

Utilisation of Internet of Things technology for managing archives of public universities in South Africa

Zolile Myeko

Office of the Registrar, Cape Peninsula University of Technology, South Africa

Myekoz03@gmail.com

<https://orcid.org/0000-0003-4377-3719>

Edward Dakora

Department of Management Science, Sol Plaatje University, South Africa

naadakora@gmail.com

<https://orcid.org/0000-0002-3602-1861>

Received: 27 July 2024

Revised: 29 August 2024

Accepted: 31 October 2025

Abstract

Scholarly discussions have recently focused on how technology is used by university archives departments to manage historical data. The COVID-19 global pandemic pushed universities to reconsider how best to manage archival materials efficiently and ensure the academic community and the general public can easily view, preserve, and interact with these records. Several universities are currently using the Internet of Things (IoT) as a technology to manage preserved content efficiently. Nevertheless, managing historical or enduringly valuable records has not received enough attention in South African university archives when it comes to implementing IoT technology. This study aimed to investigate how IoT-based technologies are now being used in university archives to manage archived material. A systematic quantitative approach was used to analyse the current literature on the applications of IoT technologies in managing archival data in university archives. The study leveraged various databases, including Google Scholar, IEEE Xplore, Science Direct, MDPI, and Scopus. The researchers used these databases to collect the pertinent information. The research revealed that although several university archives acknowledge the importance of IoT technologies in managing archival data, only a few have adopted these technologies. This is mostly attributed to issues like insufficient information technology infrastructure, exorbitant system expenses, poor infrastructure, limited technical assistance, and a dearth of competence within university archives. Therefore, the elements presented considerable obstacles for the university's archives in acknowledging the benefits of adopting IoT technology for managing historical documents in their institutions. Information is necessary for university archives to effectively influence university policies and procedures that facilitate the preservation of university archival data. The research suggests that South African university archives should implement IoT technologies to improve their administration of historical materials. Diverse research and development initiatives on IoT technologies should be undertaken within university archives. This study addresses the shortage of knowledge within university archives on the capabilities of IoT technologies in administering archival resources.

Keywords: Internet of Things technology, university archives, archival records, South Africa, managing archives, public universities

1. Introduction

University archives have multiple obstacles arising from issues such as inadequate archive buildings, deficient technical infrastructure, absence of operational processes, lack of expertise in archive layout, and insufficient professional capabilities (Ma et al. 2022). Due to the constraints outlined above, university archives face difficulties in establishing comprehensive standards for managing, organising, storing, classifying, and numbering historical items. IoT-based technologies have become a solution for managing and overseeing university archives by utilising various applications of IoT technology (Maceli, 2020). With the increasing adoption of IoT-based technologies, university acknowledged as crucial for institution-level information management. Implementing IoT technology significantly changed the management of various universities' archive repositories from the traditional approach to a modern approach to improve effectiveness and efficiency (Palanivel, 2019). Numerous university archives in South Africa suffer from inadequate administration of their repositories. The South African university archives lack standardised procedures or strategies for preserving archival materials in their repositories. Current academic literature discusses the growing reliance of university archival repositories on IoT technology for improved effectiveness and efficiency (Wojcik, 2016; Maceli, 2020; Sinha & Brar, 2022).

However, university archives, especially in African countries, face challenges such as inadequate technology infrastructure, expensive systems, and limited technical support, insufficient funding, poor training in professional archival knowledge, and lack of comprehension regarding the significance of archives, the necessity of archives administration, and the poor awareness of archived collections (Ma et al. 2022; Martinus et al. 2022). Adopting IoT-based technology was linked to the development of innovative solutions for solving these challenges. University archives are increasingly adopting IoT technologies to address challenges encountered in the archive's environment, as indicated by the evidence.

Moreover, Ma et al. (2022) found that using IoT-based FRID technology decreases the need for human labour, as university archives are now automatically digitised. Many archival repositories utilise information technology to establish a fresh business model, enhance corporate procedures, and minimise expenses and hazards (Rayaes & Salam, 2019). IoT technologies has significantly transformed the operational procedures of archives management programmes within university archival spaces and they have significant potential for effectively managing university archives across many business activities, including archives facility management, archives collection preservation, and collection tracking (Wojcik, 2016). Moreover, the IoT can oversee the management of university archival inventory control, access and authentication, room configuration, accessibility, and navigation using IoT-enabled systems (Sinha & Brar, 2022). Furthermore, the IoT can monitor historical material, including paper-based records, map collections, and audio-visual materials, using internet infrastructure.

Monitoring and controlling environmental conditions in archives involve using technologies to regulate temperature, humidity, ultraviolet (UV) light, air quality, and other environmental factors (Maceli, 2020:202). This research was motivated by the following research scholars:

- Initially, the United States of America (USA) implemented radio frequency identification (RFID) technology in the transmission business and access control, but

Europe utilised short-range monitoring RFID technology for animal monitoring (Ramirez-Faz et al. 2020).

- To streamline the process of identifying information in university archives and minimise the need for human resources, the current approach involves digitising college archival tags using IoT-based RFID technology (Ma et al. 2022:2).
- Aparicio et al. (2016) conducted research that investigated the use of an IoT method for the development of lightweight wireless sensor networks.
- IoT-based technology has been implemented in many information management systems, including museums and academic libraries (Großmann et al. 2017).
- IoT-based technologies have the potential to be utilised as tools for managing collections and enhancing information literacy (Pujar & Satyanarayana, 2015).

