

**UTILISATION OF THE INTERNET OF THINGS IN THE MANAGEMENT OF
INFORMATION SERVICES AT POLOKWANE MUNICIPALITY LIBRARIES IN THE
LIMPOPO PROVINCE OF SOUTH AFRICA**

by

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DECLARATION OF ORIGINALITY

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I, Lebitsi Mothapo, declare that the dissertation mentioned above is my own work and based on my own efforts. I confirm that I subjected the dissertation to an originality check, and it complies with the accepted standards of originality. All consulted information sources and quotations from different sources are fully acknowledged and captured in the reference list at the end of the dissertation. Additionally, I have not previously submitted this work, or any portion of it, for assessment at UNISA or any other higher education institution for a different qualification.

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ABSTRACT

The Internet of Things (IoT) is an emerging technology that enables a variety of smart devices to exchange information through machine-to-machine communication, computerisation connectivity and human interaction in libraries. In the context of libraries and information services, the IoT offers various functionalities, such as locating and protecting information resources through bases of devices such as Radio Frequency Identification Device and Library Automated Management Systems. This study investigated the utilisation of the IoT for managing information services at the libraries of the Polokwane Municipality in the Limpopo Province of South Africa. A mixed methods research approach was employed, using convergent design and parallel sampling techniques. Data was collected by questionnaires, interviews, observations and document analysis. The study population consisted of library workers and information technology (IT) practitioners at the Polokwane Municipality Libraries.

The research findings revealed that the Polokwane Municipality Libraries currently rely on a manual system for managing information services and resources, which results in slow check-in and check-out routines, human error, duplicate user records and theft. The study recommends the adoption and implementation of IoT to improve efficiency, accuracy and security of library operations at the Polokwane Municipality. The IoT has the potential to enhance resource availability through cloud-based storage; provide users with online database access; speed up the circulation processes; reduce human error; and strengthen encrypted security control. A framework is proposed for integrating the IoT into the management of library and information at the Polokwane Municipality Libraries in the Limpopo Province.

Keywords: Internet of Things, IoT, information services, radio frequency identification device, Library Automated Management Systems Technology, Polokwane Municipality Libraries

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LIST OF ABBREVIATIONS

4IR	Fourth Industrial Revolution
AI	Artificial Intelligence
ALA	American Library Association
CATI	Computer Assisted Telephone Interviewing
CBD	Central Business District
DAC	Department of Arts and Culture
DBE	Department of Basic Education
DDC	Dewey Decimal Classification
DTI	Department of Trade and Industry
DSAC	Department of Sport, Art and Culture
ECTA	Electronic Communication and Transaction Act
EU	European Union
ICT	Information and Communication Technology
IFLA	International Federation of Library Association and institution
IoT	Internet of Things
IP	Internet Protocol
IT	Information Technology
ITU	International Telecommunication Union
LIS	Library and Information Services
LAMST	Library Automated Management Systems Technology
MCC	Mobile Cloud Computing
MMR	Mixed Methods Research
NCLIS	National Council for Library and Information Services
NDP	National Development Plan
NFC	Near-Field Communication
NLSA	National Library of South Africa
OCLC	Online Computer Library Center
OECD	Organisation for Economic Co-Operation and Development
OPAC	Online Public Access Catalogue

PAN	Personal Area Network
PML	Polokwane Municipality Libraries
POPIA	Promotion of Personal Information Act
QR	Quick Response
RFID	Radio-Frequency Identification Device
SAHRC	South African Human Rights Commission
SAL	Sensors Application Layer
SALRC	South African Law Reform Commission
SNMF	Zero-Net Mass Flux
TAM	Technology Acceptance Model
UID	Unique Identifier
UL	University of Limpopo
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISA	University of South Africa
USA	United States of America
UWB	Ultra-Wideband
WCN	Wireless Sensor Network
WORM	Write Once, Read Many
ZNMF	Zero-Net Mass Flux

CHAPTER 1: INTRODUCTION: FRAMING THE STUDY IN CONTEXT

1.1 Introduction and background

Following the rise of the Fourth Industrial Revolution (4IR), the Internet of Things (IoT) has been playing a key role in the management of library and information services across the globe (Modiba 2021; Olubiyo 2024). In the context of library and information sciences, IoT includes technology such as tags and radio frequency identification (RFID) devices, which can be used to locate and protect information sources in the library (Makwana 2021). RFID essentially serves as the backbone of IoT, providing a critical function that expands data accessibility through automated devices across multiple locations (Din & Ali 2024). In this way, RFID involves an integrated wireless form of technology that transmits data by means of waves of frequency tags attached to device systems capable of identifying, classifying and tracking mechanical/smart objects (Igbinovia & Okuonghae 2021). The integration of RFID and IoT enables diverse device connectivity, enhancing the application of semantic technology to facilitate the efficient exchange of data in libraries (Ritu 2024). Solanke (2021) and Sivasankar, Soundararajan and Rajeswari (2020) express a similar view, asserting that IoT is elevated by the contribution of RFDI, which enables technologies to operate dynamically and remotely through the use of barcodes and smart cards.

In essence, the term “the Internet of Things” is conceptualised from two words, which can be considered separately for clearer understanding (Linnik 2019; Hassans 2025). “Internet” refers to multiple automatic communication systems and “thing” entails a description of dynamic technologies (Frandsen & Sørensen 2020; American Library Association. Center for the Future of Libraries 2014). Therefore, IoT represents a broad technological domain with vast potential, continuously evolving and offering limitless opportunities (Qin 2018). In particular, IoT has opened future possibilities for libraries to enhance their services, incorporating Internet Protocol (IP), self-help devices and sustainable network development, thereby remaining relevant and efficient (Qin 2021; Bassie 2025). The opportunities created by IoT offer significant potential for generating information or achieving exceptional outcomes across subject matter (Makwana 2021).

Moreover, IoT exemplifies a key component of the 4IR, supporting evolving paradigms that enable communication among electronic devices (Shammar & Zahary 2019). Similarly, Modiba, Ngulube and Marutha (2023) and Ajani, Adefila, Olarongbe, Enakrire and Rabiou (2024) describe the Fourth Industrial Revolution (4IR) as a digital landscape in which IoT, reference management tools, big data technologies and cloud systems collectively drive global technological transformations, facilitating online interactions and overcoming the limitations of slow, physical library processes. This integration progressively enables continuous real-time visibility by connecting cyber system devices with big data flows, functioning as a reliable, stand-alone technology (Olubiyo 2024; Kagalwala, Radhakrishnan, Mohammed, Kothinti & Kulkarni 2025). This technology can identify required information and information to ignore, and create an important field of digital information repository (Potter 2014; Al-Fuqaha, Guizani, Aledhari & Ayyashi 2015).

With the increasing adoption of IoT in public libraries, amplified by the 4IR, digital information repositories are rapidly expanding, helping to address longstanding challenges in library operations (Kaba & Ramaiah 2019; Sharma, Sati & Miyan 2025). However, public libraries continue to face prospective challenges, including limited information access expansion, outdated library material, operational difficulties due to high resource demand and reliance on manual systems (Bopape, Dikotla, Mahlatji, Ntsala & Makgahlela 2021; Mavani 2024). As asserted by the ALA (American Library Association. Center for the Future of Libraries 2014), challenges related to outdated library collections and manual systems can be resolved by the installation of IoT-based self-help machines. Self-service machines operating in the library to facilitate independent check-in and check-out, making the process easier for the library users (American Library Association. Center for the Future of Libraries 2024). Din and Ali (2024) assert that academic libraries at universities advance digital transformation through multifaceted approaches, including cloud storage, which offers extensive information resources and provides users with updated information remotely.

IoT systems securely store in the cloud, employing encrypted security protocols that safeguard data while enabling easy retrieval upon users' request (Bello & Adepegba 2023; Ashikuzzaman 2024b). Furthermore, the DH Hill Library at the North Carolina State University has implemented IoT technologies in practice. Within the library, IoT facilitates keycard access, monitors digital signage and automatically tracks the number of users present in the library (Bokefodea, Bhiseb, Satarkara, & Modanic 2016; Maepa & Moeti 2021). Sensors and installed robotic devices in university library also support online renewal of library materials and provide automated responses to users queries (Qin 2018; Sinha & Brar 2022; Tamil & Sudhier 2024).

The features of the IoT transform the library environment from a traditional setup into a modern, fully digital system (Kaushik 2019; Makwana 2021). The transformation of public libraries to modern library facilities calls for South African policy and legislative frameworks such as the Promotion of Access to Information Act (No. 2 of 2000), which guides libraries in the adoption and implementation of relevant IoT technologies (Hart & Nassimbeni 2016; Mondal 2021). Reinforced by legislation, modern libraries ensure the technical usability of IoT applications in library services without any fragmentation (Din & Ali 2024).

Despite its numerous benefits and positive outcomes, challenges such as security issues, privacy violations and information accuracy should be considered, as they may hinder the utilisation process (Din & Ali 2024; Vieriu & Petrea 2025). Despite these challenges, the IoT offers opportunities, including collection development, assistive technology, virtual libraries, book tracking, sustainable networks, QR code integration and shelf management systems, all of which justify the option of IoT in libraries (Vieriu & Petrea 2025). In this study, a conceptual framework (CF) is designed by incorporating the Library Automated Management Systems Technology (LAMST) and adjusting Dr. Ranganathan's Five Laws of Library Science to a technological context (Wang 2019; Makwana 2021).

The conceptual framework aims to promote diverse, interconnected systems supported by robust infrastructures that collectively achieve common goals in information management (Yosuf, Ifijeh & Owalabi 2019; Hassans 2025). The key concepts adopted from LAMST are users' perception and infrastructural development. The interaction of these two concepts reflects the future of the Internet, forming part of dynamic networks with self-configuration capabilities, where virtual and physical elements are integrated to create potential information networks (Bessarab, Hyrina, Sytnyk, Kodatska, Yatchuk, & Ponomarenko 2022; Kagalwala et al. 2025).

Furthermore, the concepts of ease of use and policy evaluation are incorporated in the technological adaptation of Dr. Ranganathan's Five Laws of Library Science. The concept ease of use examines the usability of web technology in enhancing stand-alone systems with seamless self-communication devices, thereby enabling the creation of evolving back-up systems in libraries (Ketu & Mishra 2021; Olayinka, Abdulfatai, Abiola, Adebisi, Saidu & Rotimi 2024). Policy evaluation focuses on establishing and legitimising mobile-based system databases that shape digital libraries for improved information management through comprehensive policy frameworks (Srikanth 2024).

The conceptual framework supports the provision of efficient services that effectively integrate modern technology within the library. Consequently, applying this CF to the management of information services may broaden the scope of investigation for the study. In this context, this study investigates the utilisation of IoT in the management of information services at the Polokwane Municipality Libraries in the Limpopo Province of South Africa.

1.2 Context of the study

According to Tjale (2021), the Polokwane Municipality Libraries (PML) consists of eight (8) libraries located in different communities in the Limpopo Province. This study focuses on the following eight (8) libraries located in Capricorn Districts (CD) managed by the Polokwane Local Municipality: (i) Polokwane City Library, (ii) Mankweng Public Library, (iii) Matlala Public Library, (iv) Moletji Public Library, (v) Nirvana Public Library,

(vi) Seshego Public Library, (vii) Westernburg Public Library, and (viii) Molepo Public Library (Tjale 2021).

1.2.1 Polokwane Municipality Libraries (PML)

1.2.1.1 Polokwane City Library

The largest municipality library in Polokwane, located in the city centre, is the Polokwane City Library. Established on 13 May 1904 as a “subscription library”, it initially operated from a single room in Market Street (Limpopo Provincial Government. Department of Sport, Arts & Culture 2014). In 1990, the library relocated to the corner of Schoeman and Jorissen Streets, right in the central business district (CBD) of the City of Polokwane, where it is famously known as Library Gardens. It is situated on the north side of the Polokwane Municipality headquarters.

1.2.1.2 Mankweng Public Library

The second library is Mankweng Public Library, located in the Mankweng community, commonly referred to as the Turfloop Area. Developed in 1960, this township is situated adjacent to University of the North (UN), currently known as the University of Limpopo (UL). As reported in the *Annual Report, 2015–2017* of the Polokwane Municipality, the growing population in the area prompted the Municipality to establish the library to serve the community (Polokwane Local Municipality 2022).

1.2.1.3 Matlala Public Library

The study also examines the Matlala Public Library, established in the Ga Matlala community, which consists of several areas known as Tibanefontein – commonly referred to as Tibane – located north-west of the City of Polokwane. The library was specifically launched to promote the development of an informed society within the community (Polokwane Local Municipality 2022).

1.2.1.4 Moletji Public Library

The Polokwane Municipality established another branch in the Moletji cluster, located 33 kilometres from the City of Polokwane. The creation of the Moletji

Library was driven by the need to promote the long-term sustainability of the community (Tjale 2021).

1.2.1.5 Nirvana Public Library

Additionally, Polokwane Municipality decided to open another library in an area historically inhabited by Indian residents, known as Nirvana, near Ivy Park. The Nirvana Public Library was founded with the mission of educating the community and fostering adaptation to the diverse cultural groups in the Limpopo Province (Kekana 2007; Tjale 2021; Mamabolo 2022).

1.2.1.6 Seshego Public Library

The Seshego Public Library originated in a township designated as non-independent under Lebowa between 1972 and 1974. Today, the Seshego community is situated directly north-west of Polokwane City. The library was established to broaden the knowledge base of the community.

1.2.1.7 Ga Molepo Public Library

The Ga Molepo Public Library, established in 2010, was the recent addition and was transferred to the care of the Polokwane Municipality by the Department of Sport, Arts and Culture (DSAC) (Tjale 2021).

1.2.1.8 Westernberg Public Library

The last library under discussion is the well-known Westernberg Library, located in the heart of the City of Polokwane. The library was established to promote social cohesion, knowledge and empowerment within the Polokwane community (Limpopo Provincial Government. Department of Sport, Arts & Culture 2014). These libraries serve the following groups: small children, secondary school learners, school projects, parents, university students, and the elderly, as well as recreational readers (Polokwane Local Municipality 2022).

1.2.2 Services offered at Polokwane Municipality Libraries

As stated in the Annual Report, 2015–2017 (Polokwane Local Municipality 2022), each library comprises of a preservation section, circulation desk, children's section, a cataloguing and classification section, computer labs and a reserve section, which accommodates school and academic materials. The libraries primarily operate through traditional methods. For example, in the children's section – which focuses on early childhood development to strengthen reading skills and foster a love for books – outreach programmes are conducted for foundation phase learners and preschools.

The circulation desks in these libraries are consistently available for user registration and membership creation, primarily supporting manual check-in and check-out processes. Book renewals necessitate users to interact with librarians, either by telephone, email or by visiting the library in person to return the borrowed materials.

Another key area found in these libraries is the preservation section, where books are repaired and reinforced to extend their lifespan. The core function of the preservation section is to repair, restore and preserve books by using materials such as plastics, glue, scissors and rulers (Mondal 2021; Tamil & Sudhier 2024). Through this strengthening process, any damaged items in the library collection are restored, thereby ensuring that they are ready for circulation or use with minimal risk of further deterioration (Limpopo Provincial Government. Department of Sport, Arts & Culture 2014). The primary purpose of strengthening the hard copies of books is to extend the lifespan of the items in the library collection.

The reserve section also provide information services that support academic learning for primary and high school learners, offering overnight loans of study guides. Additionally, the libraries feature computer facilities, where users can access search engines and use voucher tokens to consult e-books, e-publications, audio-multimedia collections and e-journals, although access to web databases is limited catalogued and provided by the library (Limpopo Provincial Government. Department of Sport, Arts & Culture 2014).

According to the Nkondo, Hart and Nassimbeni (2018), libraries in the Limpopo Province, including the Polokwane Municipality Libraries, are traditionally regarded as custodians of printed materials, requiring users to visit the library physically to access the collection/s (Republic of South Africa. Department of Arts and Culture 2018). However, the availability of electronic resources allows users to access library materials remotely, eliminating the need for regular visits to the library.

1.3 Problem statement

Public library users spend a great deal of time establishing where to access and locate information sources required for their projects and assignments (Soni 2023a & 2023b). As indicated by Srikanth (2024), most librarians at public libraries in rural and urban areas in South Africa use manual systems to navigate and locate reliable information for users. Consequently, manual systems are unable to keep up with the growing demand for information; particularly through online resources, due to the lack of accessible databases for e-books, e-journals and other e-publications (Bello & Adepegba 2023). Therefore, library users are required to rely on paper-based collections, with the check-in and check-out recorded manually.

While renewals can be processed telephonically or online, the system remains dependent on physical library visits (Wojcik 2019). Moreover, the manual system does not connect with other public libraries, resulting in outdated paper-based collections and limited access to inter-library loan services and recently acquired materials (Makwana 2021). As stipulated in the *Annual Report, 2015/2016* of the Polokwane Local Municipality, libraries like PML are victims of manual systems, which require users to visit the library physically to search the library catalogues for required books (Polokwane Local Municipality 2024). Such a search on the library catalogue provides the users with a call numbers required to locate the book on the shelves (Qin 2018; Srikanth 2024).

The manual search process is inflexible and time-consuming; particularly when users need to locate multiple books on the library shelves. This slows down information access, compared to libraries with online catalogues and applications (Kaushik 2019; Mokwana 2021). As observed at PML, the absence of an online database means that users cannot verify the availability of information before visiting the library (Coetzee & Ekskeen 2011). Furthermore, Mohammadi and Ezadi Yegane (2018) note that it is frustrating for users to visit the library only to find that the information or resources required for a project or an assignment are unavailable.

The utilisation of IoT can address several challenges in libraries by incorporating self-service computerised machines, robotic devices with sensors and RFID tags and Internet Protocol systems to access library databases (Qin 2018). The use of near-field communication within the IoT provides an alternative method for the rapid retrieval of books, allowing users to locate materials quickly without manually searching the library shelves (Abo-Seada 2019). Additionally, the IoT enables library members to verify the availability of hard-copy books through online catalogue databases before visiting the library (Ashikuzzaman 2024b).

According to Ambaresh (2024), the IoT facilitates and enhance extensive communication between users and librarians by providing updates on newly acquired materials via online applications. Furthermore, Frandsen and Sørensen (2020) highlight that self-service machines, powered by the IoT, allow users to access e-resources automatically at any time. Based on these advantages offered by the IoT, this study intends to investigate the utilisation of the IoT for the management of information services at the Polokwane Municipality Libraries.

1.4 Purpose of the study, objective and question

1.4.1 Purpose of the study

The purpose of the study is to investigate the utilisation of the IoT for the management of information services at the Polokwane Municipality libraries in the Limpopo Province of South Africa.

1.4.2 Research objectives

In the context of this study, research objectives involve a research map used to discover valid information on the proposed research problems and to obtain information by analysing collected primary data and reviewing secondary data (Du Plooy-Cilliers, Davis & Bezuidenhout 2014).

The research objectives of this study are to:

1. Evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries;
2. Examine the usability of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries;
3. Assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries;
4. Identify IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries; and
5. Recommend a framework for the implementation and use of IoT in the management of information services at the Polokwane Municipality Libraries.

1.4.3 Research questions

Based on the research objectives, the following research questions have been identified to guide the research:

1. How adequate is the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries?
2. How usable is the IoT in the management of information service at the Polokwane Municipality Libraries?
3. What is the perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries?

4. Which IoT infrastructure would be suitable for the management of information services at the Polokwane Municipality Libraries?
5. Which framework can be designed and implemented for use of IoT in the management of information services at the Polokwane Municipality Libraries?

1.4.4 Research dashboard

To achieve the research objectives outlined in this study, the research dashboard is essential, in that it provides a visual presentation of the information that the researcher requires, after which the information obtained can be organised systematically and displayed on a screen (Damyanov & Tsankove 2019; Modiba 2021). For this research, the dashboard functions as an analytical tool that provides an overview and helps to clarify the underlying rationale of the study. The dashboard summarises the research objectives, questions, the theories involved in the conceptual framework, methodology, and data collection methods, organised in table format and presented in Table 1.1.

Table 1.1: Research dashboard

Research objective	Research questions	Theories	Method	Data collection
Evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries.	How adequate is the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries?	Dr Ranganathan's Five Laws of Library Science in a technological context	Qualitative	Document analysis Questionnaire Interviews
Examine the usability of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries	How usable is the IoT in the management of information services at the Polokwane Municipality Libraries.	Library Automated Management Systems Technology (LAMST)	Quantitative	Interviews Questionnaires
Assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries	What is the perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries?	Library Automated Management System Technology (LAMST)	Quantitative & Qualitative	Questionnaires Interviews
Identify IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries.	Which IoT infrastructure would be suitable for the management of information services at Polokwane Municipality Libraries?	Dr Ranganathan's Five Laws of Library Science in a technological context	Qualitative & Quantitative	Interviews Questionnaires
Recommend a framework for the use of the IoT in the management of information services at the Polokwane Municipality Libraries	Which framework can be designed and implemented for the use of IoT in the management of information services at the Polokwane Municipality Libraries?			

1.5 Justification for the study

Dereese (2016) states that the justification of a study underpins methods adopted by the researcher, presenting them in a logical form that incorporates a set of variables, motives, supported by an in-depth literature review that provides a clear timeframe for the research. Mondal (2021) contends that many public libraries can be evaluated to improve the management of their information services. In this way, this study is essential to assess the utilisation process of the IoT at PML, which, in turn, can contribute valuable knowledge to the discipline of Information Science and the field of library and information services (LIS), while supporting the advancement of modern, digital libraries. In the contemporary context, Weber (2013); Vieriu and Petrea (2025) indicate that the IoT has emerged as a transformative force, delivering significant positive effects in the library environments through its capacity to enhance information services. Furthermore, Srikanth (2024) observes that the connectivity enabled by the IoT simplifies the management of information services, fosters improvements and attracts more users to the library.

Therefore, proactive use of the IoT fosters collaborative services delivered in a timely manner, thereby enhancing the quality of information services in libraries (Kumar 2023). As a result, other public libraries and librarians can also benefit from the recommendations and strategies drawn from this study for utilising the IoT in their workplaces. Furthermore, this information can motivate both users and staff members to engage more actively with libraries for their personal growth, development and stability. The primary significance of this study lies in its aim to promote the IoT as a technological tool in the public library sector, offering opportunities such as enhanced connectivity, effective user education and advanced technological capabilities. Accordingly, this study presents the case for why the IoT should be adopted and utilised for the management of information service at Polokwane Municipality Libraries.

1.6 Scope and delimitations of the study

According to Akanle, Ademuson and Shittu (2020), the scope of the study refers to the boundaries within which the required resources are identified to guide the research, clarify its breadth and specify the problems that should be addressed to understand central focus and interest of the study. In contrast, Theofanidis and Fountouki (2018) define *delimitation* as parameters set by the researcher to control the search process, thereby limiting the steps needed to locate the information required to achieve the research objectives and answer the research questions. Ridley (2012) articulates the importance of clearly defining the scope and delimitations of the study to avoid ambiguity related to the research objectives. Accordingly, this study focuses on the utilisation of the IoT, as it represents a key approach to enhancing the management of information services at the PML.

As observed by Din and Ali (2024), IoT connectivity has the potential to transform the PML into advanced, digital and user-centric information hubs, embracing cutting-edge possibilities for information access and delivery. This transformative approach supported by the IoT is highly effective in meeting user's expectations for reliable information (Olubiyo 2024). Exploring the utilisation of the IoT at the public libraries at Polokwane Municipality (PM) is crucial for providing inclusive and convenient information sources such as e-books, e-publications, e-journals, online databases and virtual learning programmes. Notably, the PML should upgrade their information service delivery methods, as several of these libraries are located in the CBD and surrounding areas of the City of Polokwane, representing the Limpopo Province.

Enhancing smart infrastructure that seamlessly links multiple device systems can enforce pro-active information services, while minimising human errors and duplication in capturing user information. Therefore, the focus of the study is the utilisation of the IoT in the effective management of information service at the Polokwane Municipality Libraries.

1.7 Definition of key concepts and terms

This section defines the key concepts and terms used in this study – i.e. the IoT, information services and public libraries. Defining and explaining these concepts and terms clarifies the content of the study.

1.7.1 Internet of things (IoT)

Mondal (2021) regards the IoT as a group of objects surrounded by processing facilities, sensors, software and hardware, as well as other technologies that connect and exchange data with other system devices, communicating with one another through internet networks. Olubiyo (2024) indicates that the IoT system interconnects mechanical and computing devices, digital machines, objects and people through unique identifiers (UIDs), eliminating the need for most human-to-human or human-to-computer interactions, as advanced networks can transfer data on their own. Similarly, Pujar and Satyanarayana (2015) confirm that IoT devices are assigned UIDs, enabling data transfer between objects with the minimum or no human intervention.

Singh, Gupta, Jain, Vashishth, Sharma (2023) consider the IoT as a technology setting that enables interventions between integrated system items. Each set of system items requires unique identification codes to serve among the internet and networks, RFIDs and in wireless communication. However, Ashikuzzaman (2024b) describes the IoT as a broad concept, first emerging in the late 1990s, with the aim of improving organisational efficiency and employee productivity. Atzori, Iera and Marabito (2017) projected that, by 2019 and beyond, the IoT would become the most widely used set of devices across organisations globally.

The mission of IoT implementation and use is supported by the International Telecommunication Union (2005) and the ALA (American Library Association 2015), who emphasise that the IoT offers significant opportunities and potential for growth – particularly through Internet Protocol Version 6 (IPv6), which has been successfully implemented and is rapidly advancing in library environments.

Makwana (2021) argues that the IoT holds great potential for enhancing inclusive library access through improved collection management, location-based services, information literacy initiatives and access to library resources. Kumar (2023) adds that these new technologies can support various operations, including monitoring and access of library materials, inventory controls and metadata management to maintain accurate online databases. Therefore, the application of the IoT is suitable for improving library functions and operations by ensuring stable information services delivery.

1.7.2 Information service

The term “information service” refers to the equitable, accessible, affordable and of high-quality delivery of information to citizens, as mandated by government and supported by private stakeholders (Purnik 2019). Governments provide such services through different channels, including archives, social media platforms, government departments and public libraries (Tamil & Sudhier 2024). As asserted by Olubiyo (2024), the provision of information enhances educational services by giving them clarity, frequency and meaningful characteristics, enabling individuals to make more informed and responsible decisions.

In order to achieve effective information services in public libraries, well-structured and adequately resourced management is essential (Islam 2015). Information services may include virtual reference services, inter-library loans, interactive web interfaces, reserve sections and personalised web portals accessible via mobile phones, laptops and self-service machines (Nkondo, Hart, Nassimbeni 2018). Collectively, these services play a vital role in meeting the diverse needs of library users, providing a broad range of knowledge resources both electronically and manually (Tamil & Sudhier 2024).

1.7.3 Public library

According to *The Library Information Services Transformation Charter*, a public library is described as a place established, supported and funded by spheres of government or implemented through a donation from well-known private companies or money generated from a community organisation and royal houses (Department of Arts and

Culture & National Council for Library and Information Services 2014). Hence, Handa, Goomer and Siddhu (2012) and Mojapelo (2022) assert that the public library delivers a range of services to provide the local community with a platform for knowledge with access to free information and works of the imagination. In other words, the information of the library is made available and accessible to all community members, regardless of nationality, race, age, religion, employment and economic status and educational level (Mugwisi, Jayane & Fombad 2018).

UNESCO presents an explanation of the public library as a democratic organisation, recognised by authoritative laws, to pursue and facilitate the educational process of lifelong learning (United Nations Educational, Scientific and Cultural Organization UNESCO 2013). Public library users visit the libraries to obtain information on how to sustain their lives by learning primary structures (International Federation of Library Association and institution 2017; Srikanth 2024). These structures promote active engagement in knowledge management, supporting fundamental sustainable activities and programmes that build the livelihoods of users.

