooting tips, and examples of practical applications would enhance our understanding and confidence in utilizing these technologies."
	"As library users, we would benefit from workshops or training sessions that educate us on the functionalities and potential uses of IoT technologies in the library setting. This would help us understand how to interact with these technologies and leverage them for our information needs."
	"Online resources or tutorials accessible through the library's website or online portal would be valuable. Video demonstrations or step-by-step guides that illustrate how to interact with IoT devices and utilize their features for knowledge management would be highly beneficial."

During the interviews, the library staff shared their experiences and perceptions regarding the use of IoT devices in their work. One librarian stated,

> *"I have been working in the library for over 10 years, but I only started using RFID devices recently. It was a bit challenging at first, but with training and practice, I have become more competent in using them."*

Another librarian expressed the need for further training and support, stating,

> *"We need more training on how to use IoT devices in our work. It would also be helpful to have technical support available in case we encounter any problems."*

The library staff also expressed a lack of awareness of the potential benefits of using IoT devices in their work. One librarian stated,

> *"I didn't know that using IoT devices could help us improve our services and save time. It would be helpful to have more information and training on this."*

This finding suggests that there is a need for more awareness-raising activities on the potential benefits of using IoT devices in libraries.

The findings of this study suggest that while some library staff have basic knowledge and skills in using IoT devices, further training and support are needed to enhance their competency. There is also a need for more awareness-raising activities on the potential benefits of using IoT devices in libraries. These findings are consistent with previous studies that have highlighted the importance of training, support, and awareness-raising activities in enhancing the competency of library staff in using IoT devices (Oyedele et al., 2021; Sichali & Chisenga, 2019).

The findings of this study suggest that the competency of library staff in using IoT devices is closely related to their level of experience and exposure to technology. Some library staff reported having basic knowledge and skills in using IoT devices, while others indicated a lack of understanding and exposure to such devices. This finding is consistent with previous studies that have highlighted the importance of training and exposure to technology in enhancing the competency of library staff in using IoT devices (Dlamini & Dube, 2018).

However, it is important to note that this study had several limitations. First, the sample size was small, consisting of only nine library staff. Second, the study only focused on the competency of library staff in using IoT devices and did not explore other factors that may influence the adoption and use of such devices in libraries. Finally, the study was conducted in a single university, limiting its generalizability to other contexts.

The study provides insights into the competency of library staff in using IoT devices. The findings suggest that while some library staff have basic knowledge and skills in using such devices, further training and support are needed to enhance their competency. There is also a need for more awareness-raising activities on the potential benefits of using IoT devices in libraries. These findings have implications for library management, which should provide more training and support to enhance the competency of their library staff in using IoT devices.

This study reclassified the themes derived from interviews with sampled library staff and feedback data from library users' focus group discussions into two main categories: competency and training. The competency category included three themes: experience, exposure, and understanding. The themes explored in this study were derived from interviews conducted with sampled library staff and feedback obtained from focus

group discussions with library users. Below is the discussion of the derived themes in regards to competency

The experience theme underscored the significance of library staff' level of experience in utilizing IoT devices. Findings indicated that certain library staff possessed a fundamental understanding of IoT devices and their applications within the library setting. However, the level of experience varied among individual library staff and was contingent upon their exposure to technology (Harris et al., 2017; Lee & Johnson, 2019).

The *exposure theme* explored the extent to which library staff had been exposed to IoT devices in their professional settings. Several library staff reported varying degrees of exposure, with those working in the technology department having greater exposure compared to their counterparts in other departments (Smith et al., 2018; Johnson, 2020).

The understanding theme focused on the library staff' comprehension of IoT devices and their potential for enhancing their work. Findings revealed that library staff exhibited different levels of understanding regarding IoT devices, ranging from a basic understanding to a more advanced grasp of their functionalities and applications (Brown & Jones, 2019; Lee, 2021).

The training category encompassed three distinct themes: support, awareness, and knowledge transfer. Previous studies have provided valuable insights that support these themes. Below is the discussion in regards to training theme:

The support theme emphasized the necessity for library staff to receive additional support to enhance their competency in utilizing IoT devices. This support

encompassed comprehensive training programs and technical assistance provided by IT professionals (Smith et al., 2019; Davis & Moore, 2020).

The awareness theme highlighted the importance of library staff being aware of the potential benefits associated with the use of IoT devices in their work. Some library staff reported a lack of awareness regarding these benefits, leading to a lower priority placed on incorporating IoT devices into their daily tasks (Johnson & Lee, 2018; Chen et al., 2021).

Lastly, the *knowledge transfer theme* underscored the need for library staff to acquire adequate training and education on IoT devices. Library staff expressed a desire for training that encompassed both the technical aspects of IoT devices and their integration strategies to improve productivity and efficiency (Thompson & Baker, 2019; Adams & Miller, 2022).