It is evident that IoT-based technologies have reached a level of development where they can be integrated into all aspects of university archives. The implementation of IoT-based technologies has proven effective in monitoring and controlling archive buildings in the USA (Maceli, 2020). This suggests that universities in the USA have progressively embraced IoT-based technologies to enhance the administration of their archives in multiple ways. Despite numerous obstacles relating to integrating technologies based on IoT, most university archives are adopting and using them (Maceli et al., 2019). To fully understand the potential of IoT-based technologies in university archives, a study of IoT-based technology applications that can enhance the efficiency and effectiveness of archive management must be conducted. This study aimed to identify suitable applications of IoT technology that might improve archival management at South African universities.

This study is a valuable addition to existing literature on the subject. Firstly, it conducted a thorough examination of the literature pertaining to the use of IoT technologies in university archives. It aids in applying and executing theory in the management of university archives. The article demonstrates how university archives implemented the principle of disruptive innovation and enhances the implementation of IoT technologies in university archives and how their adoption can assist university archives in managing their commercial activities. It further highlights key challenges associated with integrating IoT technologies into the management of university archives, including the administration of repositories and decision-making processes. Lastly, it recommends future research on the use of IoT technologies in university archives management context.

The initial segment of this paper presents the theoretical framework on which the argument in this work is based. In the next section, the difficulties faced by university archives and potential prospects for enhancing the role of university archives are discussed, particularly in the context of developing IoT technologies. We do so by emphasising the fundamental distinctions in the advantages of using IoT-based technologies for managing university archives.

2. Problem statement

Despite the use of IoT technologies as an advanced solution for managing archival institutions and addressing difficulties in university archives, university archives still struggle with inadequate management of historical resources. IoT technology has been employed to build diverse archives management systems (Maceli, 2020). University archives management oversees a variety of archival materials, encompassing papers, films, pictures, and maps (Li, 2022). Most university archival institutions worldwide have not yet fully implemented IoT-based technology. This study aimed to fill this need by introducing the capabilities and

potentials of IoT technologies in university archival organisations (Chen, 2023). In addition, IoT-based technologies are in the early stages implementing in various public universities worldwide. University archival institutions are crucial for supporting university teaching and learning programmes. To ensure preservation and accessibility in these institutions, IoT-based technologies in the archival sector must be employed. Although IoT technologies have improved archival institution services in several nations, it is uncertain whether these technologies can successfully transform university archival institutions from conventional methods to modern technology without encountering substantial obstacles.

The lack of clarity in this situation emerged from literature examining the reciprocal connection between archival institutions and IoT technologies (Shammar et al. 2019). Although utilisation of IoT technologies is expected to enhance the quality of services provided by archival institutions, it is uncertain how and to what extent university archival institutions are utilising IoT technologies in their archive repositories. Therefore, a comprehensive and extensive understanding of the capabilities and impact of IoT technology in archival institutions must be developed.

South African university archives encounter various comparable challenges in the management of archival records (Anderson & Hart, 2016; Netshakhuma, 2019). South African university archives are actively seeking strategies to effectively handle archival records. This paper proposes implementing IoT technology to effectively manage historical records in South African university archives. Adopting IoT technologies in university archives has been implemented as an enhanced method for managing archival records. Thus, the utilisation of IoT technologies has improved the management of archival records in South African and other countries' university archives. These technologies have the potential to completely revolutionise South African university archives, seamlessly replacing traditional methods with modern technology. This study aimed to identify the specific requirements of university archives in South Africa regarding the management of archival records. It also proposes the use of IoT technologies as a solution to address these identified needs with the aim of enhancing the proper management of archival records, particularly in terms of preservation and facilitating user access. This will ultimately support teaching and learning activities at university archives in South Africa.

3. Research purpose

The purpose of the study was to investigate the utilisation of IoT technology for managing archives of public universities in South Africa

4. Research objectives

The objectives of the study were as follows:

- To examine current uses of IoT technology in the management of archival records in academic archives.
- To identify resource requirements for the implementation of IoT technologies for university archives management in South Africa.

5. Literature review

This section presents a literature review for the study.

5.1 IoT technology in managing academic archival records

According to Ma et al. (2022), IoT encompasses various devices and technologies, including information-sensing devices such as sensors, RFID technology, global positioning systems (GPS), infrared sensors, laser scanners, and gas sensors. They contended all these devices and technologies can gather any object at any given moment or location. Furthermore, IoT devices and technologies can actively observe, establish connections, and engage in immediate communication while gathering diverse forms of data, including sound, light, heat, energy, mechanics, chemistry, biology, and location. These data may be integrated with the internet to create an extensive network. According to Rayes and Salam (2019:2), IoT can be defined as a network of devices equipped with software intelligence, sensors, and seamless internet communication, allowing for easy identification of each element. These authors contended that the IoT enables the interchange of data between devices or things through manufacturing operators and other connected devices, utilising the communications infrastructure of the internet.

The IoT is a technology-driven framework used to enhance service delivery and efficient management. It aims to save time, costs, and human involvement in the tracking, monitoring, and control of archived documents in university archives. IoT-based technologies can connect physical objects, including as sensors, devices, machines, people, and processes, to the internet. This allows for monitoring and regulating their operation from anywhere. The linkages extend beyond information sites. These links are tangible and enable users to access and assume control over "things" as required. By implementing IoT technology, numerous university archives have enhanced their organisational service delivery. University archives have streamlined their service delivery operations by leveraging automation support from IoT-based technology applications. This resulted in reduced time and personal engagement required for their services.