They serve as clear evidence that public libraries act as “living forces” for cultivating information cultures and fostering education, contributing to the overall welfare of communities and individuals. By responding to community needs, public libraries facilitate growth and development (United Nations Educational, Scientific and Cultural Organisation 2015), while playing a critical role in preparing community members to navigate emerging technologies and their associated challenges (Nkondo, Hart & Nassimbeni 2018). Public libraries are tasked with the responsibility of providing professional training and skills development, offering relevant information and appropriate digital tools to ensure technology open and equitable access to all users (United Nations Educational, Scientific and Cultural Organization 2015).

The Library and Information Services (LIS) Transformation Charter (Republic of South Africa. Department of Arts and Culture & National Council for Library and Information

Services 2014) also identifies the public library as the safest environment where users can browse online databases to obtain relevant information and gain knowledge.

Information services provided by public libraries have reshaped their role, positioning them as social institutions (United Nations Educational, Scientific and Cultural Organization 2015). As social institutions, public libraries are increasingly being transformed to be innovative, enabling users to access information at any time and anywhere through the utilisation of the IoT (Mondal 2021).

1.7.4 Radio Frequency Identification Device (RFID)

Ashikuzzaman (2024a) describes radio-frequency identification devices (RFID) as a sophisticated technology designed for seamless tracking, identification and management of devices and objects through wireless communication. Its core includes tags, an antenna and a unique identifier, which together enable the electronic storage and transmission of information (Billah & Dhar 2021). RFID systems encompass the following two main components: the RFID reader and RFID tags (Kaushik 2019). The reader emits communication from the signal proximities of the tags. Coercively, the RFID tag emits signals to communicate with nearby tags, while the RFID tags respond by transmitting information back to the reader.

This interaction allows data retrieval via a direct or wireless connection, using either passive or active RFID systems (Ashikuzzaman 2024a). The passive RFID primarily relies on energy emitted by the reader to enable rapid communication (Pichorim Gomes & Batchelor 2018). As observed by Kumar (2023), active RFID is characterised by its own power source, which enables it to transmit signals proactively. In conclusion, RFID technology is being adopted globally in libraries to enhance the operational quality of information services, offering powerful tools for real-time tracking, alerts for misplaced items, user-friendly check-out stations and modern, adaptive security controls (Ashikuzzaman 2024a).

1.8 Conceptual framework

A conceptual framework is used to explain the progression of the phenomenon, which is linked to empirical research, theories used in systematising and promoting knowledge of the researcher (Du Plooy-Cillers, Davis & Bezuidenhout 2014). The conceptual framework provides the researcher with a platform to articulate the research problem and the outline of how the study addresses the problem. The conceptual framework provides ideas drawn from selected concepts that are logically related and structured within the study (Du Plooy-Cillers, Davis & Bezuidenhout 2014). Furthermore, the conceptual framework enables the researcher to map the study, formulate relevant concepts aligned with the research objectives, predict the significance of the study, and support a comprehensive review of the literature (Van der Waldt 2020).

In this study, the conceptual framework is designed around the concepts of perceived usefulness and infrastructural development, as applied in the Library Automated Management System Technology (LAMST) (Makwana 2021). Additionally, the framework incorporates two concepts – ease of use and policy evaluation – derived from Dr. Ranganathan's Five Laws of Library Science, adapted to contrast and guide technological library systems. Incorporating the selected concepts in the design of the theoretical framework should support the researcher in exploring the management of information services. The LAMST and Dr. Ranganathan's Five Laws facilitate effective management and utilisation of the IoT while minimising risks in the provision of information services, thereby supporting the transformation of the PML to modern, digital libraries supported by the IoT and its networks, wireless communication devices and RFID (Mondal 2021).

1.9 Research methodology

As a key process in any research endeavour, the research methodology is essentially the lens through which the researcher looks at the reality of the phenomenon being investigated and the problem/s involved in the phenomenon, in order to answer the related research questions and achieve the research objectives (Ngulube 2015).

The research methodology is characterised and shaped by the theories and experiences involved in the collection, analysis and interpretation of data (Creswell 2013). In other words, the research methodology seeks to explain the systematic processes, logically and the research design employed in conducting the study, as well as the limitations encountered to gaining knowledge. It encompasses the broad elements of research, including the research paradigm, with its ontological and epistemological perspective, the research approach and design, the data collection and analysis methods, the validity and reliability of the study, as well as the ethical considerations considered in the study (Ngulube 2015).

In this study, the researcher adopts a mixed methods research (MMR) approach, which integrates the elements and characteristics of both qualitative and quantitative research. In the qualitative research approach, data collection techniques such as document analysis and interviews are employed, whereas the quantitative approach collects primary data by means of surveys and questionnaires. The questions consist of closed-ended and open-ended questions that research respondent's answered, in order to obtain valid results. The mixed methods approach is employed to collect the primary data and to analyse the results and interpret the research findings.

The survey population, which is identified by means of the parallel sampling technique, comprises eight (8) PML in the Capricorn District, including six (35%) librarians, ten (59%) library assistants and one (6%) IT clerk, all of whom completed the questionnaires. Additionally, interviews were conducted with two (50%) senior librarians and two employees in the IT section – one (25%) assistant director/system administrator and one (25%) IT technician. In total, primary data was collected from 17 (100%) respondents and four (100%) participants, with a detailed discussion presented in Chapter 4.

1.10 Organisation and structure of the dissertation

The dissertation is structured in the following chapters

Chapter 1: Introduction: Framing the Study in Context

The first chapter introduced the study by providing the background and research context, as well as the problem statement, the purpose, objectives and questions involved in the study, the justification, scope and delimitation of the study, as well as an outline of the research methodology to be employed.

Chapter 2: Conceptual Framework and Literature Review

Chapter 2 presents the conceptual framework designed for the study, as well as the literature review.

Chapter 3: Research Methodology and Design

Chapter 3 addresses the research methodology involved in the study and explains the research approach, research design, the research population and sampling method, as well as the data collection and analysis methods and the ethical considerations.

Chapter 4: Presentation and Analysis of Research Results

Chapter 4 presents and analyses the research results obtained through the collection of qualitative and quantitative primary data.

Chapter 5: Interpretation and Discussion of Key Research Findings

In Chapter 5, the research findings are presented and interpreted in alignment with the literature reviewed in Chapter 2.

Chapter 6: Conclusions and Recommendations

Chapter 6 concludes the study by presenting the final summary, conclusions and recommendations and offering suggestions for future research. Finally, the proposed IoT framework is presented, that can be used at the public libraries of the Polokwane Municipality.

1.11 Chapter summary

The first chapter provided a clear understanding of the role of the IoT in public libraries for the management of information services. The ever-changing demand for information in public libraries presents challenges that can be addressed through the implementation of the IoT in public libraries. The chapter is structured to include the background of the study, the research context, problem statement, the research objectives and questions, the scope and delimitation of the study, the justification of the study, the conceptual framework and an outline of the research methodology. The discussion of these elements supports the understanding of the rationale of the study. Chapter 2 presents the literature review and the conceptual framework.

CHAPTER 2: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

The preceding chapter set the research scene by presenting a comprehensive introduction and background of the study, the problem statement, the research purpose, objectives and questions, as well as the scope of and justification for the study. Additionally, the key concepts and terms involved in the study were defined to provide their broad meaning. This chapter presents the literature review and key concepts related to the IoT, as explored by various scholars and substantiated through conceptual frameworks offering solutions related to the IoT (Newby 2014). O’Gorman and MacIntosh (2015) support this view by emphasising that conceptual frameworks and literature reviews work hand-in-hand, providing a shared foundation of information developed by academics while offering advanced explanations to the research problem. This suggests that the position of the conceptual frameworks firmly grounded in the literature review (O’Gorman & MacIntosh 2015). In this context, the literature review and the conceptual framework form the foundation of the study by validating existing findings and collecting relevant information to provide a clear starting point for investigation, as well as offering possible explanations for the research problem (Creswell 2013).

Accordingly, this chapter addresses the aspects comprising the literature review, including the purpose and importance of the literature review, a literature map and thematic objectives outlined in Chapter 1. The chapter also explores the frameworks guiding the design of the conceptual framework of the study, namely the Library Automated Systems Technology and Dr. Ranganathan’s Five Laws of Library Science, as applied to technological forms. These frameworks and their concepts relevant to the context of the utilisation of the IoT in information management are illustrated in Figure 2.2

2.2 Literature review

Du Plooy-Cilliers, Davis and Bezuidenhout (2014) define the *literature review* as a process of searching directly or indirectly through books, scholarly journals and relevant documents to summarise and evaluate the information relevant to the research topic and context of a study. Bertram and Christiansen (2020) regard the literature review as a process of generating knowledge or ideas, based on the information obtained from reviewed documents and building on the foundation laid by other scholars in existing research. Ridley (2012) concurs that a literature review is an inclusive review of information related to the research problem, expressing how the literature is to be conducted and how the research problem has unfolded and how it has been resolved in other areas related to the topic (Ridley 2012).

2.2.1 Purpose of the literature review

In a scientific study, the literature review plays a critical role in supporting the development of empirical results. It enables the researcher to benchmark their work against related studies, thereby assessing the viability of conducting the research (Creswell 2013). In most instances, related studies provide a broad foundation for discussion, allowing the researcher to decide whether to focus on general or specific information relevant to the research problem (Creswell 2013). Whether general or specific, such reviews – when aligned with the selected research topic – enhance understanding and strengthen the articulation of knowledge in a formal written report. They also broaden the researcher's knowledge base by introducing key concepts, experimental patterns, and techniques holding value within the field of study (University of Mebourne 2014).

Saunders, Lewis and Thornhill (2019) assert that the literature review examines critical research previously undertaken, positioning the current study within a broader scholarly context. This stage identifies, contextualises and justifies the aim and objectives of the study, outlines relevant theories, frameworks and models and acknowledges the contributions of scholarly experts. In doing so, it establishes clear theoretical

foundations that can inform project recommendations for improvement. Additionally, Khan (2018) emphasise that the existing body of knowledge in a literature review contributes to the integration of ideas by constructing cohesive and coherent arguments that strengthen the research foundation.

The characteristics of a literature review are grounded in evidence-based on scholarly work, avoiding personal opinions, unsupported claims or assumptions. Instead, it draws on authoritative studies of recognised scholars, presenting rational ideas supported by open knowledge and diverse value-based approaches (Efron & Ravid 2018). Such open knowledge, derived from approaches including systematic, narrative, descriptive and scoping reviews, offers state-of-the-art insights. These approaches reveal prevailing trends and provide well-founded suggestions regarding theories, methodologies, findings and recommendations relevant to the research topic (Templier & Pare 2015).

Ridley (2012) points out that the researcher should not overlook sources that challenge or oppose current perspectives during the literature review. Instead, contrasting viewpoints should be examined to outline both the advantages and disadvantages of the topic under investigation. Such balanced analysis strengthens the argumentative foundation and provides a clear pathway to the purpose of the literature review. As Efron and David (2018) explain, the topic should demonstrate both subject knowledge and an awareness of the contemporary context with crucial state of development. In this way, the literature review:

- Confirms the search ability of the research title and topic;
- Classifies and defines the key terms, theories and concepts to be used in a study;
- Identifies and refines research gaps and modifies the focus of the research topic
- Reveals methodologies assisting the research design and creates suitable data collection and analysis approaches and techniques;
- Ensures avoidance of unintended duplicates and addresses critiques encountered in existing studies;
- Identifies the constraints and context that narrow the problem statement, making it flexible and feasible; and

- Establishes the links among the reviewed studies and evaluates the strength of the the existing body of knowledge.

2.2.2 Role of references

Patton (2015) emphasises the role of references as important aspect of the literature review is the careful use of references, demonstrating how authors relate to one another and how their work supports the research title and topic. These references must be cited accurately. Du Plooy-Cilliers, Davis and Bezuidenhout (2014) define *referencing* as a standardised procedure used to acknowledge the authors and/or scholars who have made significant contributions and generated original ideas for the study. Sources should be evaluated critically to avoid relying on a range of materials that may result in an annotated bibliography, which are generally unacceptable in academic writing.

The following should be considered when outlining sources for the study:

- Critically evaluate each information source used;
- Link each information source by contrasting and comparing different reviews and relating them to the selected area of interest;
- Demonstrate the contribution of each source to the body of knowledge and develop a comprehensive argument;
- Integrate both the opportunities and the challenges that each source presents in structuring the body of knowledge; and
- Reference all sources accurately to follow up to articles and other materials and avoid plagiarism.

2.2.3 Phases involved in the literature review

According to Creswell (2013), phases serve as building blocks for accurate academic reviews, enhancing the speed and efficiency of the review process; particularly in complex and multidisciplinary studies. Snyder, Witchell, Gubtafsoon, Fombelle and Kristensson (2016) assert that the application of these literature review phases reduces the risks of a study being built on flawed assumptions. It clarifies the key questions regarding what a literature review is; what it entails; how it is used; where to source relevant materials; and the criteria for evaluating the materials. In this study, the four

phases of the literature review are followed, as specified by Wong, Greenhalgh, Westhorp, Buckingham and Pawson (2013), namely (i) literature design; (ii) conduct review; (iii) analyse materials gathered; and (iv) and write the literature review.

2.2.3.1 Phase 1: Design the literature review

The design phase of a literature review requires careful planning, determination and effort to compile information of reputable value for both readers and researchers. This phase helps to determine the potential contribution of the review and the impact it may have on current studies (Palmatier, Houston & Hulland 2018). The first step involves identifying all existing studies that need to be assessed. At this stage, the scope, purpose, research questions and methodological approach are clearly formulated. Various approaches – such as integrative, narrative and other methods – are compared to identify the most suitable for the study (Chang & Taylor 2016). Research that is centred on synthesising findings and investigating specific factors leading to concrete evidence is best suited for integrative or systematic review. In contrast, studies that evaluate broader fields of research are more appropriately addressed through a narrative review, as a systematic review is less reliable for such purposes. This phase also enhances the trustworthiness of the selected approach and outlines the potential challenges in the area of study (Snyder et al. 2016).

2.2.3.2 Phase 2: Conduct the review

McColl-Kennedy, Snyder, Elg, Witell, Helkkula, Hogan, and Anderson (2017) point-out that phase 2 involves conducting the actual review relevant to the study, incorporating a pilot test process guided by an appropriate protocol. Palmatier, Houston and Hulland (2018) describe a pilot test as the application of inclusion and search criteria to test the sample, thereby ensuring that the review meets the core performance standards of the research project. The final sample depends on the articles generated, which establish the scope and nature of the review and inform the selection of the appropriate approach (Palmatier et.al 2018). The approach requires the researcher to first examine the abstracts, extract relevant information and flag articles for full-text review at a later stage. At this point, the quality of each article is assessed to identify overarching themes essential to the study (McColl-Kennedy et al. 2017).

2.2.3.3 Phase 3: Analysis of collected materials

This phase ensures the reliability of the sample by reflecting the descriptive information gathered from the articles and books (Edeling & Himme 2018). It involves verifying details such as the author, title and year of publication, thereby quantifying the relevance of the findings and ensuring their consistency with the study. Theoretical perspectives and key ideas are typically conceptualised through historical timelines, which address questions outlined earlier. Such an approach can result in a historical analysis of the developments within the research field (Carlborg, Kindström & Kowalkowski 2014).

2.2.3.4 Phase 4: Write the research review

Davis, Mengersen, Bennett and Mazerolle (2014) emphasise that the purposes of the literature review should be communicated, supported by a structured approach. This phase identifies the number of articles to be reviewed and organising them to align with accepted conventions for reporting. According to Fink (2014), the extent and nature of the articles examined in his phase depend on the maturity of the research field. The existing body of knowledge – whether historical or contemporary – provides a basis for analysing the content of the literature review. This, in turn, enables the researcher to develop the theoretical and philosophical foundations of the study, building on the knowledge collected (Palmatier et al. 2018).

2.2.4 Literature review map

A literature map is an essential first step when commencing a literature review, as it enables the researcher to determine the type and structure of information to be reviewed and to draft it in a map (Creswell 2013). Newby (2014) indicates that a literature review map can be created as a visual representation, so as to indicate the usefulness of the themes and demonstrate the structures of the streams of ideas that are linked logically. Therefore, Church and Lacobuccim (2018) describe the literature map as a method used to outline research points and present previous research results that are to be discussed throughout the review process. Newman (2011) observes that the literature map organises the collected review material, providing the researcher with a clear direction while minimising the risk of

misinterpretation and ensuring that all key points are addressed. Creswell and Guetterman (2021) further describe a literature map as a reflexive tool that illustrates the production of knowledge and supports the ongoing development of the review. In this study, the literature map was developed to identify the focus areas and strengths of the research, using themes derived from the research objectives and supported by the conceptual framework (see Figure 2.1).

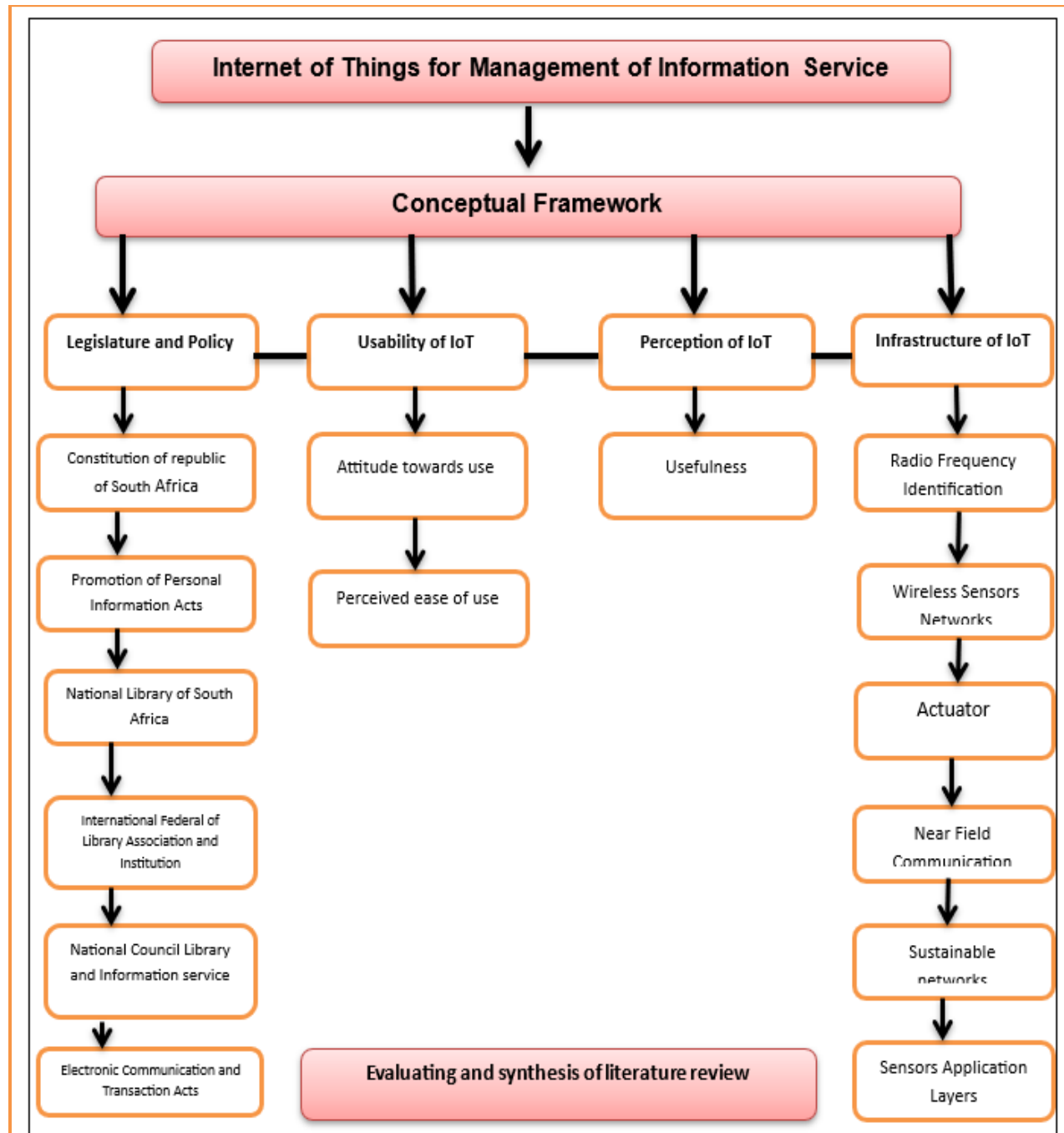


Figure 2.1: Literature review map supported by the conceptual framework

(Source: Researcher's design 2025)

2.3 Conceptual framework

According to Ngulube, Mathipa and Gumbo (2015) and Adom, Hussein and Agyen (2018) a conceptual framework (CF) can be regarded as the foundation of a research project that provides clear direction and grounds the study in its empirical questions and objectives, thereby validating the relevance of its findings. Green (2014) and Ngulube (2020) elaborate that the CF also offers a narrative structure, connecting key concepts underpinning academic research, establishing credibility and guide the development of research hypotheses. The CF also ensures that they study aligns appropriately with the defined population and the research areas. Moreover, Salawu, Shamsuddin, Balatitio, Masibo (2023) substantiate that a CF enhances coherence, helping the researcher maintain focus on the objectives and intended outcomes. As illustrated in Figure 2.2, the CF of this study was designed by incorporating concepts from the Library Automated Management Systems Technology (LAMST) and Dr. Ranganathan's Five Laws of Library Science, as applied in a technological context.

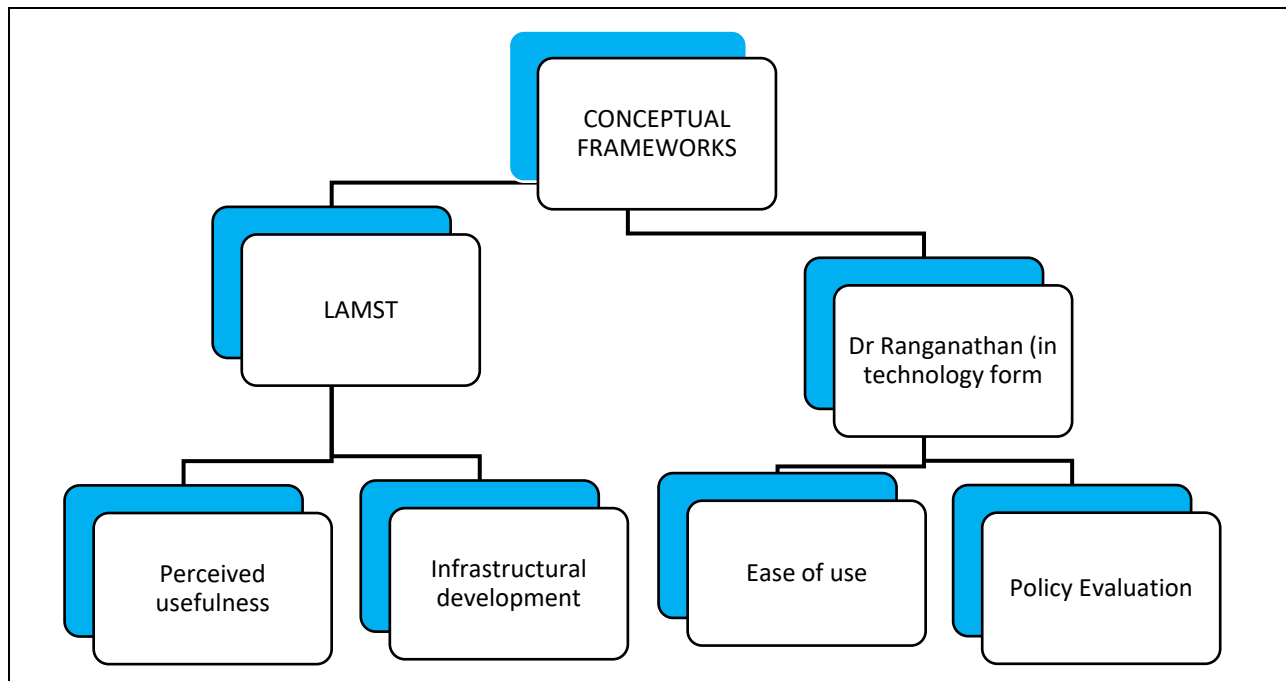


Figure 2.2: Conceptual frameworks

2.3.1 Library Automated Management Systems Technology (LAMST)

Library Automated Management Systems Technology (LAMST), which is recognised as advancement in the development of information-related sciences, driven by communication technology and computerisation progression, is often referred to as an information management system (Wang 2019). The evolution of LAMST began experimentally in the 1970s, was trialled in the mid-1980s, and by early 1990, it was operating effectively in various libraries in China (Wang 2019). LAMST enables library professionals to manage and disseminate knowledge and information electronically, utilising wireless communication devices, smart technologies, sensor devices, networks, RFID, databases, website technologies and data transfer mechanisms (Muniraja 2021). Constructs such as infrastructural development and progressive technological integration serve as the foundational elements for managing library resources and facilitating information access. LAMST is closely linked to digital libraries, where resources are accessed electronically.

Consequently, this study adopted LAMST as one of the constructs in the design of the CF and to evaluate whether new technologies can be implemented and utilised in public libraries, prioritising technological infrastructures to support computer storage, web portals, efficient communication and network access (Mutala 2012). In other words, LAMST is systematically reviewed in terms of the software and hardware it incorporates for collection management and sustainable network infrastructure necessary to sustain high-quality information services. As remarked by Weber (2013) and Makwana (2021) a LAMST enhances efficiency for both users and librarians, as the integration of software and hardware simplifies tasks such as scanning of book barcodes or using RFID tags to identify and track user-requested materials.

In the context of this research, LAMST encompasses diverse technology types, such as cloud computerisation, sensors, the internet, RFDI and communication systems, implemented through both informal and formal structures (Vandana, Bhattacharjee &

Gupta 2017). Informal structures involve managing information via social media platforms such as YouTube and Facebook, supported by quality systems in the library. Formal structures, on the other hand, are more professional and incorporate extensive internet protocols for library websites and databases, thereby facilitating effective management of e-resource in libraries (Vandana, Bhattacharjee & Gupta 2017). Therefore, LAMST is relevant to this study, as its configuration positively influences the operation and management of library information, often requiring minimal human intervention. The effective operation of LAMST – particularly when integrated with the IoT – is supported by several scholars, including Gokalp, Kayabay, Akyol, Eren and Kocyigit (2016), Liu (2017), Stergious and Psannis (2017) and Bi, Yanfei, Jeremiah, Joshua, Andrew, Daniel and Joseph (2018).

Gokalp et al. (2016) reveals that CF trends for library development emphasises the utilisation of big data technologies to establish and manage databases across multiple websites. Liu, Jiang, Osmani, and Demian (2019) confirm that RFID technology in smart libraries leverages big data to enhance collection management. Bi et al. (2018) further anticipate a CF for real-time system design that monitors IoT applications, enabling precise information delivery while reducing information processing costs. Liu (2017) designed information resources incorporating digital techniques to secure e-resources, proposing an object-oriented model to personalise library information service management.

Stergious and Psannis (2017) emphasises the importance of Mobile Cloud Computing (MCC) technologies within LAMST, based on the IoT- emphasising the automatic processing of big data to support self-service facilities when processing information. These self-service functions operate efficiently through machines, providing users with guided steps and instructions to address information queries automatically (Stergious & Psannis 2017). Similarly, Yao and Song (2014) introduced a library intelligence control system, designed with the IoT that optimises energy consumption while managing large volumes of data. Consequently, this study employed LAMST that focus on perceived technological capabilities and infrastructural development.

2.3.1.1 Perceived usefulness

“Perceived usefulness” refers to the direct influence of users’ acceptance of available services and their dissatisfaction with inadequate service levels (Ercetin & Bisaso 2014). In simple terms, perceived usefulness enables the quantification, measurement and interpretation of different situations. In the context of the IoT, user perception is shaped by the advantages embraced through innovative technology. Sustainable networks, supported by LAMST, with minimal interruptions, positively influence librarians’ attitudes, reinforcing the benefits of technology and facilitating efficient information management (Kaushik 2019). Advanced digital technologies provide comprehensive content that fosters positive user behaviour, by concentrating on positively perceived behaviour; public libraries manage the interconnectedness of IoT-enabled systems better in future.