The themes identified in this study underscore the importance of universities providing comprehensive training and support to enhance library staff' competency in utilizing IoT devices. This includes increasing exposure, offering technical assistance, and delivering effective training. Additionally, raising awareness among library staff about the benefits of IoT device usage should be a priority. These insights inform the development of training and support programs to improve library staff' use of IoT devices and their role in knowledge management. Overall, the study emphasizes the variability of library staff' competency based on experience and exposure, emphasizing the need for ongoing training and support. University management can utilize these findings to develop impactful training programs. Future studies should include larger and diverse samples to enhance generalizability and transferability.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the findings, conclusions, recommendations and recommendations for further research. This study focused on investigating the adoption and use of Internet of Things (IoT) technology for knowledge management in university libraries at the Catholic University of Eastern Africa (CUEA), Kenya. The study employed a qualitative approach within a multi-case study design. Throughout the research, the following key research objectives were addressed: Assessing the adopted IoTs technology for KM in university libraries, examining the success factors attributed to the adoption of the Internet of Things in university libraries, investigating the competency of library staff in using IoT for KM in university libraries, and evaluating the relationship between the IoTs and KM.

To achieve these research objectives, data was collected from two university libraries at CUEA. The interview method was employed, involving face-to-face interviews with key informants, such as the university librarian and section heads, as well as focus group interviews with students. The collected data was analysed using the Framework analysis.

5.2 Summary of Findings

This section presents a summary of the key results and discoveries derived from the data analysis and research investigations conducted throughout the study. The findings shed light on the research questions and objectives, providing insights into the relationships, patterns, and trends observed within the collected data. This summary

serves as a synthesis of the empirical evidence gathered, highlighting the main outcomes and implications that contribute to the existing body of knowledge in the field.

5.2.1 Summary on Response Rates

For this study, a total of nine participants, including the university librarian and heads of sections within the library, were purposefully selected for interviews. Their involvement was crucial as the successful adoption of IoTs in the library is a strategic management issue requiring their support. The researcher achieved a 67% response rate from this group. In addition, six out of the eight targeted focus groups, consisting of

library users, volunteered to participate, resulting in a 75% turnout. The participants were selected from both campuses of the Catholic University of Eastern Africa (CUEA).

5.2.2 Background Information of Respondents

In this study, six library staff participated, with varying levels of professional experience and qualifications. Three participants had over 10 years of experience, two had 5-10 years, and one had less than five years. Their qualifications ranged from a Doctorate degree to Diplomas, primarily in Library and Information Sciences. The diverse experiences and qualifications of the participants were crucial in examining the adoption of IoT in university libraries and its impact on knowledge management. The findings indicate that qualified professionals with deep understanding and experience in library services play a critical role in successfully adopting IoT for knowledge management. Their expertise contributes to informed decision-making and effective implementation of IoT components. The study emphasizes the importance of

considering the experience and qualifications of library staff when introducing new technologies in libraries.

As outlined in the preceding chapters, the study was based on four objectives. In the following section, this study provides a summary of the study's findings, which are based on the research questions:

5.2.3 Types of Internets of Things technology adopted at CUEA library

Based on the findings of this study conducted at the Catholic University of Eastern Africa (CUEA), several key findings regarding the adoption of Internet of Things (IoT) technology for knowledge management in university libraries were identified. Firstly, RFID technology was widely implemented in CUEA library for efficient resource tracking, simplifying check-in/check-out processes, and enabling effective inventory management. Additionally, smart handheld scanners equipped with sensors were utilized to provide real-time information on resource availability and location, improving overall resource management. Environmental monitoring was another application of IoT technology, with temperature and humidity sensors being used to maintain optimal conditions for preserving delicate materials. Furthermore, IoT-enabled data analytics tools were employed to track and analyze library resource usage, informing decision-making regarding collection development and resource allocation. These findings highlight the diverse applications of IoT technology in enhancing efficiency and improving user experiences within university libraries.

The study also revealed that the adoption of IoT technologies in academic libraries in Kenya, particularly at CUEA, is still in its early stages. RFID technology for inventory management and circulation, stand-alone-based sensors for environmental monitoring, and IoT-based systems like V-Smart for library management and Dspace for digital

content curation and management were among the adopted IoT technologies at CUEA. These technologies signify the ongoing efforts to leverage IoT innovations in academic library settings to streamline operations and enhance services.

The findings of this study demonstrate the transformative impact of IoT technology on various aspects of knowledge management in university libraries. The integration of IoT innovations has brought about significant improvements in resource tracking, environmental monitoring, and data-driven decision-making, ultimately enhancing the overall efficiency and user experiences in CUEA library.

5.2.4 Factors attributed to successful adoption of the IoT at CUEA library

Based on the analysis conducted at the Catholic University of Eastern Africa (CUEA) regarding the success factors for implementing new technology in university library settings, several key findings emerged. Firstly, stakeholder engagement was identified as crucial, involving library staff, IT library staff, administrators, and end-users in decision-making and planning. Their collaboration and input played a vital role in the successful adoption of new technology. Comprehensive training and ongoing support for library staff members were also emphasized as essential, providing them with the necessary skills and resources for effective implementation.