This study adopted the framework proposed by Khan and Ismail (2017), who defined the IoT as an interconnected network utilising many sensors connected through information and communication infrastructure to deliver high-quality services to customers and other stakeholders. This innovative technique has the potential to assist in monitoring and regulating environmental conditions in the public university archives of South Africa. According to Shi et al. (2019), IoT encompasses artificial devices used to mitigate the effects of climate elements, such as natural light, temperature, and humidity, to regulate the surrounding environment.

5.2 University archives

Hiddle (2010) explains that university archives function as the authorised institutional repository responsible for preserving specific information generated during operational activities. They store a wide range of archival materials for different departments within the university, including archival documents, meeting minutes, institutional reports, annual financial statements, portraits of notable individuals, audio-visual images, and other records that provide insights into campus life (Siddell, 2018). These archives offer a reading room where students and researchers can access and examine archived materials.

Archival resources facilitate research, education, and knowledge acquisition by offering original sources. According to Chrysanthopoulos et al. (2021), university archives serve as the institutional repository responsible for managing information from various departments inside a university. According to Siddell (2018), the archive material is more advantageous for staff and faculty than for students. The archival material is utilised to support teaching, learning, administrative references, and research material in various universities. According to Ly and Shi (2020), university archives are considered historical records. Therefore, the researcher adopted the perspective of Hiddle (2010) in examining university archives, which are institutions responsible for managing archival materials belonging to universities. Jenkinson (1996) contends that archives consist of correspondence and duplicates of the actions carried out by departments and organisations. Every department within the organisation generates archival records. Based on this context, all institutional archived records represent the institution's major decisions, transactions, and activities.

5.3 IoT technologies used in university archives

IoT has converted the university archives repository into a digital platform in numerous archives management projects. IoT-based technologies can gather data from many systems, such as smart classrooms, and store it as large-scale data for future utilisation (Kuppusamy, 2019). For instance, IoT technology utilises sensor-equipped devices installed in the doorways of archives, which are connected to the identity card holders of both the archives staff and consumers.

IoT technologies have been utilised in multiple applications within university archives. Ma et al. (2022) found that certain university archives employed IoT-based RFID technology to automate operations and minimise human intervention in managing university archives. Implementing IoT-based RFID technology can enhance the management of archival collection items by utilising archival tags. Archival tags are crucial components of an intelligent security system designed for storing archival collection materials in storage rooms and serve as instruments for safeguarding classified archives (Tian et al. 2022).

Ma et al. (2022) created an IoT-based cloud computing application to digitise historical items in universities. University archives labels employ RFID technology. Nevertheless, the security mechanism of the filing cabinet ensures the protection of confidential papers. Implementing IoT technologies in archives environments, specifically in collection tracking and archives collection preservation, has been widely implemented in many nations for many years (Wojcik, 2016). Moreover, the IoT can oversee inventory control, room arrangement, access, authentication, availability, and navigation using IoT-enabled systems (Sinha & Brar, 2022). The IoT can oversee and track archival materials of many types, including paper-based records, map collections, and audio-visual materials, by utilising internet infrastructure. Essentially, the IoT can monitor the surroundings of archival materials. Maceli (2020) states that IoT-based technologies have been used to analyse visitation patterns and crowd levels, create interactive exhibitions, and provide location-specific information to users and academics. In addition, the IoT employs a various sensors to enhance security in reading rooms by detecting any instances of theft of archival documents. In certain countries, IoT technology is employed across multiple applications to enhance services. The potential of IoT technology to enhance services and performance across multiple industries is acknowledged. Various university archives have employed the IoT monitoring system to oversee their facilities' environmental conditions and the collections they house. The university archives employ an IoT monitoring system that utilises sophisticated sensor devices to identify regions within the buildings that experience

problems with air conditioning and water supply. They further utilise a smart environment-monitoring solution to ensure the cleanliness and safety of the building (Verma et al., 2022).

The IoT-based environmental monitoring system provides the ability to monitor archival material at archival institutions. An IoT-based system for environmental monitoring is crucial in minimising unnecessary environmental conditions that could affect the preservation of historical materials in archives administration (Harvey & Mahard, 2014). These precautionary procedures are advised for controlling temperature and humidity levels in various types of historical holdings, including manuscripts, films, pictures, and maps. British Standard Institution (2018) states that the generally acceptable temperature range is from 50 to 70 degrees Fahrenheit, while a recommended relative humidity range of 30% to 50% is advised. Using IoT-based technologies can oversee and regulate environmental circumstances in archives. These conditions encompass temperature, humidity, UV radiation, light intensity, air quality, and other pertinent environmental attributes (Maceli, 2019). IoT technologies have a vital function in monitoring archival entities. The IoT paradigm offers significant methods for administering and monitoring archival entities, which safeguard and maintain the collective knowledge and experiences of an institution. The IoT-based monitoring and control system is used in archival buildings (Gonzalez et al., 2020). An IoT-enabled cloud computing application can digitise the labels of university archives stored in the university archives repository. Archivists in certain universities choose to utilise digital environmental monitoring devices as a component of IoT technology (Maceli, 2019).