Libraries that implement IoT services can achieve exceptional growth, compared to those that do not (El-Sherif & Elmeawad 2024). Brown (2021) conducted a study that examined librarians’ perceptions of the IoT in digital libraries, finding high levels of satisfaction. The librarians expressed appreciation for online databases, indexes, search engine access and other web-based information resources provided in the library (El-Sherif & Elmeawad 2024). These elements contribute to the concept of “library without walls” where web-based databases allow more precise access to information (Smith 2020). Web databases and online indexes integrate collections of webpages, documents, graphics and other information in a single domain, thereby providing users with comprehensive and detailed information and access to (Brown 2021).

Gunapala (2017) and Ashikuzzaman (2024b) suggest that the innovative and creative applications of IoT in librarians serve as a repository where information is stored and can be accessed by users to gain knowledge and support the successful development of their projects. These concepts align with Research Objective three (3) of this study, which assesses the perception of librarians regarding the use of the IoT in the management of information services. Through positive user’s perception, the IoT can be

effectively embraced to enhance the management of information services and address future information needs in libraries.

2.3.1.2 Infrastructure development

Bi, Da Xu and Wang (2014) and Osuchukwu and Ayeni (2017) are of the view that discussions of infrastructural development are incomplete without reference to information and communication technology (ICT). In libraries, ICT underpins infrastructural development for effective information management, which has transformed the way information is stored, processed, disseminated and retrieved (Hoque 2023). In public libraries LAMST relies on an infrastructure that includes computers, telecommunication devices, equipment, automatic printing machines, movable shelves, systems, sustainable networks and sensor devices (Adetayo & Hamzat 2021). These appliances are for the fast, reliable and accurate exchange of information in public libraries.

In the library, information is transmitted electronically to the main receiver via the internet and network systems, and this transmission depends on stable infrastructural development (Mahler, Montes & Newhouse 2019). Proper infrastructure, incorporating RFDI, actuators and near-field communication, ensures smooth and unbiased information operations (Martin, Murugiah & Nandhini 2016; Mandalia & Parekh 2017). These infrastructural tools ensure the effective delivery and retrieval of information by users (Bi, Da Xu & Wang 2014). While supporting the key quality dimensions of relevance, accuracy, timeliness, currency, completeness, conciseness and usability (Delone & McLean 2016). For libraries to achieve their objectives, meet their standards and satisfy user needs and demands, infrastructural development must be prioritised (Mondal 2021).

Infrastructure enables the development of intelligent digital libraries – often referred to as Library 4.0 – which create Web 4.0 technologies to facilitate future library interconnectivity (Noh 2015). This interconnectivity incorporates features such as the management of massive data, limitless creative space, context-aware services, cutting-

edge display technologies, open-source platforms with cloud services, virtual reference and online programming (Ding 2017). When infrastructural development is well established in public libraries, it supports transformative roles such as enhancing computer literacy, promoting stable education, fostering an informed society, and ensuring sustainable library services, all of which are strengthened by the rapid expansion of online- based platforms (Bopape, Taillie, Frank, Murukutla, Cotter & Majij 2021).

2.3.2 Dr. Ranganathan's Five Laws of Library Science as applied in a technological context

Ranganathan developed well-known Five Laws of Library Science in 1931, which are: (i) books are for use; (ii) every reader his or her book; (iii) every book its reader; (iv) save the time of the reader; and (v) the library is a growing organism (Makwana 2021). These five laws have been widely accepted in the field of Library and Information Science as they provide fundamental principles for library management and have, over several decades, promoted the core values of the profession. These values underpin efficient and effective to library services, supporting standards that remain relevant for modern and digital libraries. Bjorneborn (2004), from the Royal School of Information Science, presented Ranganathan's laws in a technological context as (i) web resources are for use; (ii) every user his or her web resource; (iii) every web resource its user; (iv) web saves the time of the user; and (v) the web is a growing organism (Bansal, Arora & Suri 2018).

Interpreted technologically, these laws redefine information access in modern libraries, enabling users to reach resources in different formats through multiple sources online (Fourie & Meyer 2016). Similarly, the ALA (American Library Association 2015) asserts that electronic access has expanded the boundaries of the physical library, reducing reliance on printed books and promoting web-based resources. Web-based systems assist users in analysing and navigating large volumes of information across different library types. Chen and Wu (2012) highlight that frequent users of electronic library

resources include students and researchers, with online patterns favouring their information needs.

As established in this study, online access has become increasingly important, restructuring information management to operate fast on online-oriented environment (Singh et al. 2023). The transformation of Ranganathan's first law into "the web resources are for use" reflects the adoption of technologically innovative methods that provide users with effective e-resource and ensure continuous access to information stored in digital files. These collections are maintained in updated databases such as Emerald and Justors, which facilitate rapid and organised retrieval of information (Sun & Youn 2012). Structured web-based information is typically organised in rows and columns in databases, simplifying storage, access and retrieval of records (Pujar & Satyanarayana 2015; Qin 2018).

Ranganathan's second law (every user his or her web resource) and third law (every web resource its user) encourage librarians to facilitate effective interaction between users and collections, addressing diverse interests and guiding users to relevant domains (Makwana 2021). Controlled access that accounts for diverse user interests that can save time during lending and returning processes at the circulation desk (Seretse, Chukwuere, Lubbe & Klopper 2018). The processes of borrowing and returning are further streamlined through the selective dissemination of information via the online public access catalogues (OPAC), which are reliable and accurate (Stergiou & Psannis 2017). The Ranganathan's fifth law-frames the "web as a growing organism", which highlights the dynamic nature of technology, thereby supporting continuous innovation and adaptation in library services (Fourie & Meyer 2016). This shift to web-based services facilitates the storage of large databases, while enhancing overall information management (Eduscapes 2015).

Ranganathan's five laws in technology/web context were relevant to the study, in that they allowed for the adoption of new technology applications in library operations and activities (Mondal 2021). The study adopted and focused on two concepts of

Ranganathan's laws in a technological context – i.e. ease of use and policy evaluation. Versmesan and Friess (2013) argue that integrated policy evaluation of technology ensures that online collections are properly maintained and preserved, while the infrastructure of the library supports user expectations. Bansal, Arora and Suri (2018) add that effective policy ensures an appropriate infrastructure that enables “ease of use” in retrieval of information without restricting access to promised online resources. In essence, policy promotes justifiable procedures and effective management of digital resources.

The law also guided technology adoption in libraries to enhance ease of use, as observed by this authors (Nag & Nikam 2016). Web resources have become increasingly user-friendly, efficient, and facilitating prompt access to accurate information (Nag & Nikam 2016). Consequently, policy evaluation is essential to ensure that web resources are both accessible and supportive of digital transformation in information management (Seretse et al. 2018). Therefore, this study used *ease of use* and *policy evaluation* as key concepts to investigate the utilisation of the IoT at PML as a means of managing and providing effective information services.

2.3.2.1 Ease of use

According to Ahmed, Bjorkman, Causevic, Fotouhi and Lindeni (2015), “ease of use” relates to the extent to which library users perceive the IoT as clear, simple and convenient, requiring minimal effort. The concept of ease of use supports information literacy by effectively enabling users to access information while benefiting from technological improvements and systems (Soni 2023a).

These ease-of-use systems guide users about well-designed databases that are flexible and compatible with portable search engines and web-based portals (Bansal, Arora and Suri 2018). These systems also facilitate understanding of technological procedures without requiring unnecessary mental and physical effort from users (Mishra, Pal & Manglam 2019). Consequently, well-implemented technological systems allow users to search across multiple information features with minimal difficulty (Ahmed et al. 2015).

The key elements of ease of use consist of simplicity, comfort, convenience and manageable interaction, reflecting the evolution of Ranganathan's Five Laws of Library Science into modern technology frameworks that enable faster and more efficient access to information (Makwana 2021). Evaluating and re-assessing the usability of the IoT, whether in digital environments or physical library spaces, aligns with the research objectives of this study, which examines the usability of IoT in the management of information services at public libraries at Polokwane Municipality. This approach also supports the continued enhancement of technological development in these public libraries.

2.3.3.2 Policy evaluation

According to the American Library Association (ALA) (2014), when adapted to a technological/web context, Dr. Ranganathan's laws are expressed as: web resources are for use; (ii) every user his or her web resource; (iii) every web resource its user; (iv) the web saves the time of the user; and (v) the web is a growing organism. Policy evaluation plays a critical role in supporting new developments in alignment with the intent of these laws. In a library setting, policy evaluation ensures that technology is strategically positioned to enable the effective management of information services (Singh 2024). The technological adaptation of Dr. Ranganathan's laws demonstrates the balance between users' fundamental rights and the provision of globally relevant web resources.

By identifying and prioritising high-demand resources, libraries can ensure the effective dissemination of information to the intended users (Tshabalala & Dube 2024). In this way, web-based platforms are organised to maintain and expand online collections that meet the information needs of informed communities. Therefore, policies and legislative frameworks have to be consistent with the mission of web resources while protecting users' rights to access to relevant information (Peng, Li-Hua & Moffett 2007; Bansal, Arora & Suri 2018).

Furthermore, policy evaluation supports the integration of emerging technologies –such as the IoT, artificial intelligence (AI) and resource indexing – into library systems, thereby enabling accurate identification and delivery of relevant web resources to the appropriate users (Hoque 2023). This integrated approach fosters the development of IoT applications for information management in alignment with sound policy and legislative frameworks and principles (Tshabalala & Dube 2024). The inclusion of the concept of policy evaluation in the study directly supported the Research Objective 1: *Evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipal Libraries.*

2.4 South African policy and legislative framework regulating the IoT in libraries

Policy and legislative frameworks involve sets of formally prepared documents or a logical structure outlining the processes and goals designed to guide and sustain the strategic intentions of an organisation (Magnusson 2017). Demaitre (2020) emphasises that, in a public libraries, legislative frameworks are increasingly vital in regulating practices and ensuring proficiency in technology adoption. Similarly, Qin (2018) remarks that certain regulation enable the support of introduction of the new technological initiatives.

The *National Policy Development Framework (2020)* is an example of a policy that contributes to technology advancement in response to the Fourth Industrial Revolution (4IR). It addresses changes resulting from emerging technologies, including cybercrime management measures and the integration of IoT across various organisations (Republic of South Africa. The Presidency 2020).

Regulatory frameworks provide standards that enable libraries to benchmark best practices in implementing policies and operational procedures (Ledwaba 2020; Mojapelo 2019). These frameworks prevent deceptive practices or threats that may compromise information resources during service delivery (Osebe, Maina & Kurgat

2018). Therefore, policies are essential in ensuring secured, authentic and easily accessible systems, protecting the technological infrastructure housed in information centres (Sivasankar, Soundararajan & Rajeswari 2020). It is important for IoT-related policies – particularly collection development policies – to align with the core library functions, in order to ensure that technological innovation complements, rather than overshadows, the mission of the library. As argued by Uplaokar and Badiger (2018) collection development policies should include clear implementation plans that support both the physical and digital growth of library resources.

In libraries, policy development ensures that collections are stored, identifiable, traceable, and retrievable in alignment with emerging technological advancements, whether in physical or electronic form, and enriched with value that creates knowledge (Qin 2018). Such identifiable information policies highlight the purpose of protecting/safeguarding and regularly updating information resources provided in libraries (Weber 2013). Consequently, library professionals need prerequisite essential legislative guidance – as an element of which the importance of the technology cannot be overstated (Khumalo 2021).

Babatunde, Alhassan and Babalola (2020) contend that, to sustain service standards in the application of the IoT in libraries, operating manual policies should be reviewed to include the latest technologies, such as RFDI systems, advanced devices and sustainable networks. These legislative frameworks should refine their impact by ensuring the retention and enhancement of professional knowledge through ongoing training, thereby enabling the smooth integration of the IoT in information services (Mondal 2021). This implies that professional training in new technologies has to be accompanied by policy reviews that require librarians to implement procedures to sustain new obligations and accommodate ongoing technological advancements (Sarmah 2015; Paraschiv 2019).

The primary purpose of these reviews is to mitigate risks arising from the failure to update policies (Sarmah 2015). Outdated policy procedures are often inadequate for

handling contemporary challenges associated with the introduction of new systems in libraries. The policy reviews ensure consistency, resilience and the capacity to address and manage libraries disasters in libraries (Ryan & Watson 2017; Wojcik 2019). Policies aligned with relevant legislation in libraries categorise information according to content, context and associated metadata related to document creators and transactions. Such classification enables the enrichment of information based on content, context and relevant metadata that outlines creators, transactions and is enriched in formation for IoT applications, thereby facilitating the development of web technologies for broader inclusion (Weber 2013).

The following legislative instruments were reviewed in relation to their suitability and effectiveness in supporting the management of information services in public libraries through IoT technologies such as: Constitution of Republic South Africa (Act 108 of 1996), Protection of Personal Information Act (No. 4 of 2013), Promotion of Access to Information Act (No. 2 of 2000), Electronic Communication and Transaction Act (No. 25 of 2002), Promotion of Administration Justice Act (No. 3 of 2000), National Council for Library and Information Services Act, (No. 6 of 2001) and National Library of South Africa Act (No. 92 of 1998) (Modiba 2021; Mojapelo 2022).

2.4.1 Constitution of the Republic of South Africa, Act 18 of 1996

Subsections 32–36 of the South African Bill of Rights – captured in Chapter 2 in the Consitution of the Republic of South Africa – apply to information centers, which include public libraries (Republic of South Africa 1996). The provisions in these sections in Chapter 2 of the Constitution affirm that everyone is entitled to the right to information, the right to education, the right to health and right to respect diverse cultures (Parent & Cruickshank 2009). Therefore, access to information is a critical public good, playing a key role in fostering an informed society and enabling citizens to engage with diverse aspects of lifecycles (Malatji 2020). The integration of the IoT in libraries supports this constitutional mandate by fulfilling users’ information needs, as reflected in Chapter 2: Section 2 of the Constitution. Its application promotes the provision of resources that

uphold the individual's basic right to information through web technologies and mobile applications in an accessible and equitable manner (Stoian 2014).

Part A (Schedule 5) in the Constitution assigns the responsibility for the management of public libraries in provinces of South Africa to management information. This aligns with technological systems like the IoT, which enhance the delivery of economic, cultural, educational, informational and social benefits to users (National Library of South Africa 2015). The capacity of the IoT is strengthened by user-friendly interfaces and relevant hypertext navigation links that integrate with other libraries, thereby improving “access and efficiency of information” (Bhoi 2017). It also addresses the challenges of users who cannot visit the library during operating hours, enabling them with information sources online at times that are convenient to them (Adebayo, Ahmed and Adeniran 2018; Tahar, Riyadh, Sofyani & Purnomo 2020).

Amendments to the Constitution have influenced the development of internal and organisational policies in South Africa (Modiba 2021). Constitutional mandates provisions encourage the inclusion of technological features in information centres that validate system design and foster technological innovation (Constitution of the Republic of South Africa, 1996). Such innovations optimise library intelligence, enabling internet-based services that promote portable access to library web pages, articles, books and journals, as well as facilitating self-service options such as self-return and self-borrowing within information management systems (Ashikuzzaman (2024a).

2.4.2 Protection of Personal Information Act, No 4 of 2013

The Protection of Personal Information Act (POPIA), No. 4 of 2013 – which was established on 26 November 2013 to protect the personal information of the individual – is supported by the Chapter 9: Section 14 (Everyone has the right to privacy) of the South African Constitution (Republic of South Africa 2013). According to Heynik (2011), the POPIA was influenced by global privacy law investigations conducted by the South African Law Reform Commission (SALRC). The key principles of the POPIA emerged

were largely drawn from the European Union (EU) and the Organisation for Economic Co-Operation and Development (OECD) (Heyink 2011).

In the context of public libraries, the POPIA governs the way in which data for multiple parties is processed, stored, disseminated and collected, with the aim of minimising violations of privacy (Republic of South Africa 2013). The act also challenges the practice of collection and sharing information anonymously or in de-identified form by default, as when such data is uncovered through IoT technologies, it may pose risks to national security. The misuse of this information could potentially endanger citizens' safety, undermine the economy, or threaten civil security and stability (Republic of South Africa 2013).

The utilisation of the IoT in organisations typically involves mobile devices, smartphones and computers, all of which generate digital footprints (Heyink 2011). These devices expose vast amounts of personal information to potential misuse by unauthorised users, often without the data subject's awareness. By safeguarding individuals' rights and ensuring accountability, the POPIA provides protection in such cases (Greenleaf 2013).

In this way, the act empowers the legislature to impose monetary penalties, enforce notices, pursue prosecutions and deliver judgements where violations occur (Republic of South Africa 2013; Tubbs 2014). In practice, every user and librarian engaging with IoT systems are required to sign online declaration forms committing to respect privacy and accept accountability for breaches of privacy. Additionally, user education – presented through online platforms – plays a vital role in explaining the purpose and implications of the POPIA, thereby fostering awareness and compliance (Tubbs 2014).

2.4.3 National Library of South Africa Act, No 92 of 1998

The National Library of South Africa (NLSA) is mandated to promote library development services and responsibility for the management of information across all types of libraries in the country (Mojapelo 2022). In line with its objectives, the integration of IoT technologies can support the strategic plan of NLSA by automating

services to meet user needs and improve library information management. However, this technological advancement still requires greater attention and awareness – particularly in promoting cultural heritage, e-resources, collection management and national documentary resources through digital platforms and websites (Ashikuzzaman 2024a).

The National Library of South Africa (2015) provides guidance on proper information management practices that foster growth, stability and information sharing. Such practices enable deep learning, collaboration and cooperative measures that align with IoT-driven solutions for 21st century electronic information management (National Library of South Africa 2015). As emphasised by the Department of Sport, Arts and Culture, professional bodies should be employed to ensure effective expansion of information and knowledge management, as they carry accountability for maintaining professional standards (Makwana 2021). These professional bodies are essential to fulfilling the mandate of the library in terms of delivering high-quality information management and driving the adoption of relevant technological inventions (Kekana 2007).

Proactively, the NLSA encourages South African libraries to invest in infrastructural development aligned with 4IR progression (Kekana 2007). This accountability places government information representatives under the obligations of transparency and openness, requiring appropriate measures to ensure wide access to information (Mojapelo 2022). These obligations further support the sustainable management of information through IoT utilisation, ensuring the creation, indexing, storage and organisation of information that complies with digital preservation standards. This application of the IoT ultimately fosters a strong information management system that actively secures and preserves audio, virtual and documentary resources (National Library of South Africa 2015).

2.4.4 Electronic Communication and Transaction Act, No.25 of 2002

The amendment of the Electronic Communication and Transaction Act (ECTA) is supported by the Department Trade and Industry (DTI), which promotes legislation aimed at strengthening commercial and organisational practices (Republic of South Africa 2002). When applied in the library environment, the ECTA seeks to enable electronic communication and facilitate complex digital transactions (Republic of South Africa 2002). As stated in Part 1 (Sections 11–17), the Act establishes the standards and guidelines for the use of electronic signatures, the legal recognition of data messages, the authentication of original information, and the permissible storage and retrieval of digital information/data (Electronic Communication and Transaction Act, No.25 of 2002).

In this context, libraries rely on IoT technologies to support accurate and efficient electronic transactions, enabling proactive communication across platforms in a cost-effective and accessible manner (Mondal 2021). These capabilities enhance the dissemination of information, reduce knowledge gaps, meet user demands and strengthen library membership and engagement. Furthermore, Part 2 (Section 10) authorises the Minister to establish policies that regulate electronic transactions and communications (Republic of South Africa 2002). This places the responsibility on the Minister to issue comprehensive policies that engage stakeholders in library and information services (LIS) and government organisations in developing frameworks to guide technological advancement in libraries (Republic of South Africa 2002).

As a result, organisations involved in information management are given opportunities innovating the IoT-driven knowledge bases that enhance databases and strengthen web technologies for digital libraries. In this way, these developments align electronic transaction policies with the evolving needs of libraries in the digital era (Electronic Communication and Transaction Act, No.25 of 2002).

2.4.5 Library and Information service (NCLIS)

The National Council for Library and Information Service (NCLIS) – mandated by the National Council for Library and Information Services Act, No. 6 of 2001 – is an advisory committee that outlines steps that the Department of Sport, Arts and Culture (DSAC) can follow to implement sustainable policies for libraries (South African Human Rights Commission 2001). As remarked in the *5th Annual report* of the SAHRC, the transformation of library and information services and the widening of information access depend on the NCLIS in collaboration with various departments, including the Department of Basic Education (DBE), the Department of Science and Technology and the Department of High Education and Training (South African Human Rights Commission 2001).

The NCLIS aligns its goals with the *National Development Plan, 2030*, which can be advanced through the integration of IoT in library sector (Republic of South Africa. National Planning Commission 2012). The Council plays a critical role in ensuring that relevant information is circulated to libraries promptly, enabling them to remain informed about innovative approaches to information management in library and information services, many of which can be successfully implemented through IoT (Makwana 2021; Mondal 2021). The Council can facilitate the adoption, maintenance and long-term sustainability of IoT in libraries (Kekana 2007). The NCLIS Board is responsible for developing strategies to address LIS challenges for presenting forward-looking policy recommendations to the Minister for inclusion in legislative frameworks governing LIS (Mondal 2021).

These strategies may include promoting innovation, enhancing efficiency and supporting the use of the IoT in libraries for communication, monitoring and oversight in library services (Library and Information Association of South Africa 2015). In building future libraries, the Council should remain globally informed and connected through various networks enabled by 4IR – particularly the IoT (National Council for Library and Information Service 2003). The committees of the Council should also establish standard norms that guide rational infrastructure allocation, thereby supporting the development and sustainability of digital libraries (James 2001; Fourie & Meyer 2016).

2.4.6 International Federal of Library Association and Institution (IFLA)

The International Federal of Library Association and Institution (IFLA) is an institution that was established to represent library and information services to support their interests by developing relevant policies for managing information services (International Federal of Library Association and Institution 2019).

The researcher decided to include IFLA in the discussion on legislative frameworks, based on its strategies, policies and conferences, which provide libraries with guidance in managing information (Makwana 2021). In the South African context, the progressive policies of IFLA provide guidance to prominent organisations and legislation – including the National Library of South Africa and the Electronic Communication and Transaction Act, No. 25 of 2002 – on the regulation of information (International Federal of Library Association and Institution 2015; Makwana 2021).

IFLA actively promotes the application of the IoT worldwide across a wide range of library functions, including literacy education, information-seeking behaviour and professional development (Kumar 2023). In its trend reports, IFLA highlights issues such as artificial intelligence, the IoT and intellectual freedom (International Federation of Library Associations and Institutions 2021 & 2024), which according to Paris and Donovan (2019), are particularly relevant to the development of virtual libraries. Together, these technologies offer opportunities to enhance knowledge sharing and improve the management of information in libraries (Paris & Donovan 2019). Effective integration of the IoT has the potential to improve search efficiency and expand information access through digital platforms and websites (Dave & Mittapally 2024).

Several of these technologies – particularly cloud-based systems, AI tools and IoT applications – have been developed or adapted by professional libraries themselves to support information management practices. For example, Wheatley and Hervieux (2019) point out that the National Library of Norway has experimented with machine

learning to automate the application of the Dewey Decimal Classification (DDC) System. These experiments demonstrated successful and largely unbiased classification of datasets and online documents, thereby emphasising the transformative potential of the IoT in broadening access to information (Wheatley & Hervieux 2019).

2.5 Usability in the management of information services

The concept of usability, which is adopted from the Technology Acceptance Model (TAM), is recognised as a key dimension for evaluating and measuring the quality of systems and technologies through users' experiences (Schorr 2023; Frandsen & Sørensen 2020). Applied in the technology context, usability is a combination of efficiency, utility, effectiveness, safety, memorability and learnability, which can serve the objectives of the LIS field (Khan, Zhang, Chohan & Rafique 2021).

Libraries powering development (2012) highlight the usability of technology that has a significant positive impact on the lives of both library users and staffs. Pujar and Satyanarayana (2015) assert that much of the work undertaken in public libraries is in nature, often classified as housekeeping functions. However, the usability of the IoT streamlines these technical processes, thereby enabling users to access library collections more effectively (Pujar & Satyanarayana 2015). Potter (2014) affirms that the high ease of use afforded by the IoT results in time savings and facilitates the quick storage and retrieval of information. Similarly, Potter (2014), Pujar and Satyanarayana (2015) and *Libraries powering development* (2012) rate the IoT highly for the benefits it brings to the library.

Collectively, their studies highlight the key areas of IoT usability in libraries, including the management and tracking of library resources, efficient communication and connectivity, applications that enhance user convenience, comfort, and energy optimisation (Pujar & Satyanarayana 2015). As asserted by Potter (2014), ease of use directly supports high-quality data management. Broadly, the IoT reduces the workload of library staff by streamlining activities and ensuring more effective information management.

Nolin and Olson (2016) describe the IoT as a “treasure” particularly when combined with artificial intelligence, envisioning it as the foundation of a “future internet”. In line with this view, Buckland (2017) argues that the IoT-enabled interaction in libraries, through advanced technologies, that fosters a science-oriented approach using unique identifiers for cataloguing references and volumes. Such cataloguing creates reliable links between information sources, shelf location and database records. As further explained by Liu et al. (2019), these systems extend to access control, stocktaking and monitoring of self-checkout services, all of which enhance usability and efficiency.

2.5.1 Attitude towards use

According to Ramzan, Asif and Ahmad (2021), *attitude* refers to the beliefs, opinions, judgements and perceptions of librarians towards application of the IoT in libraries. Mishra, Pal and Manglam (2019) emphasise that integrating technology into library services requires both commitment and positive attitudes, with the intention of exploring and exploiting the full potential of technology. Similarly, Adeyinka (2012) argues that attitude is a prerequisite for identifying the positive and negative impact of the IoT. A positive orientation towards the IoT has fundamentally reshaped the role of librarians in offering services and managing information. Corral and Jolly (2019) observe that the IoT has become an essential tool for users and librarians in processing, storing and retrieving of information, as well as in resources sharing, web application and electronic databases.

Remote access enabled by the IoT has transformed library environments, making information more valuable to users (Jantz 2017). Parashiv (2019) adds that the IoT represents an innovative edge, turning information into a valuable and transformative resource. A study conducted by Canuel and Crichton (2015) among Canadian academic libraries – with the support and assistance of the Association of Universities and Colleges of Canada (AUCC) – reported the usability of access to bibliographic databases at 42%; provision of mobile apps for users to read at 69%; and citation information management apps at 50%. Similar to these findings, Kaba and Ramaiah

(2019) suggest that partial adoption of these technologies plays a key role in enabling comprehensive access to e-books, digital newspapers, magazines and e-journals.

There is consensus among various scholars, including Parashiv (2019), Asim and Mairaj (2019) and Khan, Masrek and Mahmood (2019), that librarians' positive and optimistic attitudes motivate them to capitalise on opportunities offered by the IoT. Attitude correlates with competency, acceptance and approval, thereby strengthening an IoT-driven culture that enhances key performance areas in libraries. With the IoT, librarians can now deliver information more swiftly than in the manual era (Rehman 2016; Hoque 2023).

Moreover, this technological shift revitalises employee skills through learning, training and awareness, enabling librarians to act as system experts and provide virtual collections, reference services, interactive web platforms and personalised web portals. As noted by the present of millennium IoT reflects a significant transformation in the professional development and wellbeing of library staff (Pujari & Gadgay 2018).

2.5.2 Perceived ease of use

Perceived ease of use is derived from the Technology Acceptance Model (TAM), which is considered a suitable framework for measuring the usability of the IoT in libraries (Alsyof et al. 2023). In the TAM, perceived ease of use refers to the extent to which individuals regard a particular technology as effortless and free of complexity. As explained by Tahar et al. (2020), perceived ease reflects the functionality of technological systems, mediating critical factors that shape both acceptance and rejection, thereby quantifying the effectiveness of the systems globally. Therefore, access to electronic databases has expanded significantly due to the rapid development of IoT that is resulting to a culture of skilled and semi-skilled librarians who are better equipped to manage advanced library systems (Tahar et al. 2020).