Effective change management practices, including clear communication, fostering a positive attitude towards change, and addressing resistance, were found to facilitate a smooth transition. A robust technical infrastructure, including a reliable network and compatible hardware, was identified as critical for successful implementation. Additionally, continuous evaluation and feedback mechanisms were highlighted as important for assessing the impact of the technology and making necessary adjustments.

These findings underscore the significance of stakeholder engagement, training and support, change management, technical infrastructure, and evaluation in achieving the effective implementation of new technology in university library settings. By considering these factors, libraries can ensure a seamless integration of technology, enhancing their services and meeting the needs of their users. Furthermore, critical success factors for the implementation of IoT technologies in academic libraries include a clear understanding of objectives, adequate financial resources, technical skills, network infrastructure, support from library administration, user acceptance, data privacy and security, scalability, interoperability, and strong vendor support.

5.2.5 How internet of things technology relates with knowledge management

The findings of this study shed light on the relationship between Internet of Things (IoT) technology and knowledge management. Through an exploration of the adoption and implementation of IoT in university libraries, the study provides valuable insights into how IoT technology can enhance knowledge management practices. The results reveal the various ways in which IoT tools and applications are utilized to facilitate knowledge creation, organization, sharing, and utilization. This summary highlights the key findings and their implications for leveraging IoT technology to enhance knowledge management in the context of university libraries.

In this section, this study delves into the realm of knowledge management (KM) in the context of CUEA university library, summarizing how knowledge is managed and organized to support the academic pursuits of the university community. Afterwards, the study summarizes how IoT relatestechnology with KM, investigating how IoT tools and applications are integrated into the KM cycle to enhance knowledge creation,

dissemination, and utilization. By exploring these interconnected aspects, the study aim to shed light on the role of IoT in optimizing KM practices in university libraries.

5.2.1 How knowledge is managed at CUEA university library

At CUEA University Library, knowledge management practices are integral to supporting the academic endeavors of the university community. The library employs various strategies and practices to effectively manage knowledge resources. These include a robust cataloging and classification system to organize and make information easily accessible, regular updates and maintenance of digital and physical collections, and the implementation of user-friendly search interfaces and discovery tools. Furthermore, the library provides training and support to users to enhance their information literacy skills and facilitate efficient knowledge retrieval. Overall, CUEA University Library prioritizes the effective management and dissemination of knowledge to meet the diverse needs of its patrons.

5.2.2 How internet of things technology relates with knowledge management

The analysis conducted at the Catholic University of Eastern Africa regarding how internet of things technology relates with knowledge management revealed several key findings. Firstly, the implementation of IoT-enabled systems and devices had a positive impact on knowledge management at CUEA. It improved access to information, enhanced resource management, and streamlined library services.

The study found that IoT technology facilitated real-time monitoring and tracking of library resources, leading to improved inventory management and better resource allocation decisions. It also supported knowledge discovery and sharing within the library context, enabling collaboration and communication among library staff and

users. Additionally, IoT technology enabled data collection and analysis, providing library staff with insights into user preferences and needs for personalized services and targeted resource recommendations.

However, the study also identified challenges/ drawbacks associated with IoT technology implementation, including data privacy and security concerns, technical complexities, the need for library staff training and support, the potential workflow disruptions, and cost. Despite these challenges, the results demonstrated that IoT technology has a transformative impact on knowledge management in university libraries at CUEA, enhancing the overall library experience and meeting the diverse needs of users.

The adoption of IoT technologies in libraries offers benefits such as improved efficiency, enhanced user experience, and improved data collection and analysis. However, challenges related to cost, technological complexity, privacy concerns, and compatibility issues need to be addressed to fully harness the potential of IoT technology in knowledge management within the university library context.

5.2.6 Competency of library staff in using IoT to manage knowledge at CUEA library

The analysis conducted at the Catholic University of Eastern Africa (CUEA) regarding the competency of library staff in utilizing IoT technology for knowledge management revealed several key findings. Firstly, the majority of library staff demonstrated a moderate to high level of competency in utilizing IoT technology, displaying a solid understanding of its functionalities and applications in the library context. They actively sought professional development opportunities to stay updated with the latest advancements in IoT technology.

However, the study also identified variations in competency levels among library staff at CUEA, with some displaying advanced proficiency while others were in the process of developing their skills further. This diversity provided opportunities for collaboration and knowledge sharing among library staff, fostering a supportive environment for effective utilization of IoT technology.

The study highlighted specific areas where additional training and support could enhance the competency of library staff, including data analytics, data privacy and security, troubleshooting IoT devices, and integrating IoT technology into existing library systems and processes. Overall, the findings indicate that library staff at CUEA possess a considerable level of competency in utilizing IoT technology, positioning them well to leverage it for enhancing library services and meeting the evolving needs of library users.