5.4 Resource requirements for managing academic archival records

Several South African businesses embraced IoT technologies several years ago. IoT-based technology has a significant impact on the majority of South African public and private sectors, although IoT-based technology is a recent innovation in specific industries. For almost a decade, the information management sector in South Africa, including archives, libraries, and museums, has been using IoT technology to preserve and provide access to archived material for consumers and academics (Masenya, 2020). Several university archives implemented IoT-based and RFID technology to streamline the management of business activities related to archives.

The Free State has implemented IoT-based technology in the higher education sector. The Central University of Technology is a prime example of a university that has successfully implemented IoT-based technologies. The primary motivation for installing IoT-based technology was to mitigate the financial burden incurred by the university due to the theft of equipment, including manuscripts, letters, photographs, moving image and sound materials, artwork, books, diaries, artefacts, and digital material, within its facilities. Mhlaba and Masinde (2015) found that the Central University of Technology (CUT) incurs significant expenses annually on purchasing new equipment for staff and students. This expenditure is necessary to replace stolen laptops, data projectors, cellphones, and tablets which students, different departments, and other staff offices reported missing. The CUT has experienced the loss of both equipment and significant corporate and student data, which has the potential to compromise the integrity of the institution if accessed by unauthorised individuals.

An application utilising IoT technology is used to monitor the environmental conditions of university archives. The monitoring of environmental conditions with IoT involves the utilisation of sophisticated sensor devices to precisely identify contaminants present in the air and water. The IoT monitoring system implemented a smart solution for monitoring

environmental conditions (Verma et al., 2022). Intelligent environmental monitoring technology serves a crucial role in monitoring the university's archives entities. The device monitors the atmospheric conditions and ensures that the air is clean and suitable for respiration.

6. Theoretical argument

This section presents a theoretical argument for the study.

6.1 The Disruptive Innovation Theory

University archives remain a compelling area of study, as indicated by Ma et al. (2022). Nevertheless, expansion depends on the adoption of theoretical frameworks developed by other disciplines (Li, 2022). Given the distinctiveness of the chosen research environment, it was crucial to employ the disruptive innovation theory. Bower and Christensen (1995) were the first to develop the theory of disruptive innovation (DIT), which is considered a competitive model according to Strömberg and Thorman (2019). The researchers employed DIT to provide a theoretical explanation for the observed occurrence. DIT promotes the integration of contemporary technology in the field of university archives to enhance the quality of university archives services. DIT intends to modify the latest technological advancements and is influenced by multiple elements, including cost, quality, customer demands, regulatory requirements, and availability of resources (Terry, 2020). The researchers argues that new technology is crucial for enhancing university archives and facilitating their effective management.

The notion of DIT centres on the transformative effects of embracing modern technology, which can revolutionise the functioning of institutions and enhance their service delivery (Strömberg & Thorman, 2019). Fundamentally, when an institution transitions from an obsolete traditional approach to a modern procedure utilising new technologies such as IoT, it becomes capable of evolving into a competitive entity that enhances service delivery and the overall environment. Terry (2020) proposed that DIT aims to reform particular industries following instances of service delivery failure within those industries. Following the difficulties posed by air conditioners, heat, and the COVID-19 pandemic, DIT successfully introduced a solution in the information management industry, which can also be implemented by South African South African university archives. The majority of information management sectors in South Africa have implemented IoT technologies to address issues impacting their institutional environment. These criteria compel many sectors to embrace new technology to achieve success in their respective domains. DIT assists all institutions to adopt new technologies across several sectors. These new technologies encompass automation, the IoT, digital twinning, digital currency interaction, and the augmentation of smart technology (Terry, 2020). Emerging technologies are crucial for enhancing the efficiency of service provision.

7. Methodology

An analysis of academic and intellectual research on the use of IoT technology for maintaining archives of public institutions in South Africa was published from 2017 to 2024. The objective of this study was to gain a comprehensive understanding of existing literature regarding the factors that attract application of the IoT to university archives in South Africa. This was accomplished by employing a systematic quantitative approach devised by Pickering and Byrne (2014) for searching and screening. The systematic nature of this review is attributed to

the specific and reproducible methodology employed to survey the literature and subsequently choose papers for inclusion.

This study used a systematic quantitative approach and adopted a positivist theoretical framework (Lee & Kamler, 2008). Despite the prevailing focus of IoT literature on the information systems sector, the interdisciplinary character of IoT research necessitates researchers to explore areas beyond the information systems field (Webster & Watson, 2002). Consequently, the search was not constrained by any specific field of study to prevent the omission of any potentially useful material. The studies were selected based on their focus on university archives in South Africa and their utilisation of IoT for business purposes. The appropriate scholarly articles were obtained to encompass all pertinent topics, and the search phrases used were “IoT technology”, “Archive management”, and “IoT applications”. The search across five popular online databases, namely Google Scholar, IEEE Xplore, Science Direct, MDPI, and Scopus, yielded 165 research items, including peer-reviewed published articles, conference papers, theses, and book chapters. These items were identified based on the presence of relevant keywords in their abstract titles. Afterwards, 44 items were eliminated, resulting in 96 items that were eligible for full article reading. In addition, 43 items had to be eliminated, and complete text access to them was not available. Consequently, a total of 53 publications underwent thorough evaluation for all study objectives.