Kumar, Tiwari, and Zymbler (2019) also noted that the IoT has flourished in enhancing website-based services – particularly through large-scale data storage and retrieval. For

example, IoT-enabled collection management feature that support online library catalogues, that is enabling users to browse and access required information quickly and efficiently. These catalogues reshape user's interactions with collections by providing comprehensive, accurate, updated and error-free data, thereby supporting project implementation and academic work (Kumar, Tiwari, and Zymbler 2019). Weber (2013) further argues that user's satisfaction with the quality of information builds trust in the library, reinforcing perceived ease of use and validating system outcomes.

Fernandez (2015) and Liang and Cheg (2018) confirm that a deeper understanding of IoT applications in public libraries enhances information management services and potential betterment in management of information services. Overall, the IoT integration in library facilities has introduced greater accuracy and significant changes, positively transforming librarians' practices and users' experiences.

2.6 User perception of librarians regarding the use of the IoT in libraries

As a concept derived from the Technology Acceptance Model (TAM), user perception has been reviewed by Barranis (2011) and Olumide (2016) as the awareness and availability of existing, availability of knowledge. The awareness of user perception enables the use of relevant resources to acquire skills and apply modern technology effectively in accomplishing tasks. Ghadirians, Fauzi Mohd Ayub and Salehi (2017) opine that perception originates from exposed actions taken after an information request, which influences librarians' ability to adapt their roles and improve the speed of task completion. As noted by Martin, Murugiah & Nandhini (2016) and Olumide (2016), perception is shaped by reactions, choices and interpretations of experiences throughout the process. In this regard, librarians are often positioned to engage in continuous self-renewal in order to meet the challenges resulting from technological advancements (Usman & Gopakumar 2018; Mamabolo 2022).

The successful performance of library tasks is often hindered by factors such as poor networks, inadequate infrastructure and reliance on manual collection management, which negatively affect performance, pointing to the need to enhance librarians'

perceptions of the IoT in information management (Mondal 2021). Pal and Sharma (2017) confirm that weak networks delay in computerisation obstruct library operations and activities, with librarians sometimes being unable to complete their essential duties. Therefore, responsibilities are often postponed for days or even weeks, causing workloads to accumulate until connectivity has been restored (Abo-Seada 2019).

However, the Online Computer Library Center (2015) emphasise that application of IoT holds great promise for future libraries, offering a future in which delays performing key duties are minimised. The IoT doubtlessly paves the way for the emergence of Web 4.0, which leverages massive data intelligence and cloud-based innovations to transform and dominate knowledge management practices (Noh 2015; Linnik 2019). The dominance of digital libraries fosters advanced skills and higher levels of intelligence, enabling librarians to deliver information services more successfully and intelligently (Linnik 2019).

Yusuf, Ifijeh and Owolabi (2019) emphasise that the application of RFID technology – integrate laser scanners and sensing devices – facilitates interconnectivity, thereby simplifying monitoring, communications and collection control. Pujar and Satyanarayana (2015) assert that improved infrastructure in technical operations enables rapid cataloguing to reduce errors and alleviate the physical workload of librarians. Similar views are expressed by Purnik (2019) and Makwana (2021), who point out that such systems support quick searches, provide simultaneous access for multiple users and allow unlimited retrieval at given “real-time”, thereby reducing the number of user’s complaints. Furthermore, this progress inspires collaborative development, encouraging librarians to share knowledge and invest in computerisation, system intelligence and communication networks, thereby enhancing the overall usefulness of the IoT in library environments.

2.7 Usefulness

Usefulness is one of the core concepts of the TAM, defined as the extent to which users perceive that the IoT produces positive outcomes in achieving specific objectives, with rapid and productive solutions to identified problems (Mishra, Pal & Manglam 2019).

The usefulness of the IoT enhances key performance indicators, broadens librarians' skills and reduces weaknesses by leveraging technological strengths to overcome existing shortcomings. The study conducted by Kaushik (2019) provides valuable insight into the usefulness of the IoT in the library profession, reporting that library professionals are generally aware of the IoT to manage information at a satisfactory level.

In practice, IoT-based systems are used to remotely monitor infrastructure, ecosystem intelligence and data transmission, thereby contributing to effective information management (Khan et al. 2021). Consequently, librarians are encouraged to participate in continuous training and awareness programmes to deepen their understanding of the IoT and to apply it effectively. In this regard, Yan, Zhang and Vasilakos (2014) propose a trust-based management framework that incorporates workshops, online programmes and seminar sessions to strengthen the usefulness of the IoT in library contexts.

The optimal use of the IoT can fulfil users' demands while integrating high-value services that reflect the evolving role of modern public libraries (Goswami 2024). Automatically, IoT facilitates the development of intelligent libraries that integrate smart systems with information and communication technologies (ICTs) to enhance value-added service (Goswami 2024). For example, in China, IoT applications in libraries include the use of mechanical systems capable of managing big data, library bookmark apps, blockchains and artificial intelligence for large-scale of information processing (Paravichin 2017). Such innovations enable responsive, real-time library operations by linking data and IoT systems. Ultimately, the benefits of the IoT integrates enhanced knowledge sharing, strengthened security through e-resources tracking and improved virtual service delivery, all of which contribute to more efficient and effective library performance (Kaushik 2019; Hu, Ghohan & Liu 2020).

Broadband virtual connections enable access to electronic collection packages that support online reference services, digital acquisitions and electronic cataloguing, thereby facilitating the dissemination of information sources in libraries. Effective the

broadband engages communication through these technologies that are clearly reflected by the Orlando Public Library in the United States of America (USA). Sarmah (2015) explains that the Orlando Public Library pioneered the use of BlueBeam, a system based on iBeacon technology designed to be highly adaptive.

The system provides location-sensitive directives that transmit notifications to librarians' mobile devices, thereby assisting them in identifying information of contextual relevance (Qin 2018). In this way, the system supports librarians in guiding the library users in locating e-resources, while fostering user-focused communication in the library. Overall, the integration of e-resources and fast communication technologies is becoming effective when supported by robust infrastructural development in libraries (Makwana 2021).

2.8 IoT infrastructure required in libraries

A solid understanding of IoT infrastructure is essential for building reliable IoT systems in public libraries. Weber (2013) opines that the IoT – supported by an advanced infrastructure – plays an important role in implementing the library values in alignment with its environment. Purkin (2019) suggests that the key components of modern public infrastructure should include smart digital shelves, virtual libraries, real-time data requests, smart library cards and mobile applications for locating books. Such innovations in the library modernise libraries, ensuring efficiency and seamless user's experiences. Alam, Siddiqui, Ahmad and Shuaib (2020) assert that the IoT relies on smooth collection and transfer of data across devices. Optimal operation integrates RFID, near field communication, actuators, sensors, wireless sensor networks, all of which interact with embedded systems to transform traditional libraries into fully digital, modernised spaces.

In addition, Weber (2013) and Makwana (2020) indicate that smart infrastructure supports information management and digital processes through integration of library systems. This system is increasingly moving towards rapid acquisition of electronic learning resources, such as e-journals and e-books, which drive the advancement of intellectual integration in libraries (Weber 2013; Ahmat & Hanipath 2018).

The intellectual features of the IoT are reflected in networks where devices communicate with one another via internet connections within the library context. These devices – commonly referred to as “things” – form part of a system of attributes and their functions linked through the “internet”, enabling libraries to evolve into fully digital environments (Liu et al. 2019). The implementation of the IoT infrastructure in libraries typically involves both software and hardware, including sustainable networks, radio frequency identification devices and sensor application layers (Qin 2018).

2.8.1 Radio Frequency Identification Devices (RFID)

RFID (radio frequency identification device) technology is an automatic identification system that is widely used in libraries for tracking and managing books. RFID relies on wireless tagging systems attached to the books to enable data transfer, making it one of the most effective technologies adopted by academic and public libraries for large-scale collection management (Pujari & Gadgay 2018). In libraries, RFID tags function as automatic identifiers, capturing information that has previously been processed through barcodes and smart cards (Solanke & Deshmunkh 2018).

These systems allow for rapid remote retrieval and storage through tag devices. Solanke (2021) explains that RFID tags are typically small, adhesive stickers affixed to books, enabling them to respond to RFID transceivers under different library conditions. The tags – often referred to as “responders” – can also be embedded in CDs, DVDs or directly in books. Each tag is programmed with unique electronic information, making library materials easily traceable and effectively managed (Sivansakar, Soundararajan & Rajesweri 2020).

RFID tags function in conjunction with antennas, which determine the tag size, frequency and operating range. Tags are generally categorised into three types – read only, write once, read many (WORM) and read and write (Pujari & Gadgay 2018). The RFID reader, often referred to as an interrogator or sensor, that communicates with the tags by transmitting radio waves (Goswami 2024). RFID readers pass data to

middleware, where it is processed and converted into sustainable information, enabling immediate reading and updating of the tag data from the antennas (Chivan 2012; Pujari & Gadgay 2018; Sivansankar, Soundarajan & Rajeswari 2020).

Antennas are used as the communication channel between the reader and RFDIs chips, allowing information to be updated and modified. Renold and Joshi (2013) emphasise that RFID waves transmit data, identify and track connected devices to enable self-service functions and the monitoring of library operations. The connectivity enables continuous data exchange and effective system integration (Eteng, Abdul Rahim & Leow 2018).

In their research, Sivansankar, Soundarajan and Rajeswari (2020) determined that 80% of public libraries in Egypt were equipped with RFDI technology, based on the upgrade of usage of IoT technology and resulting in increased employee productivity, greater reliability, faster tracking of operations and easier identification of mis-shelved books. Qin (2018) asserts that adoption rates of RFDI have increased because of the “efficient and effective” security it offers to the library; particularly at the circulation desk. RFID has largely replaced traditional barcodes, significantly enhancing collection management.

The National Library of Russia, for example, implemented IoT-based collection management at its circulation desk through RFID connectivity integrated with a robotic device (Pujar & Satyanarayana 2015). This robotic system, comprising both software and hardware, which is capable of returning books automatically: it detects the book, verifies the returned item and immediately places it into the correct bin (Purnik 2019).

In addition, catalogued databases allow the user to reserve books that are currently issued to other users. When the book is returned, the system automatically places it in a designated bin for the next user. Automatically the notifications about the availability of reserved books are sent to the users through mobile applications, making the collection easily manageable (Frandsen & Sørensen 2020).

However, in South Africa, the cost implications of such systems are largely considered merely by academic libraries, rather than public libraries (Ryan & Watson 2017). The Return on Investment (ROI) of RFID systems is evident when librarians perform and are able to meet key performance areas and deliver information services more efficiently (Weber 2013).

2.8.2 Wireless Sensor Networks (WSNs)

Wojcik (2016) defines a *wireless sensor network (WSN)* as a cluster of spatially distributed sensors designed to monitor and record the conditions of physical objects, with the collection information consolidated at a central location. Similarly, Fernandez (2015) describes WSN as an advanced technology in wireless communication that integrates low-power circuits and sensors. The combined features of WSNs enhance their ability to explore and manage of intelligent sensors capable of processing, collecting and disseminating information in different environments (Qin 2018).

A fundamental component of these wireless networks is the micro-electronic and robotic device known as MOTE, which integrates computing, sensing, power and communication layers (Bahga & Madisetti 2014; Fernandez 2015). MOTEs can be used in public, private or hybrid models to support bandwidth, latency, communication and security requirements in libraries (Mavani 2024). According to Engmann, Katsrika, Abdulai, Adu-Manu, Banaseka (2018), WSNs are essential for technologies that use transducers to convert energy signals, thereby supporting smart library devices such as building infrastructure systems, computers and smart lighting, ensuring continuous data exchange and connectivity (Engmann et al. 2018).

2.8.3 Actuators

Actuators are defined as devices that actively control the flow of data in an organisation (Pujari & Gadgay 2018). In the context of libraries, the control and movement of information are facilitated through actuators, with one of the earliest and most common forms being fluidic actuators, which operate through suction or fluid injection (Suma

2019). These include synthetic jet actuators, also referred to as Zero-Net Mass Flux (ZNMF) devices. ZNMF actuators alternatively expel and ingest fluid in oscillatory patterns through slots or orifices, relying on a continuous external source and sink (Chivan 2012; Pujari & Gadgay 2018). Their function is to ensure seamless transmission of data in the library environment, directing relevant information to the appropriate station without obstruction.

In addition to information transfer, actuators also have protective functions by generating alarms through electromagnetic pulses, pressure or sound signals, thereby safeguarding library resources during emergencies such as fires or natural disasters (Patel 2019). Additionally, actuators resonate to electronic pulses that trigger signal indicators. When users request information, actuators transmit inputs to wireless sensors; interpret the signals and deliver the required information to the user (Bolano, Campos, Barral, Esudero & Garcia-Naya 2022).

2.8.4 Near Field Communication (NFC)

Near field communication (NFC) technology uses invisible radio waves to identify and interact with a variety of wireless objects (Jain & Dahiya 2015). NFC enables bi-directional communication over short distances, providing secure data transfer, convenient transactions, device connectivity and rapid digital exchange (Projes & Shailendra 2016). NFC is classified as a short-range communication technology designed to ensure inherent security and controlled access, making it particularly relevant in public libraries. Operating at the 13.56 MHz frequency band – an internationally recognised Industrial, Scientific and Medical (ISM) band shared with RFID – NFC is globally standardised.

Although NFC and RFID share similarities, they differ in scope and application in libraries. Abdel-Gaber & Abdel-Aleem (2015) indicate that NFC enables bi-directional communication, supporting the exchange of digital data within a range of 4–10 cm, typically depending on output power and antenna design. Typically, smartphones have a shorter operational range than dedicated reader devices due to power capacity (Jain

& Dahiya 2015). Hence, it can be concluded that NFC is particularly effective for use with smart cards or mobile phone as “access control badges”, where information is securely embedded in the device. In public libraries, NFC can also be applied to track the location of library materials. Engmann et al. (2018) and Fernandez (2015) remark that NFC-based tracking is integrated into smart library systems, allowing misplaced books to be identified and returned to their correct locations.

According to Amundsson (2021) NFC-enabled smartphones authenticate users through biometric fingerprints. Using smartphones, library users can trace the location of a book via the OPAC. If the book is available and not issued to another user, the NFC scanner can quickly and accurately locate it (Bolano et al. 2022). Misplaced library collections remain a challenge; particularly in large libraries, but NFC provides an automated solution for tracking and retrieving these items (Purnik 2019).

The technology also enhances user identification, making it faster and easier through NFC. Integrated with the IoT, smartphones effectively become mobile wallets, allowing users to make electronic payments for library collections and fines (Liu et al. 2019). This process directly links to users’ bank accounts, enabling seamless NFC-enabled transactions. Users also receive automated receipts for their payments, thereby streamlining the financial operations of the library and receive quality of service offered at the library (Jain & Dahiya 2015).

2.7.5 Sustainable networks

Networks are critical management infrastructures, operating under the Transmission Control Protocol/Internet Protocol (TCP/IP), either IPv6 or IPv4, to enable remote access (Liang & Chen 2018). These network interfaces, often accessed via command lines and Telnet services, continuously monitor and transmit data across systems (Wojcik 2016). The IPv6 enhances network control by reducing congestion and handling high volumes of traffic (Liang & Chen 2018; Patel 2019). Internet Protocols are widely integrated into global information-maintenance platforms and web-based library systems (Goswami 2024). Experiences in Germany and Australia in 2013 demonstrated

that libraries faced operational disruptions due to network congestion, which pointed to the need for smart, automated and sustainable networks for library monitoring (Liang & Chen 2018). The IPv6 and IPv4 sensor networks collect extensive data, monitor critical systems and manage network transmission through distributed transformers (Makori 2017; Simoes, Barbosa & Filipe 2019). IP facilitates rapid access to library websites, allowing users and librarians to read, write and transact via smartphones, tablets and computers without restrictions.

According to the International Telecommunication Union (2013), suggested technologies like video conferencing, email and telephony enable librarians and users in different locations to exchange information, producing satisfactory output. The IPv6 in particular supports development and high-speed access to meet user needs and promote knowledge sharing among a wide range of library users (Bolano et al. 2022).

The pervasive presence of the internet enhances device connectivity, ensuring smooth network control across locations while advancing semantic web technologies in libraries. Rhayem, Mhiri and Gargouri (2020) opine that sustainable networks superlatively serve as the backbone of semantic web applications in libraries, facilitating data interoperability and supporting integrated, enhanced data usage. Moreover, Igbinovia and Okuonghae (2021) note that semantic technologies, powered by the IoT, enable effective resource discovery, data access and knowledge extraction via virtual semantic web systems. These technologies aim to reduce reliance on printed materials and promote the adoption and management of e-resources in libraries (Barnaghi, Wang, Henson & Taylor 2012).

2.8.6 Sensor Application Layer (SAL)

The sensors application layer (SAL) enables the interconnection of digital and physical worlds, allowing real-time data to be collected and processed (Simoes, Barbosa & Filipe 2019). Makori (2017) classifies sensors in different categories, including organisational sensors, environmental sensors, home sensors, appliance sensors and vehicle sensors. IoT systems incorporate a variety of sensors capable of measuring air quality,

temperature, pressure, humidity and electricity flow in a library (Qin 2018). These sensors often retain memory of measurements, providing valuable data for research and library operations. Therefore, sensors can convert the raw signals that gather into interpretable information through various instruments.

In libraries, organisational sensors are primarily used to manage library appliances. According to Mondal (2020) and Makwana (2021), these sensors operate through specialised connectivity systems, such as local area networks (LANs) Wi-Fi, personal areas networks (PANs), Ethernet and Ultra-Wideband (UWB), ensuring efficient information management in public libraries. Abo-Seada (2019) affirms that this connectivity enables rapid monitoring of library environments, including occupancy status and the usage of printers, computers and other appliances. With fully integrated sensor systems, libraries can easily determine which study tables or rooms are occupied, preferred, or underutilised, and can manage room reservations efficiently (Guo Liu & Bielefield 2018; Abo-Seada 2019).

2.9 Chapter summary

Chapter 2 presented the conceptual framework, based on the Library Automated Management Systems Technology (LAMST) and Dr. Ranganathan's Five Laws of Library Science, as applied in a technological/web context, as well as the literature review. The literature review was guided by the concepts and constructs involved in the research objectives of the study. The literature includes discussions on the existing policy and legislative framework for incorporating the IoT in the management of information services, the usability of the IoT in the management of information services, user perception regarding the use of the IoT for the management of information services and the IoT infrastructure that may be suitable for the management of information services. The next chapter explores the research methodology that was employed in the study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapter presented the conceptual framework and the literature review in the context of the research focus – i.e. the utilisation of the Internet of Things (IoT) in the management of information services in public libraries. The purpose, functionality and application of the IoT were illustrated completely, focusing on the public library context. In this chapter, the research design and methodology of the study are explored.

The generation of scientific knowledge largely depends on the research by using valid methodologies (Ngulube 2015). Methodology forms the foundation of research by guiding progression, decision-making and choices of the researchers in the course of a research project of study (Brynard, Hanekom & Brynard 2014). This chapter discusses the following elements of the research methodology: the research paradigm, research approach – specifically Mixed Methods Research (MMR) – and design, the population and sampling, data collection and analysis, as well as the ethical considerations.

Saunders, Lewis and Thornhill (2019) regard research methodology as a systematic process that guides the application of appropriate research approaches. In simple terms, research methodology involves explaining research plan by clarifying the techniques to be employed in order to generate concrete data relevant to the research problem under investigation (Creswell 2018). Creswell (2017) emphasises that research can only be reliable, valid and successful if it is supported by an appropriate methodology. The research methodology clarifies the problem framed as worthy of investigation and outlines the specific steps in the research design required to test the proposed hypotheses. Ngulube (2014) and Creswell and Creswell (2018) indicated that most researchers generally consider two applicable methods when conducting scientific research.

The research paradigm underpinning this study combines ontology and epistemology within the broader worldviews of pluralism and pragmatism. The quantitative component

of the study aligns with pluralism, enabling the measurement of respondents' attitudes in relation to the main objectives and the problem statement of the study. Pragmatism, on the other hand, is reflected in the qualitative component, which involves a detailed examination of secondary data previously captured on the IoT in public libraries and incorporates these insights into the study.

Together, the quantitative and qualitative components form the foundation of the mixed Methods Research (MMR) approach. The research design emerging from the MMR allows for a comprehensive assessment of the problem statement through the application of population and sampling techniques. Four data collection techniques were employed in the study – observation, questionnaires, interviews and document analysis. The questionnaires represent the quantitative component, whereas observation interview and document analysis were employed to collect qualitative data.

Figure 3.1 presents research methodology adopted for this study, based on the outline of Ngulube (2019).

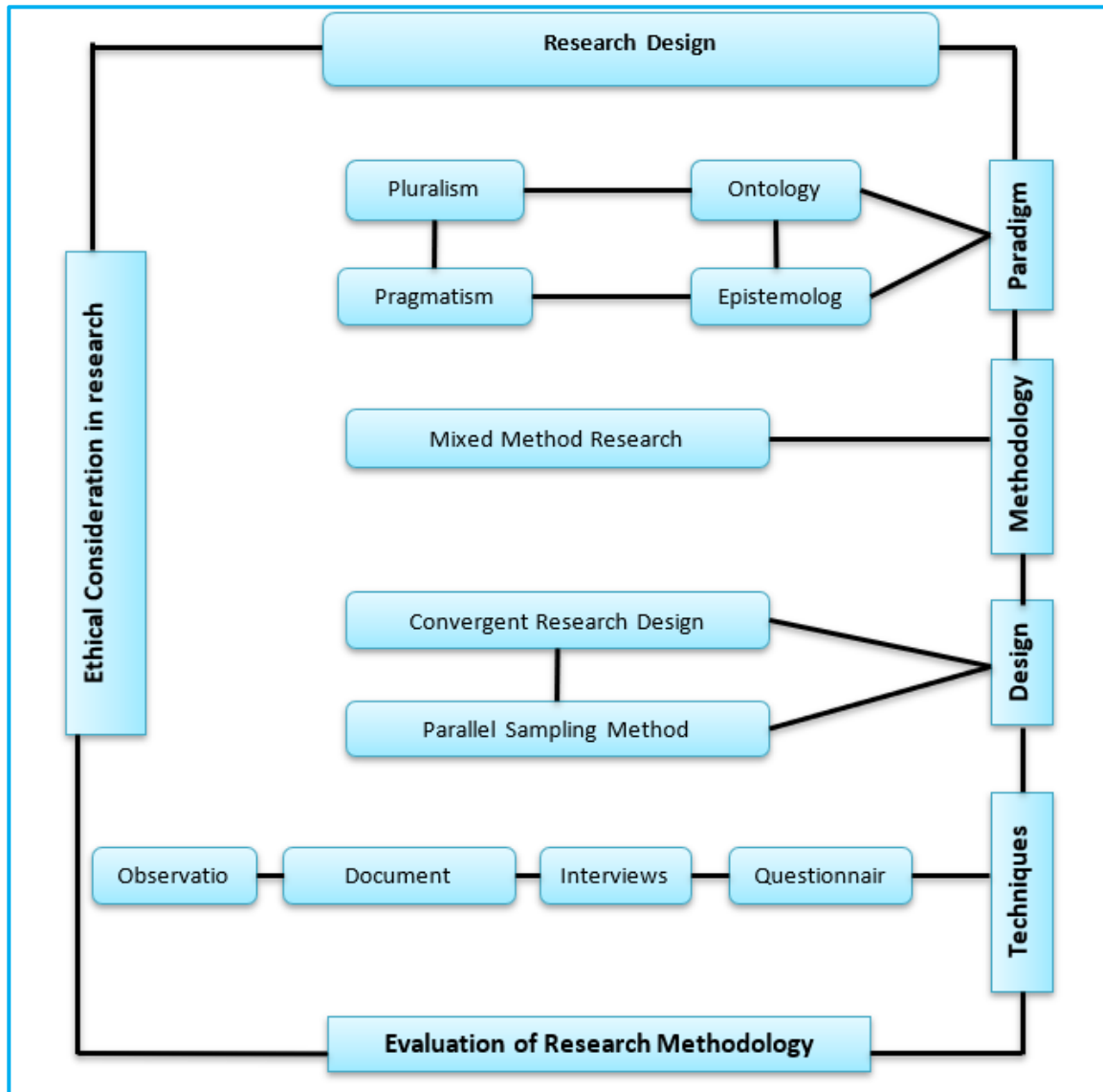


Figure 3.1: Research methodology map

(Source: Ngulube 2019)

3.2 Research paradigm

Author such as Orman (2016) noted that the term *paradigm* lacks deficient clear definition, although its origin can be traced to the Greek word named as “paradeigma”, meaning “pattern”. Therefore, research paradigms represent shared patterns of beliefs or principles that shape the way the researcher views and understands the world and guide their actions within the world (Ngulube 2019).

In social research, ontological and epistemological perspectives are closely interconnected, providing the conceptual foundations that determine the paradigm used in a particular study (Sarantakos 2013). The research paradigm reflects the underlying ideologies that explain the source of information; shapes what is considered as valid knowledge; and influence what is studied, how it is studied and how the research findings are interpreted (Romm 2018).

In this study, both positivism and interpretivism were employed as paradigms (Sarantakos 2013; Creswell & Guetterman 2021). The positivist paradigm is underpinned by realist ontology, which emphasises an objective reality that can be observed and measured. In contrast, interpretivism is rooted in constructivism, which seeks to reveal the subjective truths of human perception and to deepen the understanding of the social values held by people (Kivunja & Kuyini 2017). In this context, epistemology is grounded in human experience, whereas positivism is linked to objectivist ontology, where reality is seen as independent and well defined (Ngulube 2019). Consequently, this study adopted a pluralistic ontological stance alongside a pragmatist epistemological perspective.

3.2.1 Ontology

Ontology refers to the nature of reality and the knowledge that an individual can acquire about and what exists in the world. In a simple form “the ontology is the study of being” (Mark 2010; Danaee 2012). Ontological perspectives are commonly framed through realism and constructivism: realists align with the positivist paradigm and constructivists are associated with interpretivism. Ontology underpins epistemology by shaping the way knowledge is defined and acquired (Sarantakos 2013; Romm & Ngulube 2015). In other words, interpretivism generates subjective knowledge, whereas positivism emphasises the generation of objective knowledge that exists independently of human perception (Romm & Ngulube 2015). In order to bridge the divide between these two positions, pluralism emerges as a framework that integrates both interpretivist and positivist epistemologies (Sarantakos 2013; Romm & Ngulube 2015).

In this study, the researcher adopted pluralism as an ontological stance. Pluralism combines diverse paradigms to account for human behaviour basis and the lived experiences of reality. In research, pluralism is closely associated with mixed methods research, as it accommodates multiple forms of data and contextual interpretations across various levels (Saunders, Lewis & Thornhill 2019). By adopting pluralism, this study acknowledged the coexistence of subjective and objective realities. This perspective recognises both the physical and natural world, while also considering the role of human agency in shaping and interpreting their surroundings for deeper understanding (Creswell & Plano Clark 2018). In this way, pluralism provides a strong foundation for examining the adoption of and utilisation of the IoT in the management of information services in public libraries, ensuring accountability across all stages of data collection (Saunders, Lewis & Thornhill 2019).

3.2.2 Epistemology

Ngulube (2015) argues that epistemology, as a theory of knowledge, is primarily concerned with the research scope, the criteria for evaluating knowledge and determining whether such knowledge is necessary for a given study. Epistemology highlights the relationship between cognition and the objects of knowledge, focusing on the way knowledge is acquired and validated. Liamputtong (2013) adds that epistemology raises questions about what constitutes suitable knowledge and emphasises that it is shaped by authoritative, empirical and perspectival dimensions. Therefore, this study adopted pragmatism as the epistemological stance. It accommodates the possibility of multiple or a single reality, making it a flexible approach for guiding research (Creswell & Plano Clark 2018).

Pragmatism underlines beliefs and practices grounded in knowledge and socially constructed reality, while also articulating normative concepts as a way of viewing reality (Ngulube 2015). The study was structured around pragmatism, which naturally aligns with mixed methods research. The central principle is to determine the validity of knowledge through empirical testing and authoritative evidence, thereby supporting the pragmatist stance adopted for the study (Creswell & Plano Clark 2018; Ngulube 2015).