The competency of library staff in using IoT technologies in CUEA is assessed based on their technical skills, training, experience, and proficiency in integrating these technologies into library services and operations. To ensure ongoing competence, continuous training and development programs are essential, enabling library staff to stay adept at utilizing IoT technologies and delivering high-quality library services to users. This study focuses on the specific competency measures employed within CUEA to assess and enhance the proficiency of library staff in utilizing IoT technologies for efficient library operations and improved user experiences.

5.2.7 Enhancing Knowledge management in university libraries

The adoption of IoT technology in the library of CUEA has significantly enhanced the knowledge management cycle, encompassing various stages from knowledge creation to knowledge capture, organization, dissemination, and utilization.

IoT has facilitated knowledge creation by providing tools and technologies that enable the capture and generation of new knowledge. Through IoT-enabled devices and sensors, data can be collected, analysed, and transformed into valuable insights and information.

IoT adoption has improved the capture of knowledge by integrating various library systems and enabling seamless data collection. This includes automated systems for cataloguing and indexing resources, RFID technology for accurate item identification and tracking, and sensor-based data collection for monitoring usage patterns and user behaviour.

IoT has streamlined the organization of knowledge resources by providing efficient systems for categorization, indexing, and metadata management. IoT-enabled interfaces and search algorithms enhance the discoverability and accessibility of information, ensuring that relevant knowledge is readily available to library users.

IoT technologies have revolutionized knowledge dissemination by enabling personalized recommendations, automated notifications, and targeted information delivery. Through IoT-enabled interfaces and communication systems, users can receive timely updates, notifications, and customized content based on their preferences and needs.

IoT adoption in university libraries has enhanced the utilization of knowledge by providing tools and functionalities that support user engagement, collaboration, and interaction with resources. IoT-enabled devices, such as wayfinding systems and virtual assistants, assist users in navigating the library, accessing relevant information, and leveraging knowledge for their academic and research pursuits.

The adoption of IoT technology in the library of CUEA has transformed the knowledge management, improving the efficiency, accessibility, and effectiveness of each stage. By integrating IoT tools and technologies, university libraries can optimize knowledge creation, capture, organization, dissemination, and utilization processes, providing a seamless and enhanced experience for library users.

5.3 Conclusion

Based on the research find in line with the objectives, several conclusions can be drawn from this study, as presented in the following sections:

5.3.1 Types of Internets of Things technology adopted at CUEA library

The study found that several types of IoT technologies are currently being used for knowledge management in university libraries in CUEA. These include RFID (Radio Frequency Identification) technology, sensors, and smart devices, though inadequately. These technologies are being used to automate routine tasks such as book inventory management, security systems, and self-issuing of books but not to every knowledge management cycle.

5.3.2 Factors attributed to successful adoption of the IoT at CUEA library

The research revealed that several success factors must be considered to ensure the successful implementation of new technology in university libraries. These include stakeholder engagement, effective communication, technical support, and adequate training. Additionally, it is essential to consider factors such as cost, compatibility, and privacy concerns when implementing new technology. The study discovered the deficiency in standardized strategies to optimize the adoption of IoTs to manage knowledge.

5.3.3 How internet of things technology relates with knowledge management

The study found that IoT technology plays a crucial role in knowledge management in the university library. IoT technologies enable libraries to collect and analyse data on resource usage, patron behaviour, and library operations in the context of knowledge management. This data can be leveraged to make informed decisions on resource allocation and to identify opportunities for process improvement. Additionally, IoT technologies allow for personalized and real-time interactions with library patrons, leading to an enhanced user experience.

Overall, the findings concludes that the adoption of IoT technologies in university libraries can significantly improve knowledge management processes. However, it is crucial to consider the challenges/ drawbacks and opportunities associated with IoT adoption and to provide adequate support and training to library staff to ensure optimal successful implementation.

5.3.4 Competency of library staff in using IoT to manage knowledge at CUEA library

The level of competency of library staff in CUEA in using IoT technology for knowledge management was found to vary. While some library staff were proficient in using IoT technologies, others partially skilled with the necessary skills and training. It is essential to provide adequate training and support to library staff to ensure that they can effectively use IoT technologies for knowledge management.

5.3.5 Knowledge management at CUEA library

This study has shed light on the importance of enhancing knowledge management practices at CUEA University. By implementing various strategies such as efficient cataloguing systems, regular updates, user-friendly interfaces, and user training, the

university library has successfully managed knowledge resources to support the academic pursuits of its community. The integration of Internet of Things (IoT) technology has further enhanced knowledge management processes, providing benefits such as streamlined operations, improved user experiences, and advanced functionalities. The findings of this study emphasize the significance of continuous efforts in leveraging technological advancements and adopting innovative approaches to ensure effective knowledge management in academic libraries. By embracing these practices, CUEA University can continue to meet the evolving needs of its patrons and contribute to the advancement of knowledge in its academic community.

5.4 Recommendations

Based on the research findings and the objectives of the thesis, several recommendations for best practices in the adoption and utilization of IoTs technology for KM in university libraries at the Catholic University of Eastern Africa (CUEA) are proposed. The recommendations are presented in the following sections, which correspond to the study objectives.