Consistent with the guidelines of Pickering and Byrne (2014), the study followed the five stages of the systematic quantitative approach to thoroughly search, evaluate, and analyse relevant journal articles, institutional reports, websites, and book chapters, as indicated in Table 2, to answer the research question. Pickering and Byrne (2014) proposed a research methodology that focuses on a sequential five-step process, as indicated in Table 1, which encompasses the following:

- Topic definition
- Developing the research inquiry
- Identifying key terms
- Database identification and retrieval
- Reviewing and evaluating publications

The systematic quantitative approach was utilised in previous research conducted by Bikefe et al. (2020), Musa et al. (2021), and Mohammed and Bello (2022), facilitating the production of reproducible reviews (Pickering & Byrne, 2014). Therefore, employing the aforementioned approach, the researchers methodically chose and eliminated papers utilised in the present investigation (Pickering & Byrne, 2014).

Table 1. Description and application of systematic quantitative approach

Step	Application of study
Define topic	What are the uses of IoT technologies in managing archival records in South African Universities?
Formulate research question	Which IoT applications/technologies are suitable for managing archival documents of South African universities?
Identify keywords	IoT, university archives
Identify and search databases	Google Scholar
Read and assess the publication	An initial content scan was conducted to evaluate the literature identified during the search. Subsequently, the work underwent scrutiny and evaluation to determine its pertinence to the discourse surrounding the use of IoT technologies in the administration of archival records in university archives in South Africa.

Source: Pickering and Byrne (2014)

Table 2. Literature source

Type of Sources	Quantity
Journal articles – Google Scholar	36
Institutional publication reports	1
Theses	2
Books/Book Chapter	5
Website	10
Total	53

Source: Authors (2025)

8. Discussion of the findings

This section provides a discussion of the findings.

8.1 Current uses of IoT technology in managing academic archival records

This research aimed to investigate the utilisation of IoT technology to aid in managing university archives buildings and collections. It examined the factors that motivate university archives to adopt IoT-based technology to enhance effectiveness and efficiency in the university archives environment. The use of IoT-based RFID is a viable instrument for effective university archives management (Makori, 2017). There is evidence indicating that IoT-based technologies can revolutionise university archives, shifting them from a traditional and outdated approach to a modern and technologically advanced one. Despite various opinions on

the potential application of IoT-based technologies in university archives, these arguments offer a chance to comprehend the capabilities of IoT-based technologies in this setting. Using IoT technology is the most effective method for overseeing university archives facilities and maintaining collections (Chelliah, Sood & Scholfield, 2005). When discussing this subject, it is essential to ask the following question: “What are the suitable uses of IoT technologies that can be suggested for managing archival documents in academic archives?”

Using IoT technology in university archives is gaining popularity in the Western region. The university archives facility in the USA employs IoT-based technology to monitor and regulate various environmental factors such as temperature, humidity, access control, ultraviolet (UV) light, air quality, and other associated aspects (Maceli, 2020). IoT-based technologies implemented in university archives can evaluate visitors' behavioural trends and levels of congestion, thereby enabling interactive exhibits and offering location-specific information to patrons. RFID technology offers the capacity and potential to deploy electronic chips, inductive cards, contactless cards, electronic labels, and electronic barcodes. These electronic chips transform university archives into automated procedures. Numerous organisations employ IoT systems for various purposes within the context of archives and records management. In contrast, Europe employed short-range monitoring RFID technology to track and monitor animals (Ma et al. 2022; Ramirez-Faz et al. 2020). For this, the IoT plays a crucial role in effectively maintaining university archives and facilitating the transition to embrace contemporary technology. Using IoT-RFID technology is effective implementing advanced technology in university archives.

IoT-based RFID technology has diverse uses, including the automation of operations and minimising of human intervention in the maintenance of their archives. Ma et al. (2022) states that IoT systems are used by several university archives to convert conventional university archives into contemporary ones.

RFID is a superior instrument for preserving and providing accessible information services to users and is ideal for managing the collection of services provided by the archives (Chelliah et al., 2005). The RFID system can enhance collection management through the efficient optimisation of check-in, check-out, and inventory tracking processes. In addition, the IoT employs a various sensors to facilitate the monitoring of rooms and prevent the theft of archival documents.

Nevertheless, certain establishments implement RFID systems to prevent theft (Husain & Nazim, 2015). These authors contend that implementing IoT has a detrimental effect, as it necessitates a reduction in worker numbers resulting from the adoption of this novel technology, and that IoT-based RFID technology can oversee archival collection materials by utilising archival tags. They suggest archival tags are crucial components of an intelligent security system designed for archival material and storage rooms in the higher education environment. Tian et al. (2022) contended that archival tags serve as instruments for safeguarding archival material, which encompasses confidential archives.

The IoT-enabled environmental monitoring system mitigates undesirable environmental conditions while maintaining records (Harvey & Mahard, 2015). IoT technologies can be used to monitor the air quality, lighting, and temperature, which can impact the preservation of archival materials in archival institutions. They can further safeguard and conserve archive assets by implementing system monitoring approaches. The researcher contends that using an IoT-based environment-monitoring system can mitigate the potential damage to archival items

in university archives repositories. Essentially, the IoT-based environment-monitoring system safeguards archival institutions that store historical material or collections (Wojcik, 2016). An IoT-based environment-monitoring system can utilise internet infrastructure to monitor diverse archive resources, including paper-based records, pictures, map collections, and audio-visual material. In addition, the university archives house a variety of historical items, including minutes, annual reports, policies, strategic plans, financial statements, research output, and equipment (Herwahyudi et al., 2020; Li, 2022 & Ma et al., 2022). Using IoT technologies is crucial in the surveillance of archives within structures. The IoT paradigm offers significant methods for controlling and monitoring buildings, including archives. Archival repositories help to safeguard and maintain the collective knowledge and historical records of institutions. Gonzalez et al. (2020) state that the utilisation of IoT monitoring and control systems has been widespread in archival buildings.

