Factors Determining Successful Adoption of Internet of Things (IoT) in University Libraries: A case of Catholic University of Eastern Africa Library

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Abstract

The potential of Internet of Things technology to enhance operational efficiency and effectiveness has been recognized across various sectors. However, its adoption in Kenyan university libraries remains limited. The primary aim of this study was to examine the factors that contribute to the successful adoption of Internet of Things (IoT) technology at the Catholic University of Eastern Africa library. The ultimate goal was to identify these factors and provide recommendations for best practices in implementing IoT in the library setting. The Unified Theory of Technology Acceptance and Use served as the guiding framework. Utilizing a descriptive survey research design, this study focused on a target population of seven section head 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 that IoT adoption in CUEA libraries is limited by infrastructure challenges, training gaps, and organizational barriers. Robust infrastructure, user acceptance, staff training, and organizational support are key success factors for IoT adoption. The study recommends that CUEA libraries should partner with university departments to allocate resources for IoT implementation and establish training programs to enhance staff skills. The university administration should support libraries by removing organizational barriers, facilitating budgets, and creating a conducive environment for seamless IoT integration. Implementing these recommendations will enhance knowledge management capabilities and contribute to research and learning environments. This study's novelty lies in its focus on university libraries and its actionable recommendations for improving operations and services through IoT technology.

Keywords: *IoT adoption, university libraries, knowledge management, success factors, CUEA.*

1.0 Introduction

Internet of Things (IoT) has transformed knowledge management through efficient control and tracking of knowledge processes (Santoro et al., 2018). Advancement in digital identifiers, RFID, machine learning, AI, sensors, systems, networks, and software have facilitated the adoption of IoT for organizational tasks (Khan & Javaid, 2021). IoT connects objects into a network that collects and shares data through internet-connected devices, comprising sensors/devices/RFID, connectivity, data processing, and user interface (Trivedi, 2022). The widespread adoption of internet and IoT technology has revolutionized knowledge management (Stehr, 2020).

> *"A robust network infrastructure with stable internet connectivity and sufficient bandwidth supports seamless IoT device operation."*

In libraries, IoT technology connects objects and enhances knowledge services through sensors with networking capabilities. These sensors collect and transfer data over a network without human intervention, adding to the library's knowledge resources (Tella, 2020). IoT encompasses sensors, processors, cloud computing, wireless networking (RFID), and other infrastructure to gather, send, and act on data for knowledge management. Successful IoT adoption in the USA, UK, Denmark, Singapore, Norway, and the UAE is influenced by multiple factors.

These factors include widespread RFID use, enhanced material tracking, robust infrastructure with reliable internet and secure networks, government support in providing financial aid, partnerships for resource sharing, visionary leadership key in securing resources, user-centric approaches, research focus, and knowledge-sharing platforms that accelerate adoption.(Fizza et al., 2021). The adoption of RFID technology in these countries has significantly enhanced libraries' capabilities in effectively managing and leveraging their resources.

In Ghana, IoT adoption in academic libraries is driven by factors like increased enrolment that prompt investments in IT infrastructure, promotion of digital literacy, open access advocacy, research support, and knowledge exchange platforms (Adu-Bobi & Boamah, 2019). Leveraging on IoT technology, university libraries in Ghana have streamlined operations, effectively handled user demands, and ensured the security of valuable resources in the digital era.

The Catholic University of East Africa (CUEA) library in Nairobi serves as a successful example of IoT technology adoption in Kenya (Kavulya, 2019). CUEA has invested in information technology infrastructure, training, open access advocacy, research support, and knowledge exchange platforms. Their adoption of RFID technology has been integrated into their IoT strategy, with components such as RFID tags, tagging machines, scanners, access control gates, and self-check stations (Kavulya, 2019). This comprehensive approach has significantly improved CUEA's library operations and services.

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This paper aims to enhance knowledge management practices in university libraries, particularly in Catholic University of Eastern Africa Library. It examines factors that contribute to successful IoT adoption, and provides practical recommendations for optimizing knowledge management processes through IoT initiatives.

Statement of the problem

The rapid advancement of IoT offers significant potential for development of effectiveness and efficiency across sectors. However, adoption of IoT technology in university libraries, mainly for knowledge management purposes, has been limited. Despite the presence of guidelines and standards established by professional associations and regulatory bodies, the integration of IoT in university libraries' knowledge management practices remains inadequate (Adomi & Oyovwe-Tinuoye, 2021). This gap raises concerns regarding the efficiency and effectiveness of knowledge management processes in university libraries. Understanding the factors that determine successful adoption of IoT in university libraries, provide insights and guidance to bridge this gap and optimize knowledge management processes.