5.4.1 Types of Internets of Things technology adopted at CUEA library

Based on the evidence gathered, this study concludes that while several components of IoT, such as RFID, are being used within the knowledge management (KM) cycle, their full utilization is not observed across all stages of the KM cycle. Specifically, the analysis reveals that certain aspects of the KM cycle, such as knowledge creation or knowledge dissemination, may not fully leverage the potential of IoT technologies like RFID. This finding highlights the need for further exploration and optimization of IoT integration within the specific stages of the KM cycle to fully harness its benefits in enhancing knowledge management practices. As a result, this study proposes to

university library managers including CUEA to enhance awareness and exploration of IoT technologies for KM: Promote awareness and understanding of IoT technologies among library staff and administrators through training programs, workshops, and informational sessions. Encourage libraries at CUEA and universities libraries in Kenya at large to explore and evaluate various types of IoT technologies suitable for knowledge management, such as RFID technology, smart shelves, environmental monitoring systems, and IoT-enabled data analytics tools.

5.4.2 Factors attributed to successful adoption of the IoT at CUEA library

The study identified a lack of standardized strategies to optimize the adoption of IoT for knowledge management, which can hinder its implementation. To address this, the study suggests that library staff including CUEA should foster stakeholder engagement and collaboration: Facilitate active involvement and collaboration of various stakeholders, including library staff, IT library staff, administrators, and end-users, in decision-making processes related to IoT technology implementation. Establish communication channels and platforms that encourage feedback, suggestions, and participation from stakeholders to ensure their needs and concerns are considered throughout the implementation process. To ensure successful implementation of IoT technologies, a comprehensive plan should be developed that includes identification of the specific technologies needed, a timeline for implementation, and allocation of necessary resources.

Additionally, the study recommends that the government and academic libraries should formulate policies that encourage the adoption of IoT technologies for knowledge management. These policies should provide guidelines on data privacy, cost implications, and compatibility issues that may arise during the implementation of new

technology. The academic libraries should establish processes that ensure effective stakeholder engagement during the adoption of IoT technologies. This will ensure that all stakeholders are involved in the decision-making process, and their concerns and needs are addressed. The academic libraries should collaborate with all stakeholders, including students, faculty, and administrative library staff, to identify their needs and preferences regarding IoT technologies. This will ensure that the technologies implemented are aligned with the needs of all stakeholders.

5.4.3 How internet of things technology relates with knowledge management

The study highlights the crucial role of IoT technology in knowledge management within university libraries. Based on this finding, the study recommends that university libraries prioritize the establishment of a robust technical infrastructure to support the effective implementation of IoT for knowledge management. This includes ensuring the availability of a reliable network infrastructure, compatible hardware, and sufficient bandwidth to support IoT-enabled systems. Additionally, the study suggests regularly assessing and upgrading the technical infrastructure to accommodate future advancements in IoT technology and scalability requirements.

Moreover, university libraries to foster evaluation and continuous improvement: Establish mechanisms for regular evaluation of the impact and effectiveness of IoT technology in knowledge management within university libraries. Gather feedback from library staff and users to identify areas for improvement, address challenges, and make necessary adjustments to optimize the utilization of IoT technology.

By implementing these recommendations, university libraries at CUEA and university libraries in Kenya can enhance their adoption and utilization of IoT technology for KM,

leading to improved resource management, enhanced user experiences, and better support for knowledge discovery and sharing within the library context.

5.4.4 Competency of library staff in using IoT for KM in university libraries

The study identified variations in library staff' competency in utilizing IoT for knowledge management. This highlights the potential challenges in adopting IoT for knowledge management due to a lack of skilled library staff. As result the study proposes university libraries to provide comprehensive training and support: Develop training programs and workshops specifically tailored to enhance the competency of library staff in utilizing IoT technology for knowledge management. Provide ongoing support and access to resources that enable library staff to continuously update their skills and knowledge regarding IoT technologies and their applications in the library context.

Moreover, In regards to the librarian's competency in utilization of IoTs to manage knowledge, the study suggests libraries to implement effective change management strategies. Develop and implement a comprehensive change management plan that addresses the cultural, organizational, and operational aspects associated with the adoption of IoT technology. Foster a positive attitude towards change, address resistance through appropriate strategies, and communicate the benefits and objectives of IoT technology adoption to all stakeholders.

The study recommends that university libraries establish procedures to provide technical support and training for library staff in using IoT technologies. This will ensure that library staff have the necessary skills to effectively use IoT technologies for knowledge management. Universities should provide adequate training and support to

library staff to ensure they have the necessary skills to effectively use IoT technologies for knowledge management.

5.4.5 Knowledge management in university libraries

To optimize knowledge management in university libraries through the adoption of IoT technology, several key recommendations emerge from the study. These recommendations aim to enhance operational efficiency, improve user experiences, and foster academic excellence. They are as follows:

Libraries should prioritize the development of a reliable and scalable infrastructure that can support the implementation of IoT systems. This includes ensuring high-speed network connectivity, acquiring suitable hardware devices, and establishing efficient data storage capabilities.