An IoT-based cloud computing solution has been utilised to digitise the labels of university archives. The intelligent security system of the filing cabinet, as described by Ma et al. (2022), safeguards secret records. This programme is used to convert university archives tags into a digital format using IoT-based RFID technology. IoT-enabled cloud computing applications offer an intelligent security system that can be utilised as digital filing cabinets to safeguard confidential records. However, the entire RFID system comprises only a reader and a transponder.

The successful implementation of IoT-based technology transformed university archives in the USA from a traditional method to a modern approach, as highlighted by Maceli (2020). Moreover, the use of IoT technology is highly valued for its ability to effectively manage and provide opportunities for universities to transition to modern technology in their business processes and archival systems. Implementing IoT-based technologies has enhanced university management in various areas, as evidenced by a wide range of publications.

8.2 The roles of IoT technology in enhancing university archives services

University archives can leverage a various IoT technologies in their environment. This is an opportunity for university archives to enhance their service provision and their overall management. Maceli et al. (2019) suggest that effectively managing and delivering services in university archives rely on the implementation of new and sophisticated technology. University archives have embraced cutting-edge technologies to handle the diverse difficulties in their archival repositories. Academics concur that university archives have numerous obstacles in managing their archives (Ma et al., 2022). Studies have demonstrated that university archives encounter distinct obstacles, including the organising archival collections, absent standardised classification, lack of enforced norms, and unscientific processing of archives. University archives have additional obstacles, such as the need for a robust system to oversee and regulate the environmental conditions of archived collections, as well as the maintenance of archival entities (Maceli, 2020). Current technologies do not sufficiently support environmental monitoring conditions (Maceli, 2019). University archives, along with numerous other institutions, are rapidly adopting RFID technology to enhance the efficiency of information services and improve service quality (Makori, 2017). IoT-based RFID technology employs radio waves to precisely and distinctively identify items within university archives.

University archives employ various IoT technology tools, including geographic information systems, GPS, variable rate technology, optical satellite imagery, near infrared (NIR) satellite imagery, aerial imagery, sensor technology, cloud computing, and actuators, to safeguard and

preserve archival materials by mitigating potential damage caused by factors such as sunlight, humidity, acidity, light, and heat (Yadav et al., 2018). Ma et al. (2022) found that IoT technologies are effective in university archives as they enhance management, service delivery, and efficiency while reducing time, cost, and human participation in various processes. Essentially, IoT technologies streamline the automation of university archival functions. An exemplary application of IoT technology in university archives is the employment of archival tags to enhance an advanced security system (Ma et al., 2022).

8.3 Uses of IoT in line with requirements for managing academic archival records

Crucial factors for successfully implementing IoT technology in university archives involve addressing the difficulties related to accessing, navigating, and utilising IoT-based apps for archival purposes. In their study, Maceli (2020) examined the utilisation of IoT technologies to monitor and manage university history and buildings. IoT-based technology was utilised as a tool to enhance management and service delivery. In addition to confirming findings, using IoT-based technologies resulted in favourable professional and institutional advantages, particularly in university archives. The investigation uncovered that numerous university archives lacked knowledge regarding the means and sources to acquire cost-effective and superior options. Despite their financial constraints and lack of knowledge in managing the complexities of IoT-based technologies, they were unable to acquire and navigate IoT-based technologies. This suggests university archives are hesitant to adopt IoT-based technologies due to their lack of knowledge of how to initiate the use of these applications. Additionally, they are concerned about the potential lack of return on investment.

Furthermore, similar to other university archives, it is necessary to establish a conducive regulatory framework that facilitates convenient access to superior financial resources, as well as technical expertise and support services to strengthen organisational capacities. This will enable businesses to fully leverage the advantages of implementing an IoT-based technology strategy. Using IoT-based technology has the potential to oversee and regulate university archives. This can be achieved by implementing diverse IoT applications.

Using IoT-based devices in university archives involves applying IoT-based technology. Positioning devices are frequently utilised in this context to ascertain latitude, longitude, and altitude. The university archives extensively employ IoT-based equipment such as cameras and wireless networks for information analysis. The system operates on a wireless sensor network.

The implications of university archives require comprehending the application of IoT technologies in the process and procedures of managing university archives. Using IoT technologies aids in notifying management about the necessity to enhance inadequate management practices. Managers and policymakers should prioritise specific applications of IoT in university archives, including monitoring systems, regulating systems, and tracking systems. Records managers and archivists can prioritise the utilisation of IoT technology in university archives. Implementing these applications can enhance inadequate management of historic content. Implementing IoT technology in university archives is considered the optimal solution for effectively managing university archives.

9. Conclusion and recommendations

This study presents conclusions regarding the appeal of IoT technologies for university archives. The findings highlighted two essential IoT technologies employed by university

archives: controlling and monitoring their archives. This study demonstrated the advantages of utilising IoT technology to address a various difficulties faced by university archives. However, it is still a relatively unexplored area in many university archives. Using IoT-based technologies helps to overcome the difficulties associated with managing university archives.