Kivunja and Kuyini (2017) argue that the pragmatic paradigm values the insights of philosophers who contend that no single method – whether interpretivism or positivism – can fully capture reality. Pragmatism incorporates the elements of three paradigms normally applied in research activities – i.e. post-positivism, interpretivism and critical realism paradigm. Together, they are well suited to mixed methods research (Ngulube 2015). Accordingly, this study adopted the pragmatic research paradigm to guide the research and address the research problem without bias, enabling a more comprehensive analysis of the application of the IoT in the management of information services in public libraries (Saunders, Lewis & Thornhill 2019).

3.3 Research approach

According to Creswell and Poth (2018), a research approach is a theoretical framework that influences and guides the way knowledge is interpreted and understood in a particular study, shaping application of the research method. Evans and Lewis (2018) further explain that the research approach – which is closely linked to the philosophical worldview adopted in a study – is an essential element of research process, in that it provides direction to the research and informs the choice of research methods (Creswell 2018).

Three known research approaches are applied in scientific research, namely qualitative, quantitative that “result to mixed methods” (Ngulube 2015). As explained by Creswell and Creswell (2018), the qualitative approach as a means of exploring individuals’ perspectives to gain a deeper understanding of their experiences; particularly in terms of social issues. By contrast, the quantitative approach is associated with positivism, empiricism and objectivism, focusing on the measurement of variables through numerical data and the application of statistical procedures (Creswell 2013). In this study, the transition between the qualitative and quantitative approaches was fluid. Both approaches were employed in a planned manner, consistent with the pragmatic worldview that draws from positivism and interpretivism (Creswell 2013). Therefore, pragmatism supported the integration of the qualitative and quantitative approach, making mixed methods research (MMR), the most suitable design.

Mixed methods research (MMR) can be regarded as a research approach that integrates quantitative and qualitative methods to investigate complex research problems (Ngulube 2020). It enables the researcher to draw comprehensive conclusions by collecting and analysing data from both approaches and combining the outcomes into a single study (Creswell & Creswell 2018). Marutha and Modiba (2022) affirm that, in mixed methods research, a single, overarching purpose often generates multiple objectives for the study. This approach is employed to provide a comprehensive understanding of the research problem and to facilitate the development of flexible solutions to the research problem (Romm & Ngulube 2015). In summary, the mixed methods research approach integrates the strengths of the qualitative and quantitative approach to produce broad-based research (Ngulube 2015).

In this study, the mixed methods approach was applied to collect numerical and textual data, which enhanced the researcher's ability to address the research problem. In this way, MMR is allowed for a depth and breadth of information that could not have been achieved when relying on a single method in isolation, whether applied sequentially or independently (Tashakkori, Johnson & Teddlie 2021)

3.4 Research design

Research design can be described as a structured plan or strategy that outlines the procedures, methods and techniques to be followed in addressing the research problem, achieving the research objectives and answering the research questions (Babbie 2016). According to Du Plooy-Cilliers, Davis and Bezuidenhout (2014) and Ngulube (2015), an effective research design should answer key questions such as *how* the research will be conducted; *who* or *what* will be involved in the research and *where* and *when* the study will be conducted. Similarly, Ngulube (2020) stipulates that a research design reflects the researcher's methodological choices and ensures that appropriate techniques are employed to ensure the success of the study.

In the context of mixed methods research, Marutha and Modiba (2021) identify several design types, including multiple phase design, embedded design, explanatory sequential design, exploratory sequential design, embedded design and convergent design. The multiple phase design integrates quantitative (QUAN) and qualitative (QUAL) methods sequentially or concurrently across different data collection phases, such as interviews, questionnaires, different locations, time, content and context (Marutha & Modiba 2022). By contrast, the embedded design assumes that one dataset may not be adequate, requiring both qualitative and quantitative data to generate strong research findings, with primary data often strengthening secondary data (Creswell & Hirose 2019). This QUAL-QUAN integration is particularly appropriate when prior knowledge or the research problem is limited (Creswell and Creswell 2018). Pragmatism underpins the embedded research design, supporting both the concurrent and sequential approaches (Ngulube 2020).

Tashakkori, Johnson and Teddlie (2021) explain that the explanatory sequential design is primarily quantitative in nature, in that it addresses questions of *why* and *how* by building on descriptive and exploratory data. Creswell (2012) posits that the exploratory sequential design is predominantly qualitative and, therefore, suitable for studies that explore new phenomena and develop hypotheses through theory building.

The convergent design was selected as the most appropriate for this study. Convergent designs allow the researcher to collect qualitative and quantitative concurrently and subsequently, analyse the two datasets independently and then merge the results in the interpretation phase (Creswell & Plano Clark 2018; Creswell & Creswell 2018; Ngulube 2020). In this design, either qualitative or quantitative data may hold greater weight, depending on the research needs (Creswell & Plano Clark 2018). Sequential considerations further determine which method is prioritised first during data collection (Ngulube 2020).

The convergent design was selected for this study because of the opportunities it provided during data analysis to compare and integrate findings, ensuring richer

insights. Furthermore, it allowed for transformational and validation variants, strengthening the credibility of the study (Leedy & Ormrod 2015).

The convergent design facilitates the effective integration of qualitative and quantitative research methods, while allowing each to operate independently during data collection (Creswell & Plano Clark 2018). It enables the researcher to manage outcomes systematically and apply appropriate instruments and techniques to enhance understanding (Du Plooy-Cilliers, Davis & Bezuidenhout 2014). The primary intention of employing the convergent design is to obtain complementary data, thereby generating diverse insights into the research problem (Creswell & Creswell 2018).

In this study, the convergent design aligned with the complexity of investigating the utilisation of the IoT in the management of information services in public libraries. The quantitative methods addressed objective aspects, such as adoption measures, whereas qualitative methods provided deeper insight into subjective experiences and perceptions (Kiger & Varpio 2020). By comparing and integrating the two strands of data, the researcher was able to generate a clearer and more extensive understanding of the research phenomenon (Bertram & Christiansen 2020). The two-phase structure also allowed the researcher to explore the phenomenon from different perspectives; particularly in contexts where existing knowledge was limited or where perceptions could be uncertain or resistant, as reflected in the views of library staff. Consequently, this research design ensured a more holistic understanding of the research problem (Creswell & Creswell 2018).

3.5 Population

In the research context, *population* is defined as the total number of subjects, objects or members that share common characteristics within a specific geographical area (Du Plooy-Cilliers, Davis and Bezuidenhout (2014). Similarly, Babbie (2013) refers to population in research as the entire group of people, organisations or entities relevant to a particular study. If the population is too large, a representative sample is employed,

which reflects the essential characteristics of the entire population (Du Plooy-Cilliers, Davis & Bezuidenhout 2014).

The population of this study comprised total of (21) participants, all of whom were library professionals involved in information services. These includes two (2) senior librarians, one (1) IT Manager, one (1) IT Assistant Director, one (1) IT practitioner, six (6) librarians, ten (10) library assistants and one (1) IT clerk. The selected participants were well positioned to identify the challenges and opportunities associated with the utilisation of the IoT in libraries, and to contribute existing knowledge and practical insights with understanding of relevancy to the management of information services in public libraries.

3.6 Parallel sampling technique

Dawson (2019) describes sampling as the process of selecting actual cases from a targeted group, thereby making it a procedure for choosing a subset of a population for the study. Higson-Smith and Sithole (2013) explain that sampling involves the selection of cases to be observed, with the expectation that results can be applied to the larger, targeted population. Sampling is typically divided into two broad categories – probability and non-probability sampling, with probability sampling often including techniques such as stratified random sampling. According to Marutha and Modiba (2022), a sampling method specifies the group from which the data is to be collected.

Common sampling methods include nested sampling, identical sampling, multi-level sampling and parallel sampling. In identical sampling, the population is divided into subgroups that share similar characteristics, enabling participants to be selected simultaneously across qualitative and quantitative components of the study – a study that often aligns with probability sampling (Creswell & Plano Clark 2018). Nested sampling involves selecting a subset of participants in one phase who may also participate in subsequent phases (Creswell & Creswell 2018). Multi-level sampling focuses on drawing sub-populations from the large population, typically for both

quantitative and qualitative strands, where participants differ according to subjective alignment (Gravetter & Forzano 2016).

Parallel sampling, which was the most relevant sampling technique for this study, involves the simultaneous collection of qualitative and quantitative data from the same population, but with different components used to create separate samples collecting (Creswell & Plano Clark 2018). Marutha and Modiba (2022) indicate that the two methods remain independent, but are conducted concurrently, while Ivankova (2015) asserts that parallel sampling consists of two phases, with one phase addressing qualitative techniques and the other focusing on quantitative methods. The results are integrated to provide a comprehensive response to the research questions of the study (Creswell and Plato Clark 2018). As suggested by Bless, Higsonsmith and Sithole (2013) and Ngulube (2015), parallel sampling also supports data validation and transformation by allowing data to be collected simultaneously across different groups and contexts. Therefore, this study adopted parallel sampling as its sampling strategy, since it enabled data collection from diverse participant groups at the same time and within the same context, thereby providing a balanced integration of qualitative and quantitative evidence.

3.7 Data collection

Merriam and Tisdell (2015) and Patton (2015) observe that data collection methods refer to the techniques employed to obtain the primary data required for the study, as well as the measures used to interpret the outcomes. Saunders Lewis and Thornhill (2019) and Sukmawati (2023) emphasise that data collection methods typically include techniques such as observation, *interviews*, *questionnaires* and *document analysis*. These techniques are employed in this study to collect primary data from PML participants, which are detailed in the following sections.

3.7.1 Interviews

Oltmann (2016) defines the interview as a type of social interaction between the researcher and participants, with the researcher managing and interpreting the

relationship, in order to exchange information. In mixed methods research, the goal of the interview is to explore participants' perspectives on a given topic, so as to understand the reasons behind their attitudes (Greeff 2011).

Three types of interviews are commonly used in research, namely structured, semi-structured and unstructured interviews. The unstructured interview is typically qualitative in nature, covers loosely defined topics and often requires extended discussion lasting 30–40 minutes (Wiid & Diggines 2015). Semi-structured interviews, which differ from structured interviews, are useful when attitudinal and in-depth data needs to be collected (Cameron 2013). Structured interviews, which were used in this study, allowed the researcher to ask a set of pre-determined questions to which the participants responds in an open but standardised manner (Creswell & Creswell 2018). The researcher compiled a set of questions, based on knowledge, ideas and skills known about the utilisation of the IoT in information services, and these pre-set questions were asked during the interviews at PML.

This approach to the interview enabled the researcher to explore participants' knowledge, experience and ideas relating to the utilisation of the IoT, thereby generating compatibility and comparability of the responses (Cameron 2013). As indicated in the discussion on the population, these structured interviews were conducted with two (2) senior librarians, one (1) IT manager, one (1) assistant manager and one (1) IT practitioner. The aim of the interviews was to explore the interviewees' views of the application of the IoT in the libraries. Managers and senior staff members were targeted for interviews, as they had broader internal and external knowledge compared to staff on lower levels.

Bernard (2013) mentions that data-collection methods can also be conducted by using technology for unavailable in-person during interviews. One such method is computer-assisted telephone interviewing (CATI), which enables the researcher to conduct structured interviews via telephone by using pre-programmed questions. CATI allows participants to respond to the questions conveniently from their workplaces, while the

researcher captures the responses automatically (Bernard 2013). Furthermore, the CATI provides participants with the option of choosing their preferred interview format, including oral online participation by using headphones (Bernard 2013). In case of PML the interviews were conducted face-to face with the participants at PML premises.

3.7.2 Questionnaires

Babbie (2020) defines *questionnaire* as a set of written instructions compiled into a document that respondents are required to complete. For this study, the researcher employed self-administered questions with both closed-ended and open-ended questions, which allowed respondents the time and space to provide thoughtful answers (Creswell 2013). The closed-ended questions provided respondents with a list of pre-determined options to choose from (Creamer 2018), whereas the open-ended questions allowed them to formulate their responses in their own words (Zohrabi 2013; Kumar 2019).

To address the situation of employees on questionnaire, computer-assisted self-interviewing (CASI) is a method researcher can use for collection of data (babbies 2020). CASI enabled the respondents to access the pre-prepared questions on a computer, read them and record their answers privately (Bernard 2013). Questionnaires in electronic format can also be distributed on web platforms, email or flash drives, thereby ensuring accessibility and flexibility (Bernard 2013). In this study, the researcher administered the questionnaire to lower-level employees at the libraries through physical visit. The eight (8) comprise of 11 librarians, 17 library assistants and two (2) IT clerks, making a total of 30 respondents. However, the minimum of six (6) librarians, ten (10) library assistant and one (1) clerk managed to answer the questionnaire distributed, which marked approximate 17 respondents.

3.7.3 Document analysis

In the context of research, document analysis involves the critical analysis of documents in order to understand their content, context and potential implications. In this way, document analysis makes it possible for the researcher to gain insight into experiences,

events and systems without interaction with participants or respondents. The documents used in the document analysis process include books, biographies, private papers, government gazettes and public records (Dawson 2019; Hennink, Kaiser & Weber 2019). In most cases, document analysis assists the researcher in uncovering meaning and identifying relevant data related to the research problem (Creswell 2013).

As pointed out in the *Annual report, 2015–2017* of the Polokwane Municipality, the Polokwane municipality libraries are the largest libraries in Limpopo Provinces, thereby setting an example to all public libraries in the province (Polokwane Local Municipality 2022). The policy and legislation are to be analysed, based on how they support the development and management of library information services (Makwana 2021).

The libraries in the Polokwane Municipality operate under a number of policies designed to ensure that information remains accessible to users when needed. The following policies were analysed in this study: Technical Services Policy (governing classification and cataloguing), the Circulation Policy (managing check-in and check-out procedures through user profiles), Reference and Information Policy, Collection Management Policy and Preservation Policy (for protective measures safeguarding library collections). The policy were asked about but the little was pages pasted on walls allowed for external people to analysis and make use of as document provided by the PML.

3.7.4 Observations

According to Creswell and Creswell (2018), observation is a data collection technique tool that allows the researcher's personal observation of the actions, experiences and events involved in the study. Bertram and Christiansen (2020) regard observation as a systematic process used to examine issues related to the research focus. Bernard (2013) emphasises that objectives of recording data in the course of observation should be clearly defined and prioritised to ensure proper control and reliability of collected data. Observation methods are generally divided into two main categories – participant and non-participant observation (Creswell & Creswell 2018) – and the researcher employed both categories in this study.

In participant observation, the researcher immersed herself in the setting to examine participants' workplace behaviour, social communication and values; particularly in relation to task performance (Hennink, Hutter & Bailey 2011). The study relied more heavily on non-participant observation, where the researcher observed activities performed by individuals and teams without direct involvement, thereby ensuring simplicity and clarity in interpretation (Hennink, Kaiser & Weber 2019). This enabled the researcher to examine how library employees managed information and provide services to users. Leedy and Ormrod (2015) recommend such simple observation, where the researcher records events and practices as they naturally occur in the research setting.

A limitation of observation, noted by Bernard (2013), is that participants may alter their behaviour when they are aware of being observed, e.g. by deliberately demonstrating procedures on computers to showcase their information management skills. In spite of the limitation, observation provided the researcher with valuable insights into the way librarians in the PML manage and deliver information services. This observation technique was applied collectively by examining the state and processes of information management in the library and quantifying aspects such as librarians' behaviour, professionalism, maturity and efficiency through eye to eye conduct (Leedy & Ormrod 2015). In other words, the observation technique offered the advantage of generating first-hand practical data. This was articulated through direct examination of how information is stored, protected, accessed and retrieved within the library. Therefore, the researcher gained a realistic understanding of librarians' IoT knowledge and their daily practices across the different libraries in the PML.

3.8 Data analysis

Data analysis is the process of examining and summarising the collected primary data with the aim of drawing conclusions and generating meaningful insights and conclusions (Kiger & Varpio 2020). Evans and Lewis (2018) indicate that data analysis enables the researcher to identify consistent patterns within the collected data. The purpose is to

present the research findings derived from the techniques and methods applied – in this case, both qualitative and quantitative methods, and collectively referred to as mixed data analysis (Creswell 2015). Mixed data analysis integrates and interprets results in a way that extends beyond the insights produced by individual methods (Creswell 2013). For this study, a convergent design was adopted, which allowed the researcher to analyse quantitative and qualitative data simultaneously, thereby strengthening the overall data interpretation (Kiger & Varpio 2020).

Quantitative data, obtained from close-ended questions in the questionnaire, was interpreted using Microsoft Word, with the results presented through tables, charts and graphs. These visual representations reflected the distribution of responses and provided a clear profile of the way respondents engaged with the questions (Neuman 2014). The qualitative data – collected through interviews and open-ended questions in the questionnaire – was captured and interpreted *verbatim* to retain the richness and integrity of the primary data (Kumar 2019; Bertram & Christiansen 2020). Evers (2015) opines that verbatim transcriptions offer the researcher direct access to the analytical process by preserving the exact words of participants as recorded during the interviews. Similarly, Bazeley (2013) emphasises that audio recordings and/or notes should be clear, so that the researcher can effectively manage the data and generate meaningful findings supported by participants' quotations and comments.

3.9 Research rigour

The quality of a study is typically evaluated and expressed in terms of the research rigour criteria. Reliability is defined as the degree to which a research test consistently produces comparable results when repeated under similar conditions (Nayak 2015). The essence of reliability resides in empirical consistency. Validity, on the other hand, is more fundamental, as it addresses the accuracy of measuring critical variables and the interconnections among concepts (Taylor 2013; Creswell & Creswell 2018). Therefore, reliability and validity are essential in ensuring that the research findings are trustworthy and credible, leading to legitimate and relevant outcomes (Nayak 2015). Accordingly, the data collection and analysis procedures must be rigorously followed to minimise

research errors and to adhere to the standards of perception outlined in mixed methods research (Lakshmi & Mohideen 2013).

3.9.1 Reliability

According to Bloor, McKeganey and Fonkert (1988), and Bertram and Christiansen (2020) mixed methods research supports the integration of quantitative and qualitative approaches to produce consistent and detailed outcomes. A carefully selected methodological tool was applied in the data collection by aligning the research questions with the research method and design. When implemented correctly, the findings become transferable, dependable and confirmable (Kiger & Varpio 2020). In order to ensure trustworthiness, the identities of respondents and participants were kept confidential, thereby enhancing the efficiency and effectiveness of the data collection instruments for both qualitative and quantitative components. Leavey (2017) also highlights that the reliability of MMR lies in its ability to integrate different methodologies and approaches in creative and numerical ways.

The trustworthiness of MMR assessed through the principles of transferability, credibility, conformability and dependability, which establish the reliability of the study (Kumar 2019). Reliability in MMR is reflected in the consistency of data, whereby qualitative methods capture participants' realities as documented in interview recordings and the researcher's notes (Maguire & Delahunt 2017).

In this study, quantitative data collected through closed-ended questionnaires was captured in Microsoft Word and analysed and interpreted to generate tables, charts and graphs. Qualitative data collected through interviews and open-ended questionnaires was analysed by interpreting participants' *verbatim* responses (Du Plooy-Cilliers, Davis & Bezuidenhout 2014). Together, these methods reinforced the reliability of MMR by producing stable findings that, if replicated, would produce consistent results and outcomes (Maguire & Delahunt 2017).

3.9.2 Validity

Validity refers to the extent to which an experimental measurement accurately reflects the concept it is intended to capture (Lobiondo-Wood & Haber 2013). Validity also concerns whether the data collection instruments consistently produce similar results under stable conditions, as demonstrated in previous studies (Lakshmi & Mohidden 2013). Reliable and stable data collection instruments are crucial for ensuring the truthfulness of the research findings, reducing bias and preventing distortion of the findings. In other words, validity ensures that the collected primary data is measured accurately and precisely, so as to produce valid results and meaningful findings (Singh & Perkins 2015). Bloor, McKeganey and Fonkert (1988) further argue that validity is closely related to reliability, since accurate measurement depends on the correct use of reliable scales. In this study, the researcher strictly adhered to conformability requirements, applying both qualitative and quantitative approaches to strengthen validity (Bloor, McKeganey & Fonkert 1988).

The validity is typically categorised into four (4) types – face validity, content validity, and criterion validity and construct validity (Babbie 2020). For this study, *construct validity* was strongly emphasised as suitable for MMR. Construct validity ensured that open-ended and closed-ended questions were aligned with the research objectives and measured by means of the right criteria. *Criterion validity* was addressed by ensuring that existing knowledge was reflected through relevant indicators and measurements (Creswell & Plano Clark 2018).

To ensure quality and validity, all data collection instruments were tested prior to use, ensuring that they were appropriate and effective in producing meaningful research outcomes for the information society. Pre-testing played a vital role in strengthening validity (Creswell 2013). A small group outside the main study population – I.e. a small group of staff from the University of South Africa Library – was asked to review the data collection instruments and provide feedback to improve clarity and comprehensiveness. An additional ten (10) participants were involved in a pilot pre-test to evaluate the effectiveness of the tools in capturing the necessary data. The pre-testing process allowed the researcher to make adjustments before full data collection (Bertram &

Christiansen 2020). In this way, the pre-testing confirmed that the interview and the questionnaire items were appropriate, precise and aligned with the research objectives of the study.

3.10 Ethical considerations

In the research context, ethics involves the researcher's behaviour related to the rights of participants and/or respondents taking part in the study, or those affected by the research. Gravetter and Forzano (2016) suggest that the ethical considerations are an integral part of the research process and required to avoid unnecessary disagreement and conflict. Research ethics require the researcher to be honest and professional at all times in the research, so as to avoid undesirable research implications (Leedy & Ormrod 2015).

As required by the *Policy on research ethics* of the University of South Africa (2016), the researcher obtained ethical clearance from the University, as well as permission from the Polokwane Municipality (PM) to use their facilities and to conduct the research at the selected public libraries (University of South Africa 2016). Positively, with the correct procedures followed, the study can produce objective scientific knowledge, free from bias (Creswell 2013). In the data collection of this study, ethics included voluntary participation, confidentiality and avoidance of plagiarism, all of which ensured respect for participants/respondents and compliance with established ethical standards (Babbie 2020).

3.10.1 Voluntary participation

The researcher explained the principle of voluntary participation to participants to ensure that they were fully informed about the process (University of South Africa 2016). Participants/respondents were made aware that their participation was entirely voluntary and free – no form of compensation, such as vouchers or payment, would be provided for the information they shared (Bertram & Christiansen 2020). They are also assured of their right to withdraw from the study at any given point without being required to provide a reason. Furthermore, no participants and respondents were forced

to continue if they chose to withdraw from the research (Gravetter & Forzano 2016). The researcher respected the rights and interests of all participants and respondents throughout the study (University of South Africa 2016).

3.10.2 Confidentiality

In this study, confidentiality referred to the assurance that all information provided by respondents/participant is respected and will not be not disclosed to any other person other than the researcher's supervisor (Ridley 2012). In order to uphold confidentiality, the researcher verbally explained the purpose and research objectives to the respondents/participants, ensuring that they understood what was expected of them in the data collection process and that their identities would remain protected (Ngulube 2015). The signed informed consent form served as the formal permission to proceed and confirmed agreement to the terms and conditions of participation (Creswell & Poth 2018).

3.10.3 Plagiarism

All the information used in this study is based on the findings of existing research scholarly journal articles and, therefore, all consulted sources were acknowledged by means of citations and a reference list, aligned with the Harvard Referencing Technique (Creswell 2013). In terms of the *Policy on research ethics of UNISA*, the researcher avoided the practices of plagiarism and copying and pasting information at all costs (University of South Africa 2016).

3.10.4 Permission to conduct research

The permission to conduct research served as the official authorisation that legally ensured that the researcher had the right to investigate the proposed subject matter and to present valid, professionally appropriate information (Rayner & Bell 2017). The Ethics Committee of UNISA issued a formal letter, granting the researcher ethical clearance and approval to conduct the research as proposed. In addition, the Polokwane Municipality (PM) issued a letter of permission that allowed the investigation of the proposed study in the Polokwane Municipality libraries.

3.11 Chapter summary

This chapter presented the research methodology and design for the study on the utilisation of the IoT in the management of information services at PML libraries. The chapter outlined the relevant research paradigms, the research approach and design, the population and sampling, as well as the techniques and instruments employed in the data collection and analysis. Method, designs and survey techniques used to collect information. The study adopted a mixed methods research approach, combining quantitative and qualitative perspectives to address the research problem. This approach offered a more comprehensive understanding than would have been possible by using a single approach. Ethical considerations were also discussed, with emphasis on protecting the rights of respondents and/or participants. The fourth chapter presents the interpretation of results obtained by analysing the primary data collected through the questionnaire and interviews.

CHAPTER 4: DATA ANALYSIS AND PRESENTATION OF THE FINDINGS

4.1 Introduction

The previous chapter discussed the research methods employed in the study, starting with the research paradigms which pluralist ontological perspectives and pragmatist epistemological perspective gave direction to the study. The paradigms was followed by discussions on the mixed methods research approach and convergent research design, as well as the parallel sampling technique and the data collection and analysis methods and instruments. These elements of research methodology paved the way for collecting the primary data at Polokwane Municipality libraries (PML) as the population for the study. Chapter 3 concluded with an outline of research rigour and the ethical considerations involved in the study.

Research results, derived from the primary data, was collected from eight PML through questionnaires, interviews, observation and document analysis, is presented, analysed and discussed in Chapter 4. The results are presented in alignment with the research objectives identified in Chapter 1 (see Table 1.1). Data analysis made it possible to identify patterns in the collected data, in order to be accurate and have meaning to conclude the study (Horne 2018). As demonstrated by Mertens (2017), data analysis requires interactive strategies to interpret and manipulate numbers and to extract useful data, in order to answer the research questions and achieve the research objectives.

Furthermore, the MMR approach was applied to obtain and present research outcomes through both quantitative and qualitative methods. The quantitative results were generated by using Microsoft Word to generate statistics, based on the primary data collected by means of the questionnaire, and reported in the form of tables, graphs and charts. The qualitative results, derived from the open-ended questions are presented in *verbatim* quotations, as captured during the interviews with participants. In addition, non-participant observation was conducted, which allowed the researcher to move around

and observe activities involved in information services. The observation results were documented as they occurred and are reported in this chapter.

4.2 Data presentation and analysis strategy

The data analysis is a strategy that informs readers about the outcomes discovered during data collection process. Therefore, the data collection and analysis were conducted in alignment with four research objectives of the study, which was to:

- Evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at Polokwane Municipality Libraries;
- Examine the usability of the IoT in the management of information services at the Polokwane Municipality Libraries;
- Assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries;
- Identify the IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries.

4.3 Description of research participants and respondents

The respondents and participants in the study were PML employees, selected questions were designed around the research objectives of the study. The questionnaires and interviews were distributed across eight (8) PML. At the time of the research, these libraries collectively employed seventeen (17) library assistants (including interns) and eleven (11) librarians and three (3) IT clerks, appointed by the Polokwane Municipality and the Department of Sport, Arts and Culture (DSAC).

The total of thirty two (32) questionnaires were issued to librarians, library assistants and IT clerks. The seventeen (17) completed questionnaires were returned to the researcher, representing the responses of six (35%) librarians, ten (59%) library assistants and one (6%) IT clerk. This outcome reflected a complete response rate from those who participated, yielding a favourable and satisfactory return percentage for the study.

The senior positions in the Information Technology (IT) Division were selected for interviews, because of their significant contribution to both manual and electronic services offered by the library. The interview participants included two (50%) senior librarians, one (25%) IT Assistant Director (System Administrator) and one (25%) IT technician, that resulted in a total of four (100%) participants. However, the overall interview participation rate was lower than anticipated, as several invited participants declined to take part in the interview sessions.

4.3.1 Demographic data and response rates

This part of the study required the researcher to visit the target population, in order to collect data using drafted questionnaires and interviews. These instruments captured participants' and respondents' demographic information, including age group, educational level and job title. In other words, the study provided a clear understanding of the background and occupations of PML officials.