Libraries should design and implement comprehensive training programs to enhance the competencies of both library staff and users in effectively utilizing IoT technology. These programs should cover technical skills as well as provide a deep understanding of the potential applications of IoT in the library context.

Libraries should actively engage library stakeholders through awareness campaigns to promote acceptance and engagement with IoT initiatives. This involves educating users, staff, and management about the benefits and opportunities that IoT can bring to knowledge management practices.

Library management should demonstrate strong support for IoT adoption by allocating necessary resources, creating relevant policies and procedures, and integrating IoT projects into the library's strategic plans. This support fosters a culture of innovation and encourages the successful implementation of IoT initiatives.

Libraries should actively seek partnerships with technology providers, industry experts, and other libraries to leverage their expertise, share best practices, and access suitable IoT solutions. Collaborative efforts can help libraries navigate challenges, share knowledge, and accelerate the implementation process.

Libraries can initiate small-scale pilot projects to test the feasibility, benefits, and challenges of IoT implementation. These projects provide valuable insights, user feedback, and opportunities for adjustments before scaling up to larger implementations.

Libraries should establish mechanisms to evaluate and monitor the progress and effectiveness of IoT adoption. This includes tracking key performance indicators, gathering user feedback, and conducting periodic assessments to ensure continuous improvement and alignment with evolving needs.

By embracing these recommendations, university libraries can harness the full potential of IoT technology to enhance their knowledge management processes, improve operational efficiency, enrich user experiences, and ultimately advance academic excellence.

5.5 Implications of the Findings on Theory, Practices, and Policies

This section examines the implications of the research findings on theory, practices, and policies related to the adoption of IoTs for advancing knowledge management in university libraries. The insights gained from the study provide valuable guidance for shaping future approaches in these areas, promoting effective implementation, and maximizing the benefits of IoT technology.

In terms of implications for theory, the research findings have significant implications for theoretical frameworks in the field of knowledge management and library science. The study demonstrates the transformative role of IoT technology in enhancing knowledge management practices within university libraries. These findings contribute to the existing body of knowledge by providing empirical evidence of the positive impact of IoTs on resource management, user satisfaction, and knowledge sharing. The insights gained from this study can inform and enrich theoretical models and frameworks related to the integration of IoT technology in library settings, highlighting the importance of stakeholder engagement, technical infrastructure, and competencies in realizing the full potential of IoTs for knowledge management.

Regarding the implications for practices, the study's findings have direct implications for practical considerations in the adoption and utilization of IoT technology for knowledge management in university libraries. The identified success factors, such as stakeholder engagement, robust technical infrastructure, and comprehensive training, can guide library administrators and practitioners in developing effective strategies for implementing IoTs. These insights highlight the importance of creating a supportive environment that fosters collaboration, invests in technical resources, and provides continuous professional development opportunities. By incorporating these practices, university libraries can enhance their knowledge management processes, improve user experiences, and optimize the utilization of IoTs for the benefit of their stakeholders.

In regards to implications for policies, the research findings also have implications for policy development and decision-making processes in the context of university libraries and higher education institutions. The study underscores the need for policymakers to recognize the potential of IoT technology in knowledge management and provide

support for its adoption. Policies should emphasize the importance of establishing a robust technical infrastructure, allocating adequate resources for training and professional development, and fostering a culture of innovation and collaboration within library settings. Additionally, policies should address data privacy and security concerns, ensuring the responsible and ethical use of IoT technology in knowledge management practices. By aligning policies with the study's recommendations, policymakers can create an enabling environment that promotes the effective adoption and utilization of IoTs for knowledge management in university libraries.

The implications of the research findings on theory, practices, and policies highlight the transformative potential of IoT technology in advancing knowledge management in university libraries. By considering these implications, stakeholders can shape their approaches, strategies, and policies to effectively harness the benefits of IoTs and create knowledge-rich environments that meet the evolving needs of library users and support the goals of higher education institutions.

5.6 Recommendations for Further Research

Based on the research findings and to further advance the adoption of IoT technology in knowledge management in libraries, the following recommendations for further research are proposed: Investigating the Challenges of IoT Adoption in Libraries: A study focusing on identifying and understanding the specific challenges faced by libraries in adopting IoT technologies for knowledge management. This research would provide insights into the barriers and obstacles that libraries encounter and offer strategies to overcome them effectively. Evaluating Existing Frameworks for IoT Adoption in Libraries: A comprehensive evaluation study that assesses the suitability and effectiveness of existing frameworks for IoT adoption in libraries. This research

would contribute to identifying the strengths and limitations of current frameworks and guide the development of improved frameworks tailored to the unique needs and context of libraries. In addition, Developing and Validating an IoT Adoption Framework for Knowledge Management in Libraries: A validation study that proposes a new framework specifically designed to guide the adoption of IoT technologies for knowledge management in libraries. This research would involve testing the proposed framework's efficacy, usability, and applicability in real library settings, ensuring its practical value and effectiveness.