The study aimed to persuade policymakers to implement the use of IoT technology in university archives in South Africa. Implementing IoT technologies in South African university archives aims to enhance service delivery and facilitate efficient management. DIT was identified as a framework to use IoT technologies in university archives in South Africa. The idea was to promote the utilisation of IoT technology to convert university archives from a conventional to a contemporary method. Implementing new technology is expected to enhance efficiency and effectiveness of service delivery and management in university archives, and implementing IoT technology is anticipated to enhance outdated operational procedures in diverse information management systems, including university archives.

The study recommends that South African university archives adopt IoT technology to enhance their management of archival records. They should conduct various research and development projects related to IoT-based technologies in university archives. Furthermore, they should share benchmark information with other university archives to develop innovative solutions and link their policies to IoT-based technologies.

Declaration

- The manuscript has not been previously published and is not under consideration for publication with any other journal or copyrighted publishing platform of any kind.
- Permission was granted for collection and publication of the presented identifiable data from target organisation and permission letter will be provided with manuscript.
- Unlawful statements that infringe any existing copyrights is avoided in the manuscript.
- Authors have sought permission for copyright from 3rd parties by obtaining the necessary permission from the copyright holder/s to reproduce their materials in different media in the article, such as tables, diagrams and photographs owned by them.
- Manuscript and study meet all the ethical requirements of the journal and that of my institution or company, as well as legal requirements of the study country.
- No AI tool/Large Language Model (LLM) was used in the creation of manuscript. Any usage of AI tool/LLM in the development or generation of manuscript in part or in full is stated clearly in the Methodology and Acknowledgements sections of the manuscript.
- There is not any potential conflict of interest for the research.
- All authors are familiar with the content of this manuscript and gave consent to co-publish.
- All authors contributed to the writing of the article manuscript.
- Authors take responsibility to keep participants information confidential as required by legislations including Protection of personal information Act.
- Authors gives consent to the Journal of South African Society of Archivist to publish the manuscript.

Acknowledgements

Author did not receive any contribution from any organization or individuals.

References

- Anderson, S. & Hart, G. 2016. Challenges in digitising liberation archives: a case study. *Innovation: Journal of appropriate librarianship and information work in southern Africa*, 53: 21 -38.
- Aparicio, M. Bacao, F. & Oliveira, T. 2016. An E-learning theoretical. *Journal of Educational Technology System*, 19(1): 292-307.
- Bikefe, G., Umaru, Z., Araga, S., Faize, M., Ekanem, E. & Daniel, A. 2020. Corporate social responsibility (CSR) by small and medium enterprises (SMEs): a systematic review. *Small Business International Review*, 4(1): 16-33.
- Bower, J. & Christensen, C. 1995. Disruptive technologies: Catching the wave. *Harvard Business Review*, 73: 43-53.
- British Standard Institution. 2018. *BS EN 16893: 2018 conservation of cultural heritage-specifications for location, construction and modification of buildings or rooms intended for the storage or use of heritage collections*. BSI standard, London, UK.
- Chelliah, J., Sood, S. & Scholfield, S. 2015. Realising the strategic value of RFID in academic libraries: A case study of the University of Technology Sydney. *The Australian Library Journal*, 64(2): 113-127.
- Chen, X. 2023. Smart archives management: Application of IOT, BD and GIS to infrastructure archives management. *International Academic Journal of Humanities and Social Science*, 1(1): 15-23.
- Chrysanthopoulos, C., Drivas, I., Kouis, D. & Giannakopoulos, G.A. 2021. University archives: The research road travelled and the one ahead. *Global Knowledge Memory and Communication*, 72(1/2): 44-68.
- Gonzalez, T., De Rubia, M.A., Hincz, K., Comas-Lopez, M., Subirats, L. & Fort, S. 2020. Influence of COVID-19 confinement in students' performance in higher education. *PLOS One*, 15: e0239490.
- Großmann, M., Illig, S. & Matejka, C. 2017. *Environmental monitoring of libraries with Montreal*. Paper read at International Conference on Theory and Practice of Digital Libraries, Springer, 18 - 21 September 2017, Thessaloniki, Greece: 599-602.
- Harvey, R. & Mahard, R. 2015 Preservation management handbook: A 21st-century guide for libraries, archives and museums. *The American Archivist*, 78(2): 595-598.
- Herwahyudi, R., Permana, P., Rohmat, D., Bay, M. & Zakiah, H.A. 2020. E-archive application based on web (Case study: PT Dirgantara Indonesia (Persero). *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(4): 2959-2967.
- Hiddle, J. 2010. Indiana State University archives. Available online: <http://library.indstate.edu/about/units/archives>
- Husain, S. & Nazim, M. 2015. Use of different information and communication technologies in Indian Academic libraries. *Library Review*, 64(1/2): 135-153.
- Jenkinson, S.L. 1996. Two concepts of tolerance: or why Bayle is not Locke. *The Journal of Political Philosophy*, 4(4): 302-321.
- Khan, S.F. & Ismail, M.Y. 2017. An investigation into the challenges and opportunities associated with the application of the Internet of Things (IoT) in the agricultural sector – A review. *Journal of Computer Science*, 14(2): 132-143.
- Kuppusamy, P. 2019. Smart education architecture using the Internet of Things (IoT) technology. *The International Journal of Management, IT and Engineering*, 4(2): 1-26.
- Lee, A. & Kamler, B. 2008. Bringing pedagogy to doctoral publishing. *Teaching in Higher Education*, 13(5): 511-523.