The response rate refers to the number of respondents and participants who returned complete data collected tools or answered a set of questions (Letsoalo 2024). Lau, Cronberg, Marks and Amaya (2019) define *response rate* as the percentage of respondents who answered during data collection, divided by the total number of respondents estimated by the sample size.

As illustrated in Figure 4.1, a total of 32 (50%) questionnaires were distributed; 15 (23%) questionnaires were returned blank/unanswered; 17 (27%) questionnaires were completed by ten library assistants, six librarians and one IT clerk, which are demonstrated in Figure 4.1.

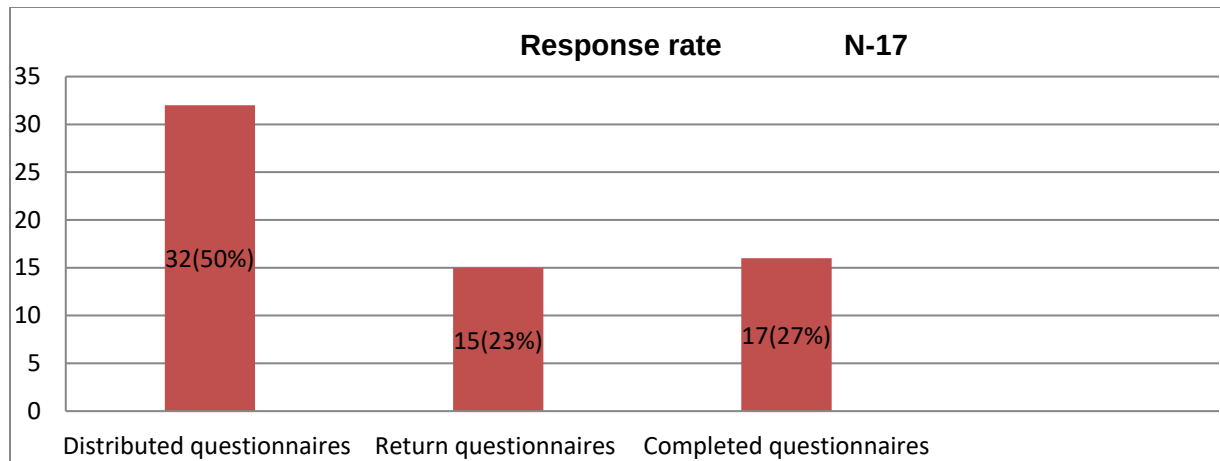


Figure 4.1: Response rate

The interviews were conducted with a total of four (100%) participants – two (50%) senior librarians, one (25%) IT Assistant Director (System Administrator) and one (25%) IT technician.

4.3.2 Response rate across genders

The closed-end questionnaires were used to determine the response rate across respondents' gender. As illustrated in Figure 4.2, the questionnaires were completed by 11 (65%) female and six (35%) male respondents. The interviews were conducted with four (100%) female participants.

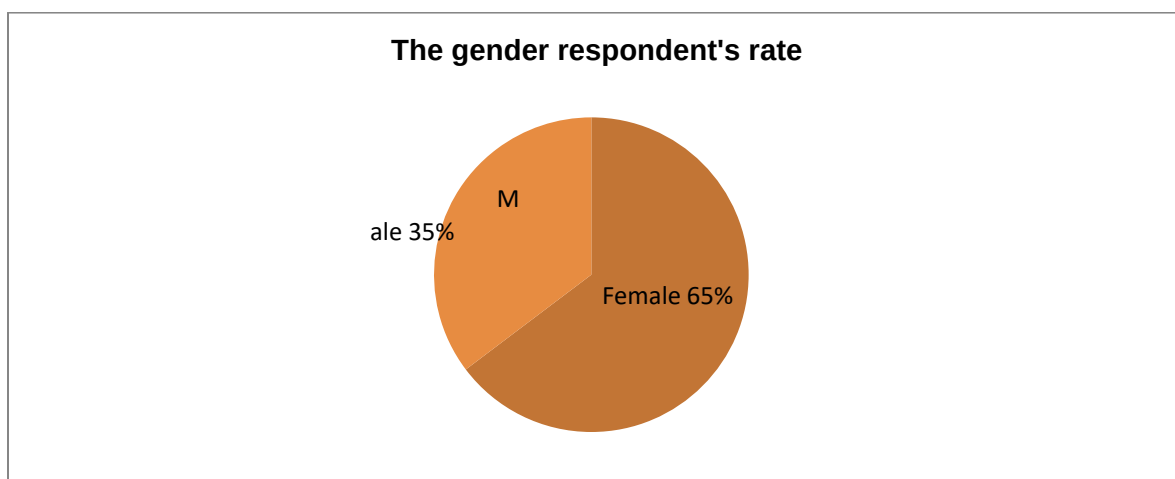


Figure 4.2: Response rate across genders

4.3.3 Response rate across age groups

The closed-end questionnaires were used to reveal respondents' age group, which produced the following results: four (47%) respondents in the 18–30 age group; eight (29%) respondents in the 31–40 age group; five (24%) respondents in the 41–50 age group; and 0 (0%) respondents in the age group of 51 and above. See also Figure 4.3. The interviews were conducted with the four participants in the age group of 41–50.

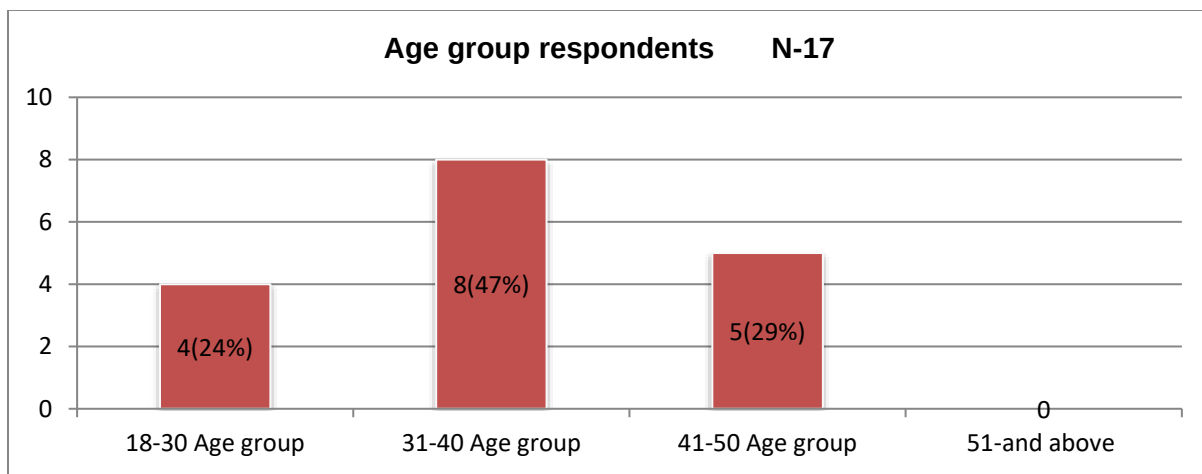


Figure 4.3: Responses rate across age groups

4.3.4 Educational level of respondents

The closed-end questionnaires were used to determine the educational level of respondents, with the following results: five (29%) respondents had higher certificates in Archives and Record Management; six (35%) respondents had degrees in Information Science; four (24%) respondents obtained postgraduate diplomas/Honours in Information Science; one (6%) respondent has a Master's in Information Science and one (6%) respondent had a PhD in Information Science. These results are illustrated in Figure 4.4.

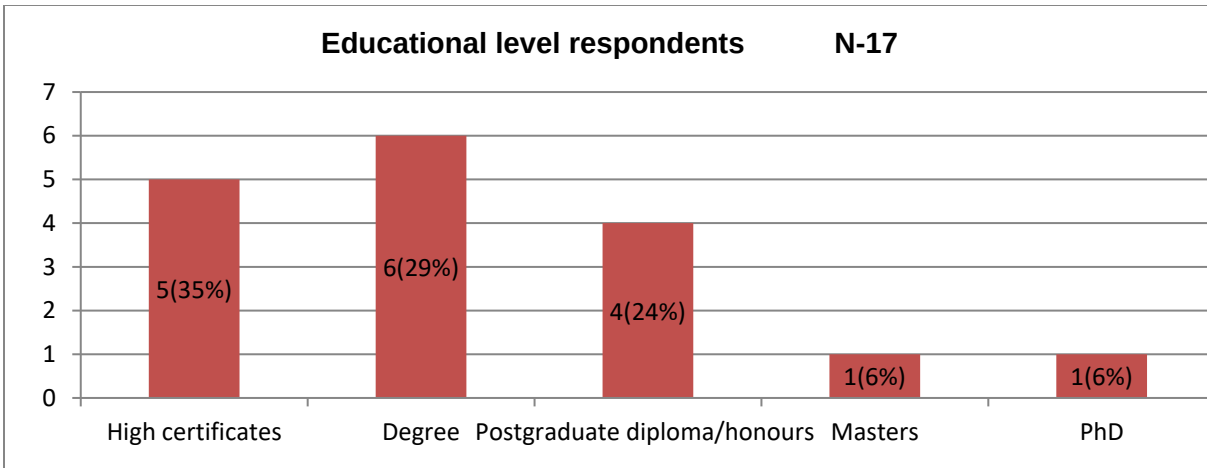


Figure 4.4: Education level of respondents

The interviews were conducted with two senior librarians – one who held a Bachelor’s degree in Information Science and one who held a Master’s degree in Information Science. In the IT Division, one participant held an Honours degree in IT and the second participant held a degree in Computer Science.

4.3.5 Job titles of respondents

The researcher used closed ended questions to collect data on respondents’s job titles. The results revealed that there were six (35%) librarians, ten (59%) library assistants and one (6%) IT clerk. Figure 4.6 illustrates these results.

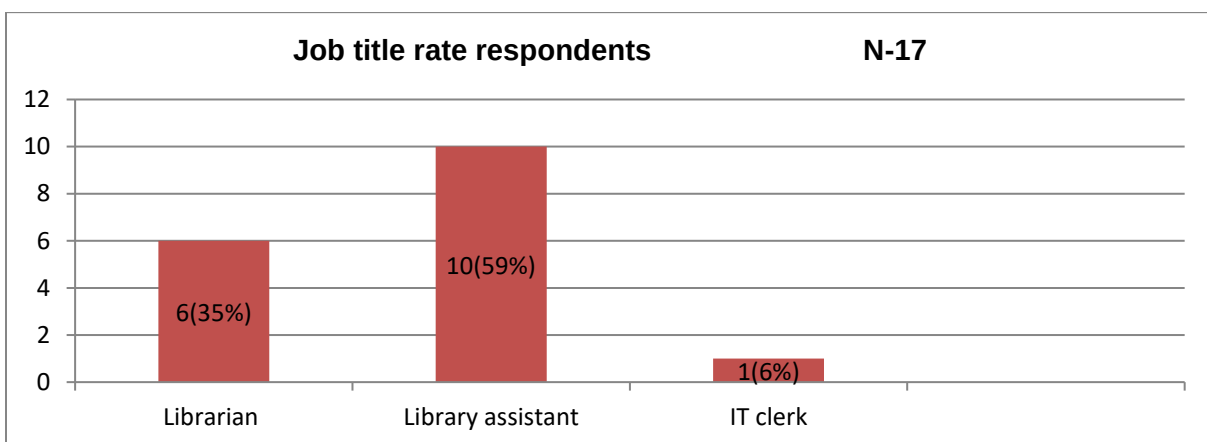


Figure 4.5: Job titles of respondents

The job titles of the interview participants were as follows: two senior librarians, one IT Assistant Director (Systems Administrator) and one IT technician.

4.3.6 Work experience of respondents

Figure 4.6 illustrates the overall breakdown of work experience of the 17 respondents. The results are as follows: five (29%) respondents had 0–2 years' work experience; four (24%) respondents gained 3–5 years' work experience; two (12%) respondents generated 6–7 years' work experiences; 0 (0%) respondents fell in the 8–10 years' work experience category; and six (35%) respondents had generated +11 years' work experience.

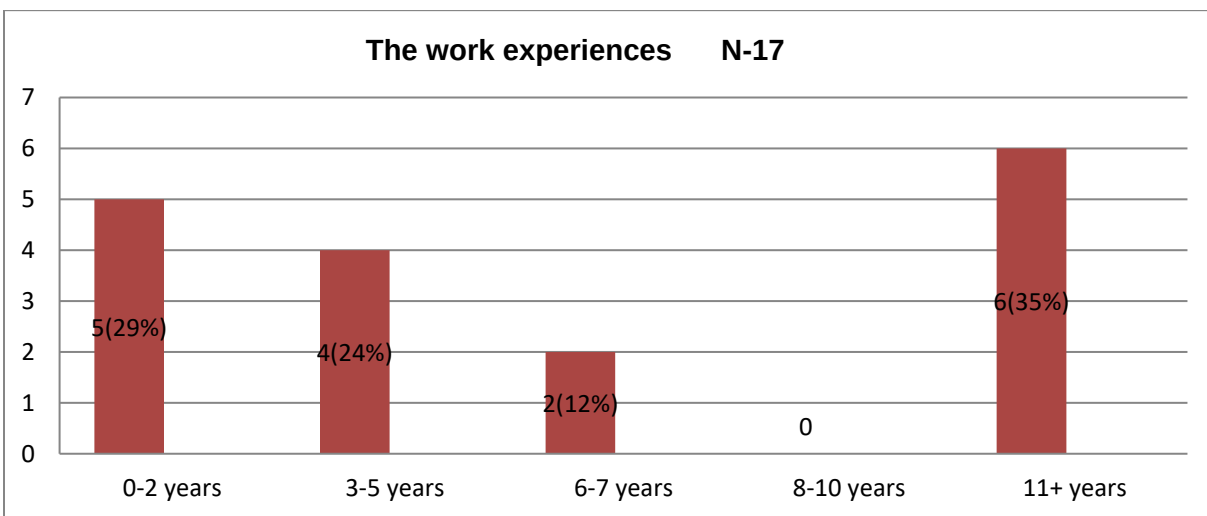


Figure 4.6: Work experience of respondents

The work experience of the interview participants was as follows: two senior librarians had +11 years' work experiences; one Assistant Director (System Administrator) had gained +11 years' work experience; and the IT technician had gained 4–6 years' work experience.

4.4 Legislative and policy framework relevant to the use of the IoT in information services

The discussion in this section is based on the first research objective and research question of the study:

Research Objective 1: Evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries.

Research Question 1: How adequate is the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries?

4.4.1 Policy for information services

When the respondents were asked if libraries had specific policies for information services, the following responses were given: 17 respondents replied by ticking yes, indicating that they agreed that PML had such a policy. In the interviews, Participants 1–4 responded affirmatively, indicating that the libraries had a policy for information services.

The respondents were asked open-ended questions on how the policy addressed the information service. The following responses were captured:

Respondents 1–3: *“The policy regulates and promotes information service for users to get a quiet place for reading and restrictions of information in computer lab”.*

Respondents 4–11: *“Policy provides relevant information access that promotes a culture for reading through the circulation of books”.*

Respondents 12–13: *“Protection of information and other services such as charges on copies or printouts and lost books”.*

Respondents 14–17: *“Good communication, ICT development and address users’ information needs”.*

When the interview participants were also asked about how the policy addressed information service at PML, their responses were as follows:

Participants 1–2: *Policy gives procedure on collection development, lending procedure, and guide when users want to open memberships and rules to adhere to within library premises to protect library collection.*

Participants 3–4: *Treat users fairly and consistently in applying the rules to day to day functions of the library by following established policy on circulation policy, access policy, references section, inter-library loans,” in rendering information services.*

4.4.2 Policy for library collection

The respondents were asked if their policy could be used to manage the library collection. All the respondents agreed that their policy could be used to manage the library collection. When asked to explain how the policy supported the management of the library collection, the following responses were given:

Respondents 1–7: *“Maintaining a cost-effective, high-quality collection in all eight PML libraries branches in order to store information on systems the policy remains a guiding tool”.*

Respondents 9–11: *“Allowance in asking users for information they require and give direction on how to sustain library collection and outline criteria for the selection of material”.*

Respondents 12–13: *“Provide measures for obtaining electronic resources, and minimise uncertainty for risk and express full function of the libraries”.*

Respondents 14–17: *“Guideline for purchasing, limit to internet access, and support users’ special information needs requested for purchase”.*

When the interview participants were asked how the policy supported the management of the library collection, the responded as follows:

Participants 1–2: *“Regulate inter-library loans, communication channels between users and library and employees when lending and returning books (paper-based collection) as well as requisition procedures when purchasing the library collections”.*

Participants 3–4: *“Integrate system that deducts risks attached to repository storage of library collection and digital electronic automated security that is active and able to alert workers about mismanagement of information services”.*

The researcher observed that these libraries had a policy that was used to manage the library and information services.

4.4.3 Purpose of policy in library

The respondents were asked about the the purpose of a library policy. Figure 4.7 illustrates the following results: two (12%) respondents indicated that the purpose of the library policy was information protection; two (12%) respondents indicated that the policy was used for efficient communication; one (6%) respondent indicated the policy was used to track physical resources; six (35%) respondents indicated that the policy

was used for adequate updates of information; and eight (47%) respondents identified/ticked all of the above options.

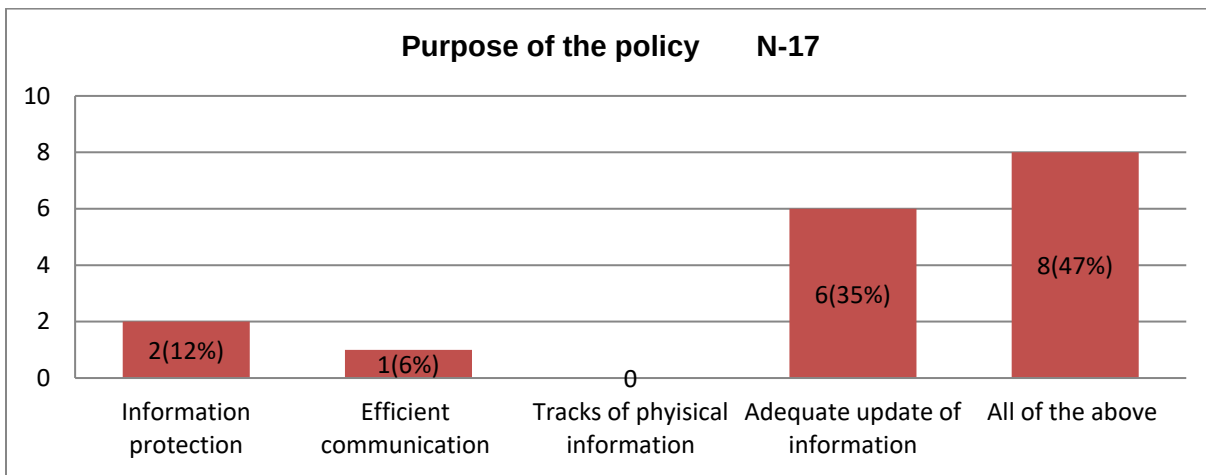


Figure 4.7: Purpose of the policy

In the interview, participants were also asked about the purpose of the policy in the library and the four participants answered as follows:

Participants 1–2: “The policy is used to provide *terms and conditions in rendering information service and security in accessing library books and library internet services*”.

Participants 3–4: “*Protects any means or resources used to provide information services and updates on new collection and increases in municipality tariffs charged on library service*”.

Researchers observed that the purpose of the policy was to assist the library with labour matters, rendering of library service/s and security in managing library resources.

4.4.4 South African legislation used to manage electronic information

The respondents were asked about which legislation was used to manage electronic information. Figure 4.8 shows the following results: one (6%) respondent chose the Protection of Personal Information Act, No. 4 of 2013; one (6%) respondent selected the Promotion of Access to Information Act, No. 2 of 2000; one (6%) respondent selected the South African Public Library and Information Service Bill (2012); five (29%) respondents chose the Constitution of Republic of Sout Africa, Act 108 of 1997; and nine (53%) respondents selected all of the foregoing acts.

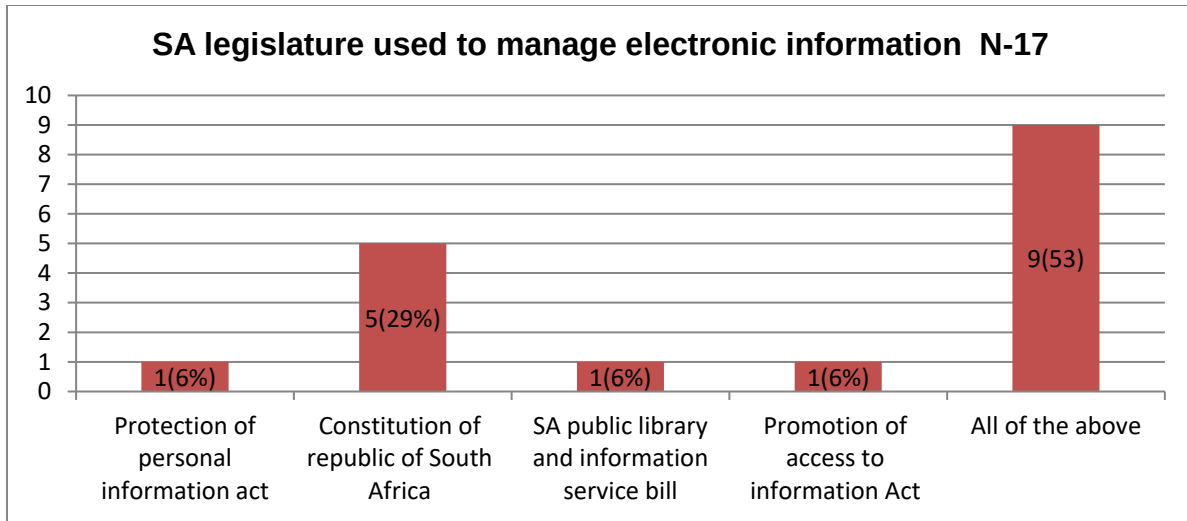


Figure 4.8: South African legislation for managing electronic information

In the interviews, participants were asked which of South African legislation was used to manage electronic information sources at PML, and Participants 1–4 identified *the* Constitution of Republic of South Africa, Act 108 of 1996, the South African Public Library and Information Services Bill (2012) and the Promotion of Access to Information Act, No. 2 of 2002.

Document analysis revealed there were chapters and sections in the following legislation that addressed the management of internet access in computer labs: the Protection of Personal Information Act, No. 4 of 2013; Electronic Communication and Transaction Act, No. 25 of 2002; the Constitution of the Republic of South Africa, Act 108 of 1996; the National Council for Library and Information Services Act, No. 6 of 2001; the Promotion of Access to Information Act, No. 2 of 2002; and South African Public Library and Information Services Bill (2012).

4.4.5 South African legislation assisting the management of electronic information

In the questionnaire, respondents were asked how South African legislation assisted with electronic information in the library. As illustrated in Figure 4.9, the following results were obtained: 11 (65%) respondents selected access to information; two (12%)

respondents chose ICT development; 0 (0%) respondents selected web technology; and four (23%) respondents ticked all of the foregoing options.

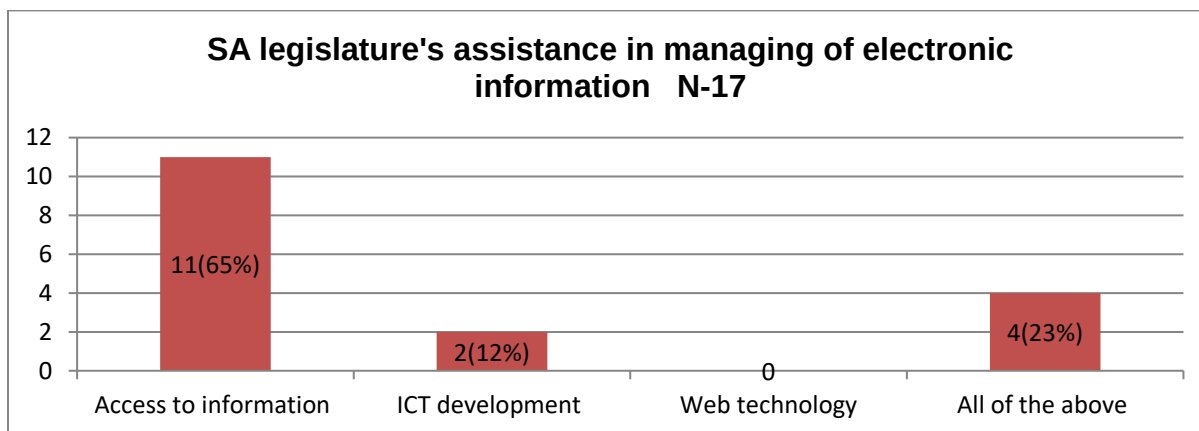


Figure 4.9: South African legislation assisting in the management of electronic information
When this question was posed to the interview participants, the responded as follos:

Participants 1–3: *“The legislature assists in computer labs to restrict information not acceptable to access in library and procedures applied when using computer equipment in computer labs”.*

Participants 3–4: *“Connectivity protection that gives allowance to minimum restriction and time usage in computers and limit to voucher to internet access in library”.*

Document analysis revealed guidelines on the use of ICT equipment, such as printers, computers, tablets and systems, emphasising respecting access for personal information.

“The researcher observed that, there is internet access available and governed by rules; with no digital cloud storage to support database access”.

4.4.6 Review of policy

When asked in the questionnaire if PML reviewed their policy, all respondents answered “yes”. The interview participants were asked the same question, the also affirmed that they policy was, indeed, reviewed. In a follow-up question, respondents were asked how regularly the policy was reviewed, with respondents answering as follows:

Respondents 1–16: *“The policy is reviewed every financial year or annually”.*

Respondents 16–17: *“Not sure when it is reviewed”*.

In the interview, the participants were also asked how regularly the library policy was reviewed, and all four participants indicated that the policy was reviewed annually, or whenever amends were required.

Document analysis confirmed that PML conducted policy reviews every financial year, in the beginning of June.

4.4.7 Policy to be used for the IoT

The respondents were asked about the gaps in the current policy that could support the adoption of the IoT at PML. They responded as follows:

Respondents 1–6: *“Policy that covers internet, technologies, e-books, and automated system that provides for databases and e-resources”*.

Respondents 7–11: *“Policy that support advanced technology and capacity building, data management and security”*.

Respondents 12–17: *“Gaps were not identified”*.

When the interview participants were asked about the gaps in the current policy that could assist in the adoption of IoT at PML. The following responses were captured:

Participants 1–2: *“IoT and other advanced technology that are new and the rate of extra budget for training which must be preserved and stated within the policy circular”*.

Participants 3–4: *“Amendment on proper planning in terms of information and communication technology (ICT) and infrastructural development”*.

The document analysis revealed that the policy did not cover the implementation and application of the IoT for the management of information services at the PML.

The researcher observed that the PML policy could add IoT integration for access to e-resource, upgrade of security measures and smart modern infrastructure.

4.5 Utilisation of the IoT to manage electronic information

The respondents were questioned if they thought that the IoT could be useful to manage electronic information at the PML. A total of 15 (88%) respondents indicated

that the IoT could be used to manage electronic information, whereas two (12%) respondents said that the IoT could not be used to manage electronic information. Figure 4.10 illustrates these results.