Kavulya (2019), Jumba et al. (2020), Ocholla et al. (2022), and Roy et al. (2016) have explored the role of ICT in different sectors, the emerging challenges 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, these studies have not addressed the adoption of IoT in university libraries,

the reason for the slow uptake, nor have they provided a comprehensive best practice for implementation of IoT. Therefore, there is need to examine the factors that contribute to the successful adoption of IoT technology in the CUEA library.

By examining factors that contribute to successful adoption of IoT technology in the CUEA library, this study aims to provide valuable insights for library administrators and decision-makers. The proposed IoT adoption best practices will guide university libraries in effectively implementing IoT technology to enhance knowledge management processes and services.

Purpose of the study

The primary aim of this study was to examine factors that contribute to successful adoption of IoT technology at the CUEA library, with a view to recommend best practices in the implementation of IoT in a library setting.

Objective

To examine factors attributed to successful adoption of the Internet of Things at Catholic University of East Africa library.

Research question

What factors contributed to the successful implementation of IoT technology at Catholic University of East Africa library?

Literature review

The adoption of IoT technology in libraries is driven by the fact that libraries recognize the importance of enhancing knowledge management (KM) practices to meet evolving demands (Kim, 2020). Other factors include the need to invest in

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technology and innovate library services (Koul & Eydgahi, 2017). Additionally, careful planning, training, and ongoing support are crucial for successful IoT adoption (Ruiz et al., 2022). Creating a culture of transformation, utilizing digital adoption platforms, and continuous support from trainers play significant roles in facilitating IoT adoption and enhancing KM, and enables libraries to identify areas for improvement; hence, enhance the user experience (Whatfix, 2020).

Research conducted in different regions shed light on the success factors for IoT adoption. Developed nations like the UK and UAE have recognized the significance of investing in technology, innovating library services, and implementing efficient management procedures for successful IoT implementation in university libraries (Dawar et al., 2021). Their proactive approach towards IoT implementation in university libraries is commendable, as it contributes to enhanced efficiency, improved services, and optimal utilization of resources. By recognizing the significance of these factors, nations have paved way for successful integration of IoT technology in libraries, thereby benefiting the academic community and fostering knowledge advancement.

Studies conducted in developing nations, including Nigeria, South Africa, Saudi Arabia, Malaysia, Pakistan, and Bangladesh, highlight key factors for successful IoT adoption. These factors include proper budgetary allocation, encouraging tech operations, capacity building for library staff, and management involvement (Hakim et al., 2022). Sufficient allocation of funds, promoting effective tech operations, enhancing staff

skills, and providing management support are crucial in driving IoT implementation in libraries (Madni et al., 2022). By prioritizing these factors, developing nations can harness the power of IoT technology to enhance their library services and contribute to knowledge advancement. In Kenya, CUEA, Umma, and University of Eldoret libraries have successfully implemented RFID as part of IoT, thereby leveraging on its potential for long-term development (J. M. Kavulya, 2019).

Factors such as vendor engagement, comprehensive trainings, budgetary allocation, robust data security policies, and compatibility with the KOHA system have played crucial roles in implementation of IoT (Kavulya, 2019; Machii et al., 2020). Through these practices, these libraries have seamlessly integrated knowledge management processes with IoT elements and supplementary technologies, resulting to creation of smart IoT ecosystems (Kajiyama Ikeda, 2019). These initiatives highlight the effectiveness of IoT adoption in addressing knowledge management needs and generating value for university libraries in Kenya.

2.0 Materials and Methods

The study was conducted at the Catholic University of Eastern Africa library. Utilizing a descriptive survey research design, this study focused on a target population of seven section head librarianslibrarians 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.

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Content analysis was used to analyse data. The study presented respondents' responses in tables. To ensure validity and reliability, the data collection tools were pre-tested to ensure clarity and specificity of questions. Correct selection of representative participants, triangulation of data sources, consistent procedures, respondents' orientation, detailed documentation, and independent analysis were also ensured.

3.0 Results and Discussion

This section presents the study's findings on the success factors of IoT adoption at CUEA. Data was collected through librarian interviews, patron focus group discussion, and document analysis that aimed to explore factors that contribute to successful IoT adoption, the role of IoT in knowledge management. The study involved six respondents, including the university librarian, five heads of sections, and six focus group participants, all possessing diverse qualifications and experiences. Table 1 highlights the success factors associated with IoT adoption in university libraries.