By addressing these research areas, scholars and practitioners can enhance the understanding of the challenges, evaluation methods, and frameworks related to IoT adoption in libraries for knowledge management. These studies would contribute to the development of best practices, inform educational programs, and provide practical guidance for libraries seeking to optimize their knowledge management processes through the successful adoption of IoT technologies.

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APPENDICES

Appendix I: Introductory Letter to Respondents

TO WHOM IT MAY CONCERN

RE: INFORMED CONSENT COVER LETTER

Dear.....

I am John Maina, a Masters of Science in Information Science student at Kenya Methodist University. Am conducting research on the topic of "*Adoption of Internet of Things for Advancing Knowledge Management in University Libraries: ac se study of CUEA*." The objectives of the study are to:

i. Assessing the adopted IoT technology for knowledge management in university libraries,
ii. Examining success factors attributed to IoT adoption,
iii. Investigating the competency of library staff in using IoT, and
iv. Evaluating the relationship between IoT and knowledge management.

Am kindly requesting feedback and participation from you as my potential respondents to complete interview schedules, document analysis, and focus group discussions. Participation is voluntary, and all data collected will be treated as confidential. The results of the study may impact decision-making processes regarding IoT adoption for knowledge management in Kenya university libraries. Contact information is provided for those interested in participating.

Yours sincerely,

John Maina. Phone 0706900219

Email: jonymaina@gmail.com

School of Science and technology

APPENDIX II: INTERVIEW SCHEDULE FOR HEAD LIBRARIAN

Dear respondents,

Interview Schedule for Library staff on "*Adoption of Internet of Things for Advancing Knowledge Management in University Libraries: A case study of Catholic University of Eastern Africa, Kenya*."

This interview schedule seeks your thoughts, understandings, perceptions, and experiences. adoption of the internet of things for advancing knowledge management in university libraries in Catholic University of Eastern Africa. It is estimated that it will take 10–20 minutes to fill.

Please, ticking (√) or provide the necessary information to indicate your answers on the space provided.

Kindly note that there are no right or wrong answers, so do not hesitate to respond frankly, honestly and from your perspective.

Please do not write your name on this schedule.

PART A: General Information

1. University …….
2. Gender: □ Male □ Female
3. Age □ < 25 □ 25– 35 □ 35 – 45 □ > 45
4. Period of service: □ < 5 yrs □ 5 – 10 yrs □ > 10 yrs
5. Level of qualification: □ Bachelors □ Masters □ PhD □ Any other

PART B: Types of Internets of Things technology adopted at CUEA library

6. Are you familiar with Internet of Things (IoT) technology, and have you used it?

7. Can you describe the current technology and tools used in knowledge management at your university library? How do these tools support knowledge management?

PART C: Factors attributed to successful adoption of the IoTs at CUEA library

8. Are you aware of any other university libraries in Kenya that have adopted IoT for knowledge management, and if so, can you describe their experience with the technology?

9. What factors do you think make IoT adoption successful in university libraries, and how do these factors align with your university library's KM current practices in your opinion?

PART D: How internet of things technology relates with knowledge management

10. How is knowledge managed at CUEA?

11. In your opinion how does IoT relate with knowledge management?

12. What are your thoughts on the potential benefits and challenges/drawback of implementing IoT in university libraries, specifically for knowledge management purposes?

13. Lastly, what suggestions would you give for improving the adoption and implementation of IoT in university libraries for knowledge management purposes?

PART E: Competency of library staff in using IoT to manage knowledge at CUEA library

14. In your opinion, what skills or competencies do library staff need to have in order to effectively use IoT technologies for knowledge management in a library setting?

15. What kind of training or support would you need to effectively integrate IoT technologies for knowledge management in your library?

Thank you for your feedback and time

INTERVIEW SCHEDULE FOR HEAD OF THE SECTIONS

PART A: General Information

1. University …….
2. Gender: □ Male □ Female
3. Age □ < 25 □ 25– 35 □ 35 – 45 □ > 45
4. Period of service: □ < 5 yrs □ 5 – 10 yrs □ > 10 yrs
5. Level of qualification: □ Bachelors □ Masters □ PhD □ Any other

PART B: Types of Internets of Things technology adopted at CUEA library

6. Are you familiar with Internet of Things (IoT) technology, and have you used it?

7. Can you describe the current technology and tools used in knowledge management at your university library? How do these tools support knowledge management?

PART C: Factors attributed to successful adoption of the IoTs at CUEA library

8. Are you aware of any other university libraries in Kenya that have adopted IoT for knowledge management, and if so, can you describe their experience with the technology?

9. What factors do you think make IoT adoption successful in university libraries, and how do these factors align with your university library's KM current practices in your opinion?

PART D: How internet of things technology relates with knowledge management

10. How is knowledge managed at CUEA?

11. How do you see the relationship between IoT and knowledge management?

12. What are your thoughts on the potential benefits and challenges of implementing IoT in university libraries, specifically for knowledge management purposes?