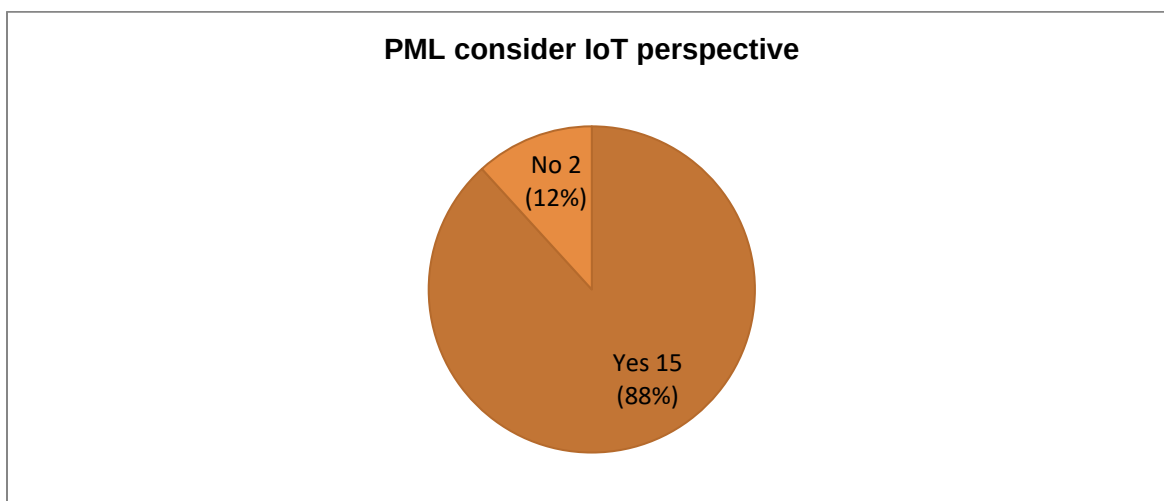


Figure 4.10: PML libraries considering an IoT perspective

Respondents were also asked to explain through open-ended questions in the questionnaire how the IoT could be used to manage electronic information. The following responses were captured:

Respondent 1: *“Smart shelving with usability of RFIDs and sensors automatically used to track misplaced library books easily and makes it easy for library to classify the book to its rightful location on shelves”.*

Respondents 2–6: *“Service access will be expanded to 24/7 to users, provided online with the usage of self-help machines, to reply to users’ queries and respond to open access of users’ information demands by issuing e-journals, periodicals and e-book requested”.*

Respondents 7–11: *“Library workers will be exposed to technical and creative thinking skills with reflection of IoT devices integrated of computer connectivity for library functionality and personal growth”.*

Respondents 12–13: *“Rendering timely information service as the advantage of IoT provide users with near field communication that will provide location notification for books on shelves, and communicate with librarians on new updated library materials, references, interviews, libraries awareness and reserve section service”.*

Respondent 14–15: *“Actuators, sensors, RFDIs add an extra security protection of information which includes books stolen and restricts access of personal information as well as virtually library set-up application access electronically”.*

The respondents were also asked to explain why the IoT could not be used to manage electronic information. They answered as follows:

Respondents 16–17: *“PML due to budget and lack of support from management there may not implement IoT”.*

When the interview participants were asked if the IoT could be used to manage electronic information, they answered as follows:

Participants 1–2: *“Is an ongoing process that will take time to consider as PML must first look at the proper planning needed for IoT, more advanced knowledge and budget, as well as considering that labour force of library workers will not be affected”.*

Participants 3–4: *“For fast communication, information access, security measures, best modern library infrastructure PML can consider IoT perspective to benefit library users” with adequate information services”.*

4.6 Usability of the IoT in managing information service in libraries

The discussion in this section aligns with the second objective and research question of the study:

Research Objective 2: Examine the usability of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries.

Research Question 2: How usable is the IoT in the management of information services at the Polokwane Municipality Libraries?

4.6.1 IoT for information services

In the questionnaire, respondents were asked if the IoT was used to manage information services in their library. As shown in Figure 4.11, 15 (88%) respondents indicated that the IoT was not used to manage information services, while two (12%) respondents indicated that the IoT was used to manage information services in the library.

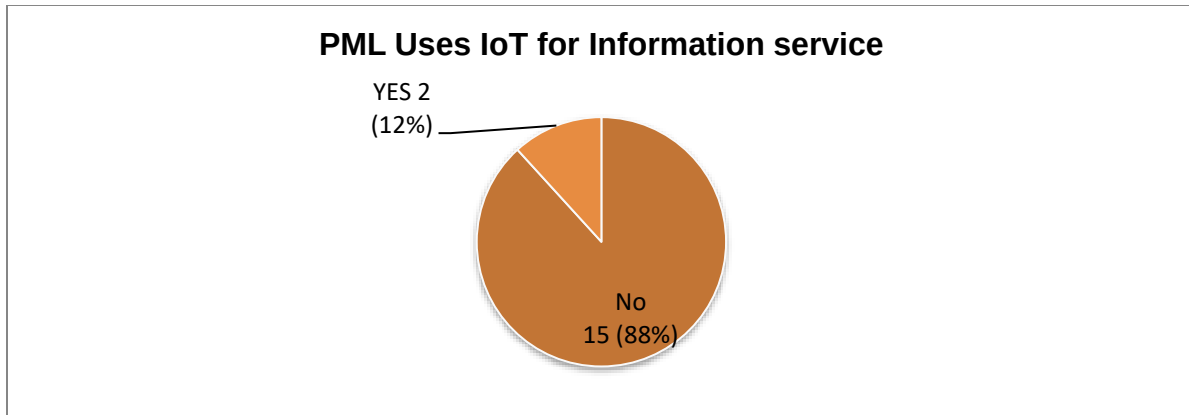


Figure 4.11: Uses of the IoT for information services at PML libraries

When the 15 respondents were asked to explain what should be done to use IoT to manage information services in their library, their responses were as follows:

Respondents 1–6: *“Library staff needs technological knowledge to use IoT, through arranged workshops or training, because there is a lack of Knowledge and poor understanding on how IoT works”.*

Respondents 7–13: *“Management can motivate for libraries to get extra budget to plan for development of IoT which will help convert library from a manual to automated library system permanently”.*

Respondents 14–15: *“Never heard about the IoT in libraries. We need to be educated about IoT as the first step with practicals that illustrate how IoT functions in a library”.*

The two respondents were further asked to explain how they used the IoT to provide information services in the library. Respondents 1–2 responded as follows: Through services offered in computer lab for access of information in internet to users.

When participants in interviews were asked what should be done to use the IoT in the management of information services at PML, they answered as follows:

Participants 1–2: *“Budget and proper planning strategies to utilise IoT in all the libraries with exclusion of political intervention when taking steps to implement to avoid misuse of funds or funds not directed to relevant intervention of IoT development in libraries”.*

Participants 3–4: *“More budgets are needed as procurement of system is known to be very expensive and come with the expense leverage of maintenance of the system for every*

financial year. Deep thinking is needed before taking a decision to migrate from one system to another”.

The researcher observed challenges in terms of budget constraints, so is going to take time to utilise the IoT to provide online information access to library users.

4.6.2 Simplicity of IoT use

The respondents were asked how simple it could be as library employee to work with IoT to provide information service. They answered as follows:

Respondents 1–8: *“IoT easily locate library materials and other information and makes means of communication to remind users about library fines for books borrowed, loss of books and damage to hard copy of books”.*

Respondents 9–10: *“It eliminates risk of lost book materials as users will consider e-books”.*

Respondents 11–12: *“Assist to facilitate users’ virtual library orientation engagement through library website created online”.*

Respondents 13–15: *“Everyone will access library collection wherever there are and employees will not have to do hard labour like shelf reading on shelves as tag sensors installed on book can alert librarians to mis-shelved books”.*

Respondent 16: *“Good personal growth with innovative ideas and technical skills that sharpens computer literacy skills”.*

Respondent 17: *“Regulate good organisation behaviour between library workers with easy communication linked with other public libraries branches such as copy catalogues and interlibrary loans done easily for users”.*

The participants were also asked how simple it could be for library employees to work with the IoT to provide information service. The following responses were captured:

Participants 1–4: *“Stated that IoT assist in Monitoring of security systems, e-learning online, and promotion and marketing of library service online”.*

Participants 4: *“IoT is capable of performing auto-renewal of a book electronically without users physically visiting the library”.*

4.6.3 Access in usability of the IoT

In the questionnaire, respondents were asked what the PML libraries were doing to access information by using the IoT. The following responses were given:

Respondents 1–9: *“Nothing is being done to implements IoT in libraries”*.

Respondents 10–13: *“Still in research process to implement while using Wi-Fi in computer lab to search for information”*.

Respondents 14–15: *“Nothing”*.

Respondent 16–17: *“Nothing can be done with poor leadership”*.

When the four interview participants were asked what PML libraries were doing to access information using IoT, the following answer was given:

Participants 1–4: *“Not much is being done due to budgets mandates which limit the libraries in utilising IoT in libraries”*.

The researcher observed that nothing was planned for the utilisation of the IoT or any advanced technology incorporating 4IR in the library.

4.7 User perception of librarians regarding the use of the IoT in information service

This section presents the results around the closed-ended and open-ended questions that focused on the third research objective and research question:

Research Objective 3: Assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries.

Research Question 3: What is the perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries?

4.7.1 IoT awareness

The respondents were asked if they were aware of the application of the IoT in libraries. As captured in Figure 4.12, the responses were as follows: six (35%) respondents indicated they knew about IoT application in libraries; and 11 (65%) respondents indicated they did not know about IoT application in libraries.

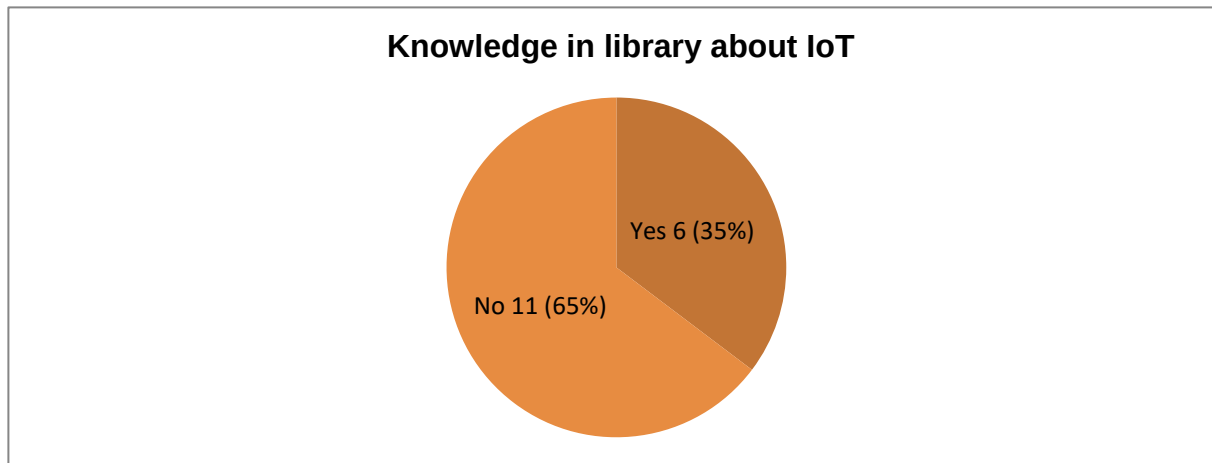


Figure 4.12: Awareness of IoT in libraries

Interview participants were also asked if they knew about the application of IoT in libraries. They answered as follows:

Participants 1–2: *“Theoretically we heard about IoT in libraries, but practically we do not know enough about its utilisation process for managing information services in libraries”.*

Participants 3–4: *“No, we do not know about IoT”.*

The researcher observed there is a lack of knowledge about IoT operation in managing information services at the PML.

4.7.2 Difficult part in understanding IoT

The respondents were asked what made it difficult to know about IoT in the management of information service. They answered as follows:

Respondents 1–6: *“It was never introduced to us as library staff, and it is not available at PML”.*

Respondents 7–9: *“Lack of knowledge about IoT”.*

Respondents 10–11: *“Poor networking with other libraries and being afraid of new challenges as well as ignorance of 4IR is the biggest problem in our libraries”.*

When the four interview participants were asked what made it difficult to know more about IoT for managing of information service, they replied as follows:

Participants 1–2: *“The comfortableness of how information services are rendered ends up delaying library development and growth in the library”.*

Participants 2–4: *“Never heard about IoT in managing information service in public libraries”.*

4.7.3 Usefulness of the IoT

The respondents were asked how useful the IoT was in managing information services. The following responses were captured:

Respondents 1–4: *“IoT is important for storage and retrieval of information captured on computer system and provides adequate access to information online. IoT gives more advantage in rendering library services by ensuring proper security to information and not forgetting to mention how library functionality became faster and quicker”.*

Respondents 5–6: “Although the respondents ticked “yes”, they did not reply to follow-up questions. Explanation was not provided; it clearly indicates they ticked yes, instead of no”.

The researcher observed that PML employees used manual and paper-based systems, which are not part of IoT technology.

4.7.4 Willingness to learn about the IoT

In the questionnaire, respondents were asked if they were willing to learn about the utilisation of the IoT in their libraries. All 17 respondents affirmed that they were willing to learn about IoT in libraries. In the interviews, participants were asked if they were willing to learn about IoT in their libraries. All participants indicated their willingness to learn more about IoT in libraries.

4.7.5 Recommended training

In the questionnaire, respondents were asked about the preferred type of training platforms for library workers to learn about the application of the IoT in managing information services. In response, three (18%) respondents chose an educational programme; eight (47%) respondents selected all the given options; and six (35%) respondents chose workshops, with no (0%) respondents choosing seminar meetings. Figure 4.13 illustrates the results.

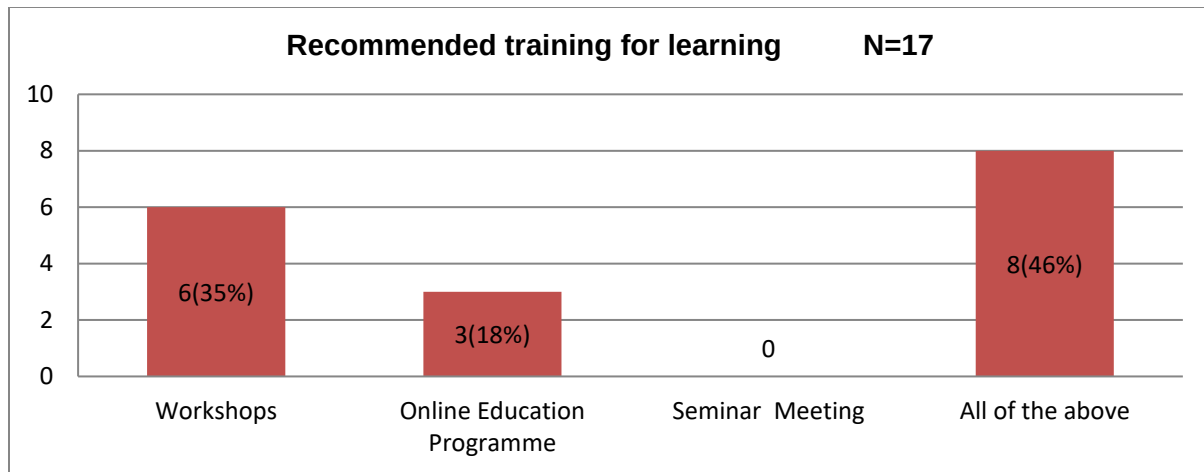


Figure 4.13: Recommended training

When the interview participants were asked about the preferred training platforms for library workers, they all identified workshops.

When the respondents were asked why their selected training platform could be effective in learning about IoT, the following responses were given:

Respondents 1–6: *“Workshops facilitators can demonstrate the practical part of IoT usage in managing information service in libraries”.*

Respondents 7–9: *“Online programmes are good as we can work and learn in our flexi-time. The distance learning gives the privilege to create your own timetable schedule suitable for you to learn that come with no disturbances”.*

Respondents 10–17: *“All types of training will be suitable as it assists library workers to provide service with advanced skills and knowledge that make the library to operate much easier and quicker. What important is for library workers to be trained”.*

When participants were asked in the interview why the selected training could be effective in learning about IoT, the provided the following answers:

Participants 1–3: *“Learning through teamwork for clear clarity on the operation of IoT, as that will improve skills and knowledge capacity in managing of information”.*

Participant 4: *“Since I joined Polokwane Municipality, the only platform I used is workshops where I was trained with other IT specialists sharing the same expertise and networking with each other on the same interest of development and it was easy for me to learn and understand quickly”.*

4.7.6 Factors affecting adoption of the IoT in libraries

Respondents were asked a question about the factors affecting the adoption of the IoT in libraries: Their responses were as follows:

Respondents 1–6: *“Lack of budgets as well as resources needed”*.

Respondents 7–16: *“Limited funding with back-up of poor proper planning management”*.

Respondent 17: *“Adoption of IoT can have negative effects toward human labour”*.

When asked the same question, interview participants gave the following answer: *The unfunded mandate with a limited budget allocated to libraries.*

4.7.7 Adoption of the IoT at PML

The respondents were asked if they thought that the PML needed the IoT to manage information services. All 17 respondents indicated that there was, indeed, a need for adopting the IoT at PML. In the interviews, participants also answered affirmatively, indicating that the PML needed to adopt the IoT for managing of information service.

In a follow-up question, the respondents were asked to explain why the libraries should adopt the IoT. The following responses were given:

Respondents 1–7: *“IoT makes library work easier so that users can find information in need of easily”*.

Respondents 4–7: *“IoT looks like it can foster active functioning of the library to operate effectively in a timely manner through access to electronic resources and eas to trace books anywhere around the library”*.

Respondents 8–15: *“To access information anytime or in a distant space without visiting the library”*.

When the follow-up question was posed to the interview participants, there gave the following answers:

Participants 1–3: *“The adoption of IoT will be helpful for better integrated connectivity capable of providing electronic material, databases, copy catalogues, security measures, tracing of lost books, and movable shelves for better information management in library”*.

Participants 4: *“Access of library online neutralises discrimination as people living with disability will have access to library collection accessed easily online”*.

The researcher observed that the IoT could minimise overcrowding in small libraries and bring libraries closer to the community, where the geographic location is far from the library.

4.8 IoT infrastructure required to manage information services

This section presents responses to the questions aligned with the fourth research objective and question:

Research Objective 4: Identify IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries.

Research Question 4: Which IoT infrastructure would be suitable for the management of information services at the Polokwane Municipality Libraries?

4.8.1 IoT infrastructure for the management of information services

The respondents were asked if there was any IoT infrastructure used for managing information service in the library. As shown in Figure 2.14, seven (41%) respondents indicated there was an IoT infrastructure to provide information services; and ten (59%) respondents indicated that there was no IoT infrastructure to provide information services at libraries.

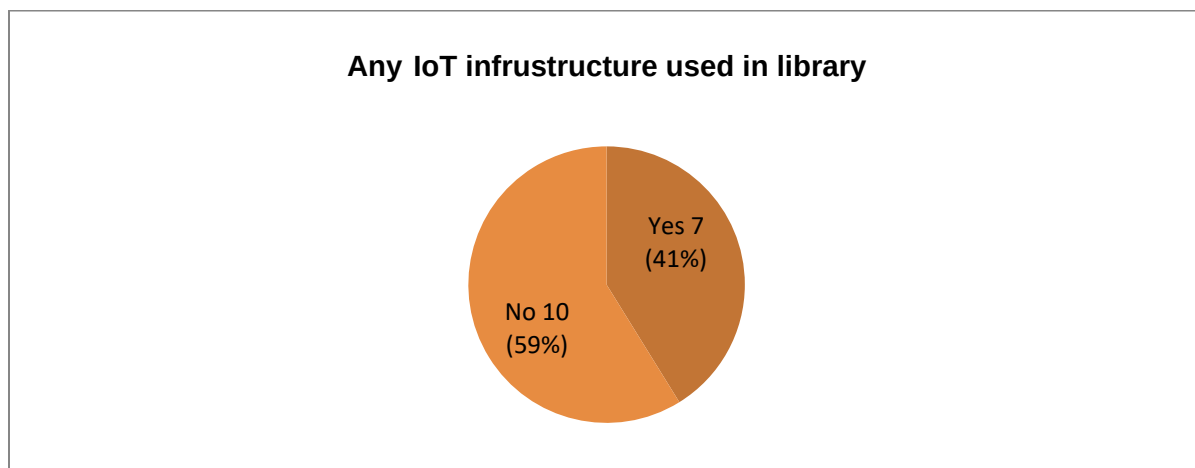


Figure 4.14: IoT infrastructure used in library

In the interview, participants were also asked if there was any IoT infrastructure used in their libraries for managing of information services. The participants answered that there was no IoT infrastructure to provide information services at PML.

4.8.2 IoT infrastructure used at PML

In a follow-up question, the respondents were asked which IoT infrastructure was used, with a list of options to choose from. Seven (100%) respondents chose sustainable networks, with no respondents selecting RFIDs, sensor application layer, actuators, wireless sensor networks, near field communication. Figure 2.15 illustrates these results.

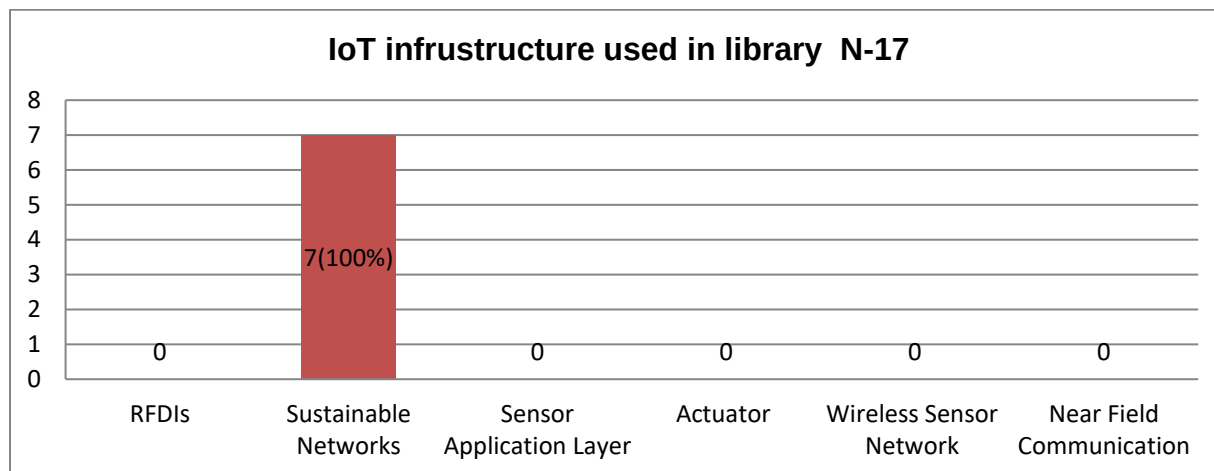


Figure 4.15: IoT infrastructure used in library

In the questionnaire, ten respondents were asked to list the infrastructure used at the library for managing information services. They identified *Papyrus*, *slim systems*, *scanners*, *printers* and *computers* used to manage information.

Then the interview participants were asked to list the infrastructure used in the library; they all mentioned computerisation, MOU tablets, scanners, landline telephones, printers, slim and Papyrus systems are used to provide information services in libraries.

The researcher observed that IoT infrastructure, such as moveable shelves, self-help machines and RFIDs, were not utilised at PML

4.8.3 Knowledge of IoT infrastructure

A number of statements were compiled to test library workers' knowledge of IoT infrastructure in libraries. Respondents were asked to select and tick the relevant answers, and participants were asked to answer with 1 – Agree, 2 – Unsure and 3 – Disagree. The results are captured in Table 4.1.

All 17 respondents and four interview participants agreed with the following statement:

IoT infrastructure is effective in information retrieval.

All 17 respondents and four participants agreed with the following statement:

IoT infrastructure helps with security.

All respondents and participants agreed with the following statement:

IoT infrastructure increases work performance.

All respondents and participants agreed with the following statement:

IoT infrastructure tracks the location of library resources.

All 17 respondents and four participants agreed with the following statement:

IoT with elements of RFDIs transform data quickly.

All 17 respondents and four participants agreed with the following statement:

IoT infrastructure's sustainable network is maintained.

Table 4.1: Responses to knowledge of IoT infrastructure

LIBRARY INFORMATION MANAGEMENT	RESPONSES		
	1: Agree	2: Unsure	3: Disagree
IoT infrastructure is effective in information retrieval.	X		
IoT infrastructure helps with security.	X		
IoT infrastructure increases work performance.	X		
IoT infrastructure tracks the location of library resources.	X		
IoT with elements of RFDI transforms data quick.	X		
IoT infrastructure's sustainable network is maintained.	X		

4.8.4 Elements of IoT infrastructure to manage electronic information

The respondents were asked about the other elements of IoT infrastructure which were required for the library to manage electronic information. Figure 4.16 illustrates the results.

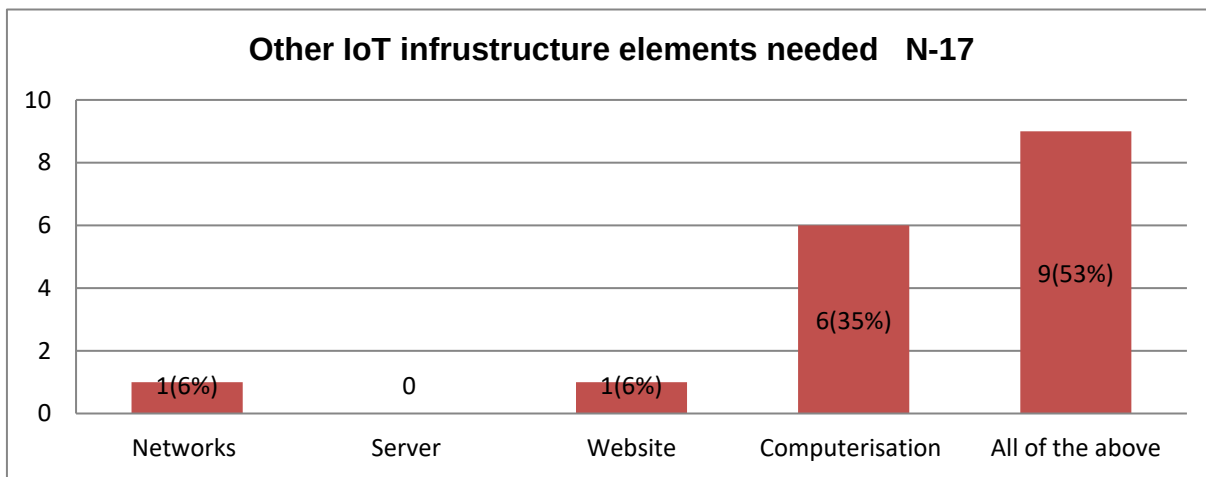


Figure 4.16: Other IoT infrastructure elements required to manage electronic information

In the interviews, participants were asked about the additional IoT infrastructure elements needed for the library to manage electronic information. The following answers were given:

Participants 1–3: *“Sustainable network connectivity boosted by server and WI-FI router for stable internet”.*

Participants 4: *“Library security detectors, 3m systems that remotely control access of books by users to the library and securely protect measures by sensing and deducting stolen library collection”.*

When conducting observations at the libraries, the researcher noticed that the library had unstable networks that tampered with systems used for daily rendering of information services.

4.8.5 Process to implement IoT infrastructure

The respondents were asked what could be done at PML to implement IoT infrastructure for the management of information, the respondents answered as follows:

Respondents 1–4: *“Active management are needed to push implementation of IoT infrastructure in the libraries”*

Respondents 5–13: *“It requires a good strategic planning and budget for the development of IoT in libraries”.*

Respondents 14–17: *“IoT to be introduced in libraries and added to PML policies”.*

In the interviews, four participants were also asked what could be done to implement IoT infrastructure for information management at PML. They answered as follows:

Participants 1-4: *“Funds are needed such as special government grants, donations and demanding of extension of budget for the adoption of IoT in libraries”.*

4.9 Chapter summary

The chapter employed the mixed methods research approach to analyse the research results obtained by collecting primary data by means of questionnaires for the quantitative component and interviews, observations and documents analysis for the qualitative components – all of which were guided by the objectives of the study. Consequently, the libraries mainly relied on minimal technological applications, such as systems for checking library items in and out and providing internet access in a computer lab. Observations further highlighted the absence of essential infrastructural tools needed to manage information services in the libraries. Consequently, the librarians continued to depend largely on manual systems, with limited exposure to the IoT for enhancing the management of information services in the libraries.