Table 1

Results on success factors attributed to the adoption of IoT at CUEA

Respondents	Responses	themes raised 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?	Understanding of the role of IoT and library
Librarians	"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."	User acceptance Technical expertise. Training and support
	"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."	Financial resources. Clear understanding of the library's objectives and the role that IoT technology will play.
	"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."	Necessary technical skills.
	"Yes, I am aware that USIU library attempted to adopt RFID technology a few years ago, but it was not	

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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 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."

Robust and reliable network infrastructure.

Data privacy and security.

Scalability& Interoperability.

Continuous monitoring and evaluation.

Strong vendor support.

| 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."

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?

Librarians   "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 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 technology is 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 staff is 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."

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"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 decision-making processes, but there is still room for improvement."

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

" 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."

In order to examine feedback received in response to the 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?"* the study explores participants' awareness of IoT adoption in Kenyan university libraries and gathers insights from their firsthand experiences with this innovative technology.

The successful adoption of IoT in university libraries requires proper planning, implementation, and training, as emphasized by librarians. The head-digital librarian (HSL 3) stated;

> "*In my opinion, Successful IoT adoption in university libraries requires proper planning, implementation, and training, as well as sufficient support for library staff. We have invested in training our staff on IoT technology and its applications in knowledge management, which has helped us align with our current practices.*"

Training and support are crucial for successful adoption of IoT in libraries since it enhances staff proficiency (Lamb, 2021;

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Urrutia, 2019). Ongoing technical assistance ensures optimal utilization. Proper planning, implementation, training, and support for library staff are essential for successful IoT adoption in university libraries. Studies have highlighted the importance of planning, evaluation, and training in IoT adoption (Rahmani et al., 2021). Human factors, including staff training and collaboration, also play a significant role (Wang et al., 2018).

The second question sought to identify factors influencing IoT adoption for KM, i.e. *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?* To explore the alignment of these factors with knowledge management practices, valuable insights emerged from the interviews, categorizing key themes into internal and external factors.

Internal factors that influence successful IoT adoption in university libraries include understanding of the role of IoT and library, user acceptance, technical expertise, and training and support. User acceptance entails librarians understanding the benefits of IoT and how it can enhance their work. As one librarian stated during the interview;

> *"If the users don't accept it, then there's no point in implementing it because no one will use it"* (HSL 5).

Technical expertise is crucial to operate IoT systems effectively, and librarians must possess the necessary skills. Another librarian mentioned:

> *"If you don't have the technical expertise, then you can't make it work"* (HSL 2).

Training and support programs are important in equipping librarians with the

knowledge and competence to leverage IoT tools and applications. A respondent emphasized the significance of training by stating:

> *"Training is very important because if you don't understand how it works, then you can't make it work"* (HSL 4)

External factors include financial resources, network infrastructure, data privacy and security, scalability, interoperability, continuous monitoring and evaluation, and vendor support. Adequate financial resources are necessary for implementing and maintaining IoT systems. A librarian at CUEA highlighted the financial aspect by stating,

> *"IoT systems are expensive, and we need adequate financial resources to implement and maintain them"* (HSL 5).

A robust network infrastructure with stable internet connectivity and sufficient bandwidth supports seamless IoT device operation. Data privacy and security measures safeguard sensitive information, while scalability allows for future growth. Interoperability ensures integration with existing library management systems, and continuous monitoring and evaluation facilitate system upgrades. Strong vendor support provides timely assistance and software updates. These findings align with existing literature emphasizing user acceptance, technical expertise, financial resources, and training and support in IoT adoption (Dimza, 2021).

Further research is necessary to validate these findings and identify additional success factors specific to IoT adoption in university libraries. The identified factors can be visually summarized in Figure 1;

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Figure 1

Summary of Key Success Factors

Figure 1 illustrates the significance of key factors in successful adoption of IoT. The figure explains the implementation of IoT technology in libraries.

4.0 Conclusion

The research revealed that several factors must be considered to ensure successful implementation of IoT in university libraries. These factors 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 deficiency in standardized strategies to optimize adoption of IoTs to manage knowledge.

5.0 Recommendations

The study highlights the need for standardized strategies to optimize IoT adoption for knowledge management in university libraries. To address this, university librarians, including CUEA, should foster stakeholder engagement and collaboration. This can be achieved by actively involving librarians, IT staff, administrators, and end-users in decision-making processes, and establishing communication channels for feedback and participation. Universities' library management officers should develop a comprehensive implementation plan, specifying the required technologies, timelines, and resource allocation. Additionally, the government and university libraries policymakers should formulate policies guiding the adoption of IoT technologies, while considering data privacy, cost implications, and stakeholder involvement. Implementing these recommendations will enhance knowledge management capabilities and contribute to research and learning.

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