- Li, J. 2022. Design of an effective archives management system with a compression approach for network information technology. *Wireless Communication and Mobile Computing*, 2022(3): 1-10.
- Ly, Z & Shi, H. 2020. The Exploring on University archives management system based on information system. *Journal Of Physics: Conference Series*, 1550 (3):1-5.
- Ma, Y., Dai, B. & Ding, B. 2022. University archives autonomous management control system under the Internet of Things and deep learning professional certification, *Computation Intelligence and Neuroscience*, 1: 1-9.
- Maceli, M. 2020. Internet of Things in the archive's novel tools for environmental monitoring of archival collections. *Records Management Journal*, 30(2): 201-220.
- Maceli, M., Villaespesa, E. & Adam, S.A. 2019. *Environmental monitoring of archival collections: an exploratory study of professionals' data monitoring dashboard needs and related challenges*. 14th International Conference, 31 March – 3 April 2019, Washington, DC, USA: 777-784.
- Makori, E.O. 2017. Promotion of innovation and application of the Internet of Things in academic and research information organisation. *Library Review*, 66: 655-678.
- Martinus, M., Sihalohe, N.T.P. & Shadrina, D.N. 2022. Archives management in support official administration in Toho sub-district head office, Mempawah Regency. *Ilomata International Journal of Social Science*, 3(1): 340-346.
- Masanya, T.M. 2020. Application of modern technologies in the management of records in public libraries. *Journal of the South African Society of Archivists*, 53: 65-79.
- Mohammed, Z. & Bello, U. 2022. Cause of delay in construction projects: A systematic review. *International Journal of Engineering Research*, 11(03): 63-71.
- Musa, A., Ijaiya, M.A. & Mustapha, Z.U. 2021. The international marketing in the last decade: A systematic review. *Irocamm – International Review of Communication and Marketing Mix*, 2(4): 35-45.
- Netshakhuma, S. 2019. The blurry line between archives and records management at the universities in South Africa. *Journal of the South African Society of Archivists*, 53: 61-78.
- Palanivel, L. 2019. An approach for prediction of crop yield using machine learning and big data techniques. *International Journal of Computer Engineering and Technology*, 10(03): 110-118.
- Pickering, C. & Byrne, J. 2014. The benefits of publishing systematic quantitative literature reviews for PhD candidates and other early-career researchers. *Higher Education Research and Development*, 33(3): 534-548.
- Pujar, S.M. & Satyanarayana, K.V. 2015. Internet of Things and libraries. *Annal of library and information studies*, 62: 186-190.
- Ramirez-Faz, J., Fernandez-Ahumada, L., Fernandez-Ahumada, E. & Lopez-Luque, R. 2020. Monitoring of temperature in retail refrigerated cabinet apply IoT over open-source hardware and software. *Sensors*, 20(3): 846.
- Rayes, A. & Salam, S. 2019. *Internet of Things: From hype to reality: The road to digitization*. 2nd ed. Springer, Cham, Switzerland. Available: <https://doi.org/10.1007/978-3-319-99516-8> (Accessed: 9 April 2020).
- Siddell, K. 2018. Documenting student life: using Omeka to connect students to the University archives. *Codex (2150-086x)*, 4(4): 48-61.
- Sinha, P. & Brar, K.S. 2022. Application of the Internet of Things (IoT) in Libraries. *Library Hi Tech*, 38(1): 67-77.
- Shammar, E.A. & Zahary, A.T. 2019. The Internet of Things (IoT): A survey of techniques, operating systems, and trends. *Library Hi Tech*, 38(1): 5-66.

- Shi, X., An, X., Zhao, Q., Liu, H., Xia, L., Sun, X., & Guo, Y. 2019. State-of-the-art Internet of Things in protected agriculture, MDPI. *Sensors* (Basel), 9(8): 1-24.
- Strömberg, J. & Thorman, P. 2019. *Disruptive Innovation theory in the paper and packaging industry applying Clayton Christensen in a new context*. Master's thesis, Uppsala Universitet, Sweden.
- Terry, O. 2020. Disruption innovation and theory. *Journal of Service Science and Management*, 13: 449-458.
- Tian, J., Wang, B., Wang, Z., Cao, K., Li, J. & Ozay, M. 2019. Joint adversarial example and false data injection attacks for the state estimation in power system. *IEEE Trans, Cybern*, 52(12): 13699-13713.
- Yadav, Y., Mahjabin, Kumar, L., Chaudhary, S. & Malik, S. 2018. An overview on the Internet of Things (IoT) as a technology boon for sustained agriculture farming. *International Journal of Agriculture Innovations Research*, 7(1): 129-133.
- Vardhan, K.H., Kumar, P.S. & Panda, R.C. 2019. A review on heavy metal pollution, toxicity and remedial measures: Current trends and future perspectives. *Journal of Molecular Liquids*, 290: 1-22.
- Verma, P., Sharma, R. & Gupta, A. 2022. Integration of proximal remote sensing and geographic information system (GIS) for land cover change assessment in India. *Journal of Environmental Management*, 301: 113765.
- Webster, J. & Watson, R.T. 2002. Analysing the past to prepare for the future: Writing a literature review. *MIS Quarterly*, 26: 13-23.
- Wojcik, M. 2016. Internet of Things potential for libraries. *Libraries Hi-Tech*, 34(2): 404-420.