CHAPTER 5: INTERPRETATION AND DISCUSSION OF RESEARCH FINDINGS

5.1 Introduction

The previous chapter presented the research results obtained from the collection and analysis of primary data from questionnaire respondents and interview participants at the Polokwane Municipality Libraries. The quantitative results were captured in tables, graphs and charts, whereas *verbatim* participants' responses captured the results of the qualitative interviews. In this chapter, the research findings are interpreted and discussed, with the purpose of reaching meaningful conclusions that can be used to make relevant recommendations.

The interpretation and discussions align with the following four research objectives of the study, which were to:

1. Evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries;
2. Examine the usability of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries;
3. Assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries; and
4. Identify IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries.

5.2 Legislative and policy framework used in the application of the IoT to manage information service

This section presents the interpretation and discussion of the findings based on the first objective of the study: *To evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries.*

Demaitre (2020) emphasises that legislative frameworks play a critical role in public libraries in terms of regulating the development and integration of new technologies. This regulation includes the implementation of South African legislation, which the Polokwane Municipality Libraries follow to support electronic information services. This section of the study elaborates on the purpose of policies and how they govern information services, with particular attention to the policies applied to library collections and the frequency of the policy reviews at PML. In other words, regular policy reviews provide an opportunity to assess and enhance provisions for the adoption and use of the IoT in information services in libraries.

5.2.1 Purpose of policy in libraries

As indicated by the respondents and participants at PML, the purpose of having a policy is to ensure meaningful protection of information; promote efficient communication; enable tracking of physical information; and support the regular updating of library resources. The policy serves as a governing tool, as libraries perform a variety of activities to ensure that information services reach the library users. Therefore, the purpose of the policy is to ensure efficiency and organisation in delivering satisfactory services, as reflected in the policy amendments.

In the review, both the policy and legislature frameworks are presented as sets of documents outlining the goals guiding organisational intentions, with provisions for amendments when necessary (Magnusson 2017). These regulations provide supporting standards that reinforce the operational objectives of the library (Ledwaba 2020). This means that potential threats or actions that fall outside the define purpose of the policy can be declined, as they undermine, rather than advance, the library goals (Sivasankar, Soundararajan & Rajeswari 2020). Hence, the authenticity of policy purpose ensures strong safeguards in the delivery and management of information services to users (Osebe, Maina & Kurgat 2018).

5.2.2 South African legislation used in the management of electronic information

The respondents and participants were asked which legislation is used to manage electronic information. This question was included because South African legislation contains policies, chapters and sections that support the integration of the IoT in different types of libraries. As indicated in the literature review in Chapter 2, several South African legislative frameworks are applied in public libraries for management of electronic information. In the literature review, the following South African legislation was identified as relevant to the study: the Constitution of the Republic of South Africa (Act 108 of 1996), the Protection of Personal Information Act (No. 4 of 2013), the Promotion of Access to Information Act (No. 2 of 2000), the Electronic Communication and Transaction Act (No. 25 of 2002), the Promotion of Administration Justice Act (No. 3 of 2000), the National Council for Library and Information Services Act (No. 6 of 2001), and the National Library of South Africa Act (No. 92 of 1998) (Mojapelo 2019; Modiba 2021).

These sources of electronic information include online databases equipped with e-books, e-periodicals, e-journals, websites, audio-visual materials and CD-ROMs. However, these resources are inadequate at PML (Weber 2013). The main form of electronic information at PML requiring management is internet connectivity, which is provided in computer labs and accessed via personal cellphones within library premises through vouchers issued at the circulation desk.

Internet connectivity is limited to search engines and other social platforms, where South African legislation is applied to ensure compliance with conditions and standards acceptable in libraries. Consequently, the Constitution of the Republic of South Africa, Protection of Personal Information Act, South African Public Library and Information Services Bills, Promotion of Access to Information Act are used for the management of information at PML, as confirmed by the respondents and participants. According to Modiba (2021), the compliance requirements of South African legislation are derived from the Constitution of Republic of South Africa to ensure that all individuals have access to reliable information that is protected – whether in electronic or manual format – in accordance with fair by-laws policy.

5.2.3 Assistance of South African legislation in managing electronic information

The respondents and participants were asked how SA legislation assists with the management of electronic information in libraries. This question was posed because South African legislation provides support for the “*effective and efficient management of information services*”. Legislation assists the PML by enabling access to information through Wi-Fi connections that are available during physical visits to the libraries. However, such assistance remains limited, as stipulated by the Constitution (Parent & Cruickshank 2009).

Chapter 2 of the Constitution of Republic of South Africa promotes resource that sustains individuals’ basic right to information, including access through mobile applications and technological devices – provided that these are used in an acceptable manner (Republic of South Africa 1996). Essentially, this framework supports systems that foster a culture of reading, education and social development, while contributing to the growth and development of individuals, as stated in Part A of Schedule 5 of the Constitution (Republic of South Africa 1996).

Furthermore, the South African Protection of Personal Information Act, No. 4 of 2013, protects against the violation and misuse of personal information, including the de-identification of third party data, which is crucial for maintaining personal privacy in (Republic of South Africa 2013). The dissemination of electronic information is, therefore, guided by legal provisions to prevent misconduct, breaches of confidentiality or the misuse of digital footprints on public computers (Heyink 2011). In this way, South African legislation empowers libraries to deliver electronic information service securely and responsibly, minimising risks and ensuring that user’ rights are protected.

5.2.4 Policy used for library collection

When the research respondents and participants were asked whether the policy is used to manage the collection, they all agreed that the policy was, indeed, used to manage collections at PML. The PML policy covers collection development; particularly hard

copies of books and journals. Reviews of the policy emphasise that a library collection policy serves as an implementation framework and a guideline for essential library tasks (Uplaonkar & Badiger 2018). Accordingly, collections should be easily identifiable and traceable within repositories, whether stored physically or electronically, to ensure and secure resource management (Qin 2018). However, at PML, locating and tracing a book requires significant time, as librarians first have to search the computer for catalogue records and then direct users to the appropriate shelf for retrieval.

5.2.5 Reviews of policy

Libraries in the Polokwane Municipality review their policy every financial year, as indicated by the respondents and participants, but the content of the policy largely remains unchanged. According to two respondents, the Polokwane Municipality focuses on reviewing the timeframe of the policy, rather than its substantive content. Policies that are not routinely updated typically that poses unforeseen risks (Paraschiv 2019). For this reason, reviews should ensure that the policy content is revised to align with new developments and to mitigate risks associated with outdated frameworks (Sarmah 2015). Ryan and Watson (2017) and Wojcik (2019) emphasise that updated policies are better equipped for addressing and managing potential library-related crises. Therefore, PML should consider reviewing not only the timeframe, but also the content of policies, incorporating new developments to resolve emerging library challenges effectively.

5.2.6 IoT to manage electronic information

The respondents and participants were asked how the IoT could be used to manage electronic information. The only electronic information currently available at PML is internet access in the computer labs. The literature review highlighted that the National Library of South Africa requires libraries to invest in infrastructural development aligned with 4IR advancements to enhance the management of electronic information. This obligation promotes the effective use of the IoT in libraries by enabling the creation, indexing, storage and organisation of information in sustainable formats. Through the invention of IoT, audio-visual resources, documents, databases and websites can securely be accessed and managed (Mojapelo 2022).

5.3 Usability of the IoT manage information services in libraries

The interpretation and discussion in this section align with the second research objective of the study: *To examine the usability of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries*. In libraries, the usability of the IoT encompasses utility, memorability, effectiveness, efficiency and learnability – all key elements that enhance the standards of the LIS field in terms of delivering information services (Khan, Zhanga, Chohan & Rafique 2021). The effectiveness of the IoT in information services is influenced by users' attitudes towards its use and their perceptions of ease of use. Attitude plays a critical role in determining both the positive and negative impacts of the IoT (Adeyinka 2012), while perceived ease of use enables the adoption of new technology without the unnecessary complexity (Alsyof et al. 2023). At PML, usability relates to the practical application of the IoT in information services, its simplicity and the extent of access it provides.

5.3.1 IoT for information services

At present, numerous public libraries have migrated to 4IR technologies, with the IoT identified as a key tool for managing information (Liang & Chen 2018). Therefore, the participants and respondents were asked if the IoT is used to manage information services at the PML. Through both questionnaires and interviews, the majority of respondents and participants indicated that the IoT is not currently utilised to manage information services at PML. However, the literature review recommends the adoption of the IoT in libraries, drawing on various studies demonstrating its potential for improving communication, tracking library resources and connecting multiple services to provide convenient, efficient and sustainable information services.

The absence of the IoT at Polokwane Municipality makes it difficult to manage large collection in different libraries branches effectively. Buckland (2017) emphasise that IoT interaction in libraries through “hi tech” applications enables purposeful, science-oriented management of collections by using unique identifiers for catalogued reference and volumes. Such catalogues establish strong links between information sources, shelf locations and database records. Furthermore, IoT facilitates access control, stock-taking

and monitoring of self-checkout systems, all of supported by user-friendly designs that enhance ease of use (Liang & Chen 2018).

5.3.2 Simplicity in the use of the IoT

Then participants and respondents were asked how simple it would be to work with IoT tools, they indicated that using the IoT to provide information services at PML would make their work much easier. A few respondents elaborated, noting that the IoT could eliminate the risk of lost materials, as users would rely more on e-resources, while networking with users will ensure optimal conditions for managing library collections. The literature review on perceived ease of use supports this view, showing that staffs generally welcome new technologies that simplify and streamline their daily activities and tasks at the libraries (Alsyounf et al. 2023). More broadly, the global reality of perceived ease of use is reflected in the expansion of electronic database Access, which has grown significantly in recent years, due to the advancement of the IoT (Tahar et al. 2020).

With the IoT, users can access electronic information from any location – a development that has contributed to a new culture of higher intelligence and professionalism among both skilled and semi-skilled librarians (Kumar, Tiwari & Zymbler 2019). The scholars also explain that the IoT has become an effective tool for supplying website-based services with large-scale data storage and retrieval systems, enabling information to be delivered more intelligently and efficiently (Kumar, Tiwari & Zymbler 2019). The effectiveness of the IoT is particularly evident in services such as check-in and check-out of books through ask-a-librarian websites, which re-shape access to library resources by ensuring the provision of up-to-date, verified and accurate information (Makwana 2021). Ultimately, users entrust librarians with the perceived ease of use, as it assures them of quality and reliable information (Weber 2013).

5.3.3 Access in IoT usability

Attitude toward the use of the IoT reflects either a positive or negative perception of new systems introduced in libraries. To assess this, all the respondents and participants

involved in the study completed questionnaires or participated in interviews regarding the efforts of PML to provide access to information by using IoT.

The respondents and participants indicated that the Polokwane Municipality Libraries has not implemented any IoT initiatives. Feedback was predominantly negative; highlighting that PML is far from utilising the IoT for information access. Consequently, the libraries continue to rely on manual systems, even in the 21st century.

The literature review suggests that positive attitudes are essential for the successful integration of technology into library services – requiring employee commitment to explore and exploit the full potential of the new systems (Mishra, Pal & Manglam 2019). Positive engagement with the IoT fundamentally transforms the role of librarians in delivering services and managing information. Corral and Jolly (2019) emphasise that the IoT is an essential tool for both librarians and users, facilitating resource sharing, communication processing, information retrieval and storage, as well as access to websites and electronic databases. Therefore, PML has the opportunity to take proactive steps towards implementing the IoT in public libraries.

5.4 User perception of librarians regarding the use of IT to manage information services

The interpretation and discussion of the research findings in this section, which involve user perception of librarians regarding the use of the IoT to manage information services, are aligned with the third research objective of the study: *To assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries.*

Martin, Murugiah and Nandhini (2016) and Olumide (2016) define *perception* as a cognitive framework that shapes interpretation, reaction and decision-making in response to developments. In the context of libraries, librarians' perceptions of the IoT may influence their ability to overcome challenges such as poor networks, inadequate

infrastructure and incorrectly catalogued collections, as well as to address limitations in current information management techniques.

The assessment of the perceptions of librarians at PML focuses on factors such as IoT awareness, difficulties in understanding the IoT, perceived usefulness of the IoT, willingness to learn about the IoT, recommended training and the adoption of the IoT for the effective management of information services at the PML.

5.4.1 IoT awareness

The awareness of the IoT at PML was gauged by asking respondents and participants about their knowledge of IoT applications in libraries. The findings revealed that the majority of respondents are unaware of IoT applications in libraries. Notably, even the participants, occupying senior positions in public libraries, also indicated limited knowledge of IoT application in libraries.

In the literature review, the Online Computer Library Center (OCLC) indicated that formal information management responsibilities require support systems that promote IoT applications, ensuring timely and efficient library operations (Online Computer Library Center 2015). Broadly, the application of IoT facilitates the development of Web 4.0 technologies, enabling the exploration of massive data intelligence, innovative cloud services and enhanced knowledge management across diverse websites (Noh 2015; Linnik 2019).

5.4.2 Difficulties in understanding the IoT

In the questionnaires and interviews, the participants and respondents were asked what makes it difficult to understand or use the IoT in libraries. Most participants and respondents explained that the IoT has not been introduced in their libraries, which indicates that PML still rely on manual methods combined with an unreliable electronic Papyrus system, which operates at a slow pace.

In the literature review, Pal and Sharma (2017) also indicate that poor networks and inadequate computerisation delay library activities across various library sections.

Consequently, intermittent, unsustainable networks and systems prevent librarians from performing their key duties, causing tasks to be postponed for days or even weeks (Abo-Seada 2019). Such delays increase the workload and make library collections difficult to manage.

A clear understanding of the IoT would enable librarians to undertake tasks with greater efficiency and adapt to technological improvements (Usman & Gopakumar 2018). Therefore, the librarians have to support the implementation of the IoT to ensure sustainable networks and effective resource management in libraries.

5.4.3 Usefulness of the IoT

Usefulness refers to the extent to which the IoT can positively impact the achievement of library objectives and effectively address challenges faced in library operations (Mishra, Pal & Manglam 2019). Consequently, the respondents and participants were asked about the usefulness of the IoT in providing information services. This question aimed at determining whether the respondents and participants recognise the potential user-friendliness of the IoT in libraries, even though the IoT is not currently in use in the libraries.

The participants highlighted several advantages associated with the IoT, aligning with the literature review, where Kaushik (2019) emphasises the significant benefits pertaining to the usefulness of the IoT in library practice. The results of the study indicate that library professionals who are fully aware of the IoT perceive it as a valuable tool for managing information, rating its usefulness at a satisfactory level. Additionally, IoT-based systems can monitor infrastructure, manage ecosystems intelligence and facilitate data transmission, making them an essential part in the practical management of information (Khan et al. 2021).

5.4.4 Willingness to learn about the IoT

The PML employees were asked if they are willing to learn about IoT as a means of enhancing their knowledge of this technology system. The respondents identified their preferred form of training, with most participants identifying workshops as the most

suitable method for learning about the IoT. Such willingness to learn is crucial, as it shapes librarians' perceptions, making them more confident and comfortable in using the IoT.

The literature review highlights the importance of training and awareness programmes to help librarians acquire the necessary insights to adopt and manage IoT actively and effectively. Yan, Zhang and Vasilakos (2014) assert that trustworthy management surveys should propose mechanisms that enhance the usefulness of the IoT in the library context. These learning mechanisms not only address user demands but also integrate higher service standards that proactively represent the future direction of modern public libraries. With its intelligent systems, the IoT enables the creation with smart libraries by integrating information and communication technologies for value-added, first-class information services (Girish 2025).

5.4.5 Adoption of the IoT at Polokwane Municipality Libraries

The question on the adoption of the IoT in the Polokwane Municipality Libraries was posed to determine whether the IoT is needed to manage information service in these libraries. Participants and respondents unanimously agreed that the libraries in the Polokwane Municipality need the IoT to manage their information services. A follow-up question asked them to explain why IoT adoption is necessary. The benefits identified align with the findings of the literature review. – (Goswami 2024) and Paraschiv (2019) assert that, in China, the implementation of the IoT includes mechanical tools capable of handling blockchains, big data, library bookmark applications, moveable shelves and artificial intelligence (AI) systems that manage the storage of vast amounts of information. The proactive nature of the IoT further enables real-time connectivity between data and spatial library devices, thereby streamlining operational processes.

Essentially, the IoT facilitates seamless knowledge sharing while enhancing security, offering users high-quality experiences through tracking notifications and reliable access to e-resources, which, in turn, improves perceived performance in virtual information services (Kaushik 2019; Hu, Ghohan & Liu 2020). In addition, virtual connectivity

through the IoT strengthens electronic systems to support online reference services, digital acquisitions and the electronic cataloguing of information sources (Mondal 2021).

5.5 IoT infrastructure required to manage information services

The interpretation and discussion of the findings related to the IoT infrastructure required to manage information services based on the Research Objective 4: *To identify IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries.*

Accordingly, IoT infrastructure in libraries are important and research will look into IoT infrastructure for management of information service, IoT infrastructure used at PML, elements of IoT infrastructure to manage electronic information, and process to implement IoT infrastructure.

5.5.1 IoT infrastructure for management of information services

IoT infrastructure plays a key role in ensuring efficient and reliable information services. The participants and respondents were asked whether IoT is currently being used manage the information services at Polokwane Municipality Libraries (PML). The majority of respondents – and all participants – indicated that no form of IoT infrastructure has been integrated or being used in the libraries. Instead, the libraries continue to rely on traditional paper-based methods to document library operations. These responses highlight the importance of understanding and implementing IoT infrastructure as a means of establishing dependable and sustainable IoT systems in public libraries.

According to Weber (2013), IoT plays a vital role in enhancing the value of libraries by aligning technological resources with the workplace environment through advanced infrastructural development. Therefore, adopting IoT infrastructure could significantly reduce failures in information service delivery – something PML should consider prioritising in the near future.

5.5.2 IoT infrastructure used at PML

The study set out to identify the IoT infrastructure currently being used at PML by asking the question, *Which IoT is used at PML?* Seven (7) respondents indicated sustainable networks, while others mentioned computerisation, MOU tablets, scanners, landline telephones, slim printers and the Papyrus system as that are used to support the information services in the libraries. However, these technologies do not constitute genuine IoT infrastructure. As indicated in the literature review, the most relevant IoT infrastructures in public libraries include radio frequency identification devices (RFID), wireless sensor networks (WSNs), actuators, near field communication (NFC), sustainable networks, sensor application layers (Mavani 2024). These IoT infrastructures can enable innovations such as smart digital shelves, virtual libraries, real-time data requests, library smart cards and mobile devices for book location (Purnik 2019). Therefore, PML should integrate IoT infrastructure to enhance information services and strengthen the management of these services.

5.5.3 Knowledge of the IoT

Weber (2013), Solanke (2021) and Makwana (2021) assert that IoT infrastructure in libraries supports digital processes in different and “intellectual significant ways”. To assess this at PML, participants and respondents were asked to indicate whether they agreed, were unsure or disagreed with statements designed to test their understanding of IoT infrastructure in libraries. The questions were developed to explore the awareness of the potential of the IoT in delivering efficient information services, in contrast to the labour-intensive methods currently being used at PML. The literature review also emphasises that IoT infrastructural development modernises libraries by enabling the rapid and seamless delivery of services that meet the highest professional standards.

IoT infrastructure is effective in information retrieval.

Seventeen (17) respondents and all the participants agreed with this statement. However, at the PML, information is still retrieved by manually, browsing the shelves using catalogue and classification numbers (call numbers). The literature shows that tags, which are central to RFID systems, can be attached inside CD and videos, or

directly to the books, allowing for quick and efficient retrieval (Sivansakar, Soundararajan & Rajesweri 2020).

IoT infrastructure helps with security.

Seventeen (17) respondents and all the interview participants (i.e. four participants) agreed with this statement too. Currently, PML safeguards resources through 3M systems designed to block theft attempts. The literature highlights that RFDI tags can play a critical role in security by tracking and identifying books (Makwana 2021). In addition, sensors can detect fires or unforeseen risks that may damage or compromise library collections (Purnik 2019).

IoT infrastructure increases work performance.

Although all respondents and participants chose to agree with the statement, shelf reading and monitoring of library spaces are performed manually at PML. However, the literature indicates that IoT connectivity enhances work performance by making tasks more effortless (Qin 2018). With IoT and connectivity, the status of libraries rooms can be remotely determined, including the number of computers in use, occupied chairs and tables, less-preferred study areas and the number of readers accessing resources through sensor-based connectivity (Guo, Liu & Bielefield 2018; Abo-Seada 2019). Fully enabled sensor connectivity also allows librarians to reserve rooms in the library. Daily statistics and operations can, therefore, be automatically identified and addressed/solved.

Furthermore, Abo-Seada (2019) confirms that connectivity in library environments allows librarians to monitor room status (busy or free) rapidly and remotely, and indicates the usage of printers, computers and other devices.

IoT infrastructure tracks the location of library resources.

In terms of resource tracking, all the respondents and participants agreed that IoT infrastructure can effectively track the location of library materials. However, at present,

PML relies on staff physically searching shelves and storerooms to locate library items. The literature review shows that NFC technology enables bi-directional communication over short distances, provide and secure transactions, electronic tagging of books and remotely exchange to pinpoint item location rapidly (Projes & Shailendra 2016).

IoT with elements of RFDI transforms data quickly.

Again, all 17 respondents and four (4) participants agreed with the statement, although at PML, data transfer is still carried out via telephone or email. The literature review explains that RFID uses wireless contactless systems with book tags to transfer data quickly and reliably, making it one of the most powerful technologies adopted by academic and public libraries for managing large collections and enabling access through websites (Pujari & Gadgay 2018).

IoT infrastructure's sustainable network is maintained.

All the respondents and participants agreed to the statement. However, at PML, networks are sustained through routers, although services are sometimes disrupted and operate slowly due to the high volume of users accessing the library. The literature confirms that sustainable networks in libraries minimise risks of overload by adopting Internet Protocol Version 6 (IPV6), which ensures stable and secure network operations (Weber 2013). IPV6 enables globally secured connectivity by integrating internet platforms with reliable access to web-based platforms (Alam et al. 2020).

In addition, sustainable networks in public libraries are supported by local area networks, Wi-Fi connections, personal area networks (PANs), Ethernet and Ultra-Wideband (UWB), all of which provide “efficient and reliable” facilities for library services (Mondal 2020; Makwana 2021).

5.5.4 Element of IoT infrastructure to manage electronic information

The respondents and participants were asked what additional elements of IoT infrastructure are needed to improve the management of electronic information in

libraries. This question was pertinent as, at present, PML cannot share information electronically with users requiring immediate access for work or study projects. In order to address this gap at PML, the incorporation of IoT elements is essential. The literature highlights robotic machines and frequency tags as examples of IoT elements that can significantly enhance the electronic management of information services. Purnik (2019) observes that, through integrated hardware and software, IoT infrastructural elements can automatically detect datasets that are incorrectly catalogued, and correct them and deliver the relevant data to the users. The hardware and software can automatically retrieve information and authorise digitised books for electronic access to users (Ryan & Watson 2017).

5.5.5 Process to implement IoT Infrastructure

The respondents and participants were asked what measures could be taken to implement IoT infrastructures for the management of information services at PML. The question was regarded as relevant, because IoT infrastructure fosters progressive development in libraries compared to the manual systems still in use. Most respondents and participants pointed to the financial requirements and the budget as the main challenge, while others emphasised the need to incorporate the IoT into library policies. The literature suggests that the implementation of IoT infrastructure in libraries enhances digital information processes and supports the integration of intellectual resources (Solanke & Deshmunkh 2018; Makwana 2021).

Despite financial constraints (Weber 2013; Ahmat & Hanipath 2018), respondents and participants believed that libraries would eventually adopt IoT technologies to improve access to e-journals and e-books. Furthermore, the majority noted that public libraries are increasingly adopting the IoT to improve usability, and Polokwane Municipality Libraries risk being left behind if they do not keep pace with this trend (Liang & Chen 2018; Qin 2018).

5.6 Chapter summary

The presentation and analysis of the research results presented in Chapter 4 was based on the primary data collected from respondents and participants in Polokwane

Municipality Libraries as the research study area. In this chapter, the research findings – based on the results and in alignment with the first four research objectives – were interpreted and discussed, in order to reach meaningful conclusions. The next chapter concludes the study by presenting the final summary and conclusion, as well as a number of recommendations, based on the research findings and the conclusions. As the final chapter, it also proposes an IoT framework for public libraries in the Polokwane Municipality, thereby addressing Research Objective 5: *To recommend a framework for the use of the IoT in the management of information services at the Polokwane Municipality Libraries.*

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATION

6.1 Introduction

Chapter 5 interpreted and discussed the research findings, based on the research results obtained through primary data collected by means of quantitative surveys and qualitative interviews. As the last chapter in the dissertation, Chapter 6 presents a summary of the research findings, as well as final “conclusions and recommendations”, based on the first four research objectives of the study. The chapter also identifies areas for further research, based on the research results and findings presented, analysed, interpreted and discussed in Chapters 4 and 5. Finally, the chapter proposes an IoT framework for the management of information service at Polokwane Municipality Libraries in Limpopo Province of South Africa, thereby achieving Research Objective 5 of the study.

6.2 Summary of the research findings

This section summarises the essential aspects involved in the research findings, as established through the analysis of the research results (Babbie 2020). The summary aligns with the first four research objectives, with each sub-section involving a research objective.

6.2.1 Legislative and policy framework for the management of information services

Research Objective 1: *To evaluate the existing policy and legislative framework for incorporating the use of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries.*

In other words, legislation and policies are required for the effective utilisation of the IoT in the management of information services in public libraries.

The research findings pertaining to the first research objective are summarised as follows:

- Polokwane Municipality Libraries (PML) has an endorsed authenticated operational policy to provide fair and equal information services.
- PML do not have a policy in place that can be used for the utilisation of the IoT.
- PML have principles and procedures governing all the sections and/or operations involved in information services.
- PML have a guiding protocol to regulate users on the handling of internal and external use of the library collections.
- PML review the policy every financial year, although the content often remains unchanged, with the main focus being placed on updating timeframes, rather than substantive amendments.
- A policy gap exists at PML, as current policies do not adequately address access to electronic resources. This limitation mainly results from budget constraints and the potential implications for the labour force.
- Relevant South African legislation that can inform the development of an IoT policy includes: Constitution of Republic South Africa (Act 108 of 1996), Electronic Communication and Transaction Act (No. 25 of 2002), Promotion of Access to Information Act (No. 2 of 2000), Promotion of Administration Justice Act (No. 3 of 2000), and Protection of Personal Information Act (No. 4 of 2013).
- With the exception of internet access in computer labs, existing policies at PML do not regulate electronic information. The internet access is subject to restrictions related to privacy, confidentiality and acceptable use, with oversight provided through monitoring rounds conducted by librarians.

6.2.2 Usability of the IoT to manage information services

Research Objective 2: To examine the usability of the Internet of Things (IoT) in the management of information services at the Polokwane Municipality Libraries.

In order to utilise the IoT to manage the information services in public libraries, the usability of the IoT should be considered, so as to implement it as a reliable information

source. The findings pertaining to the second research objective can be summarised as follows:

- Librarians expressed the view that hard copy collections they have inside the libraries alone do not provide sufficient sources of information, whereas the utilisation of the IoT offers extensive information resources to meet user needs.
- Librarians further indicated that the IoT optimises easy tracking of library resources and enables virtual library tours that serve as effective library orientation for users.
- IoT also allows users to retrieve information at any time and from any geographic location, including locations outside the library.
- In addition, librarians indicated that the IoT can respond rapidly to users' information queries without delays, while ensuring the security and protection of library collections.

6.2.3 User perception of librarians regarding the use of the IoT to manage information services

Research Objective 3: *To assess the user perception of librarians regarding the use of IoT in the management of information services at the Polokwane Municipality Libraries.*

Utilising the IoT for the management of information services, the perception of the librarians should be considered – particularly in terms of productiveness, efficiency and protection of IoT used in libraries.

These findings can be summarised as follows:

- Only a few librarians were aware of the application of the IoT and its functionality for the management of information services in public libraries. The majority of librarians did not know much about the application of the IoT in libraries and the efficient information services it offers in libraries.
- Librarians indicated that the IoT can