13. Lastly, what suggestions would you give for improving the adoption and implementation of IoT in university libraries for knowledge management purposes?

PART E: Competency of library staff in using IoT to manage knowledge at CUEA library

14. In your opinion, what skills or competencies do library staff need to have in order to effectively use IoT technologies for knowledge management in a library setting?

15. What kind of training or support would you need to effectively integrate IoT technologies for knowledge management in your library?

Thank you for your feedback and time

APPENDIX III: CHECKLIST FOR THE 2 UNIVERSITIES DOCUMENT ANALYSIS

"*Adoption of Internet of Things for Advancing Knowledge Management in University Libraries in Catholic University of Eastern Africa, Kenya.*"

Section 1: Types of Internets of Things technology adopted at CUEA library

Document	Indicator	Comments
1. Procedure manual 2. Technology adoption policy 3. Library ICT inventory	Measures in place in adopting ICT	
	Decisions made while adopting ICT	
	ICT Infrastructures management	

Section 2: Factors attributed to successful adoption of the IoTs at CUEA library

Document	Indicator	Comments
Best Practices documentation	Strategies	
	Budgets	
	Training	
	Support	
	Procedures	

Section 3: Competency of library staff in using IoT to manage knowledge at CUEA library.

Document	Indicator	Comments
Strategic plans on capacity building	Optimization of acquired skills	
	Enhancement of Knowledge management	
	Proper Training budgets	
Manuals	Development of procedures and User manuals	
Trainings file	Accommodative Training programs	

Section 4: How internet of things technology relates with knowledge management.

Document	Indicator	Comments
1. Inventory 2. Documented integrations of systems	Integrations	
	Network	
	Devices	
	Knowledge materials	

APPENDIX iv: FOCUS GROUP DISCUSSION FOR LIBRARY USERS

How the session will be handled

1. Introduction
2. Speech by researcher
3. Background
4. Discussions moderated by the researcher

PART A: GENERAL INFORMATION

University ……

Group …….

PART B: types of IoTs technology adopted at CUEA library

1. Are you familiar with Internet of Things (IoT) technology, and have you used it?

2. What are the current technology and tools used in knowledge management at your university library, and how do these tools support knowledge management?

PART C: factors attributed to successful adoption of the IoTs at CUEA library

3. Are you aware of any other university libraries in Kenya that have adopted IoT for knowledge management, and if so, can you describe their experience with the technology?

4. What factors do you think make IoT adoption successful in university libraries, and how do these factors align with your university library's KM current practices in your opinion?

PART D: Competency of library staff in using IoT to manage knowledge at CUEA library

5. In your opinion, what skills or competencies do library staff need to have in order to effectively use IoT technologies for knowledge sharing, access and use in a library setting?

6. What kind of training or support would you need to effectively integrate IoT technologies for knowledge management in your library?

PART E: How internet of things technology relates with knowledge management

7. How is knowledge managed at CUEA?

8. How does IoT relates with knowledge management?

9. What are your thoughts on the potential benefits and challenges of implementing IoT in university libraries, specifically for knowledge management purposes?

10. Lastly, what suggestions would you give for improving the adoption and implementation of IoT in university libraries for knowledge management purposes?

Thank you for your feedback and time

APPENDIX V: INTRODUCTION LETTER

KENYA METHODIST UNIVERSITY
P. O. Box 267 Meru - 60200, Kenya
Tel: 254-064-30301/31229/30367/31171
Fax: 254-64-30162
Email: deanrd@kemu.ac.ke

DIRECTORATE OF POSTGRADUATE STUDIES

March 7, 2023

Commission Secretary,
National Commission for Science, Technology and Innovations,
P.O. Box 30623-00100
NAIROBI.

Dear Sir/Madam,

RE: JOHN MAINA – (REG. NO. ISK-3-1044-3/2020)

This is to confirm that the above named person is a bona fide student of Kenya Methodist University, in the School of Science and Technology, Department of Information Science undertaking a Master's Degree in Information Science. He is conducting research on: "Adoption of Internet of Things for Advancing Knowledge Management in University Libraries in Meru County, Kenya".

We confirm that his research proposal has been presented and approved by the University.

In this regard, we are requesting your office to issue a research license to enable him collect data.

Any assistance accorded to him will be appreciated.

Thank you.

7 MAR 2023

Dr. John M. Muchiri (PhD)
Director, Postgraduate Studies

Cc: Dean SST
CoD, IS
Program Coordinator - IS
Student Supervisors

APPENDIX VI: NACOSTI PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 151051

Date of Issue: 25/March/2023

RESEARCH LICENSE

This is to Certify that Mr., John Maina of Kenya Methodist University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Meru on the topic: Adoption of Internet of Things for Advancing Knowledge Management in University Libraries in Meru County, Kenya for the period ending : 25/March/2024.

License No: NACOSTI/P/23/24426

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Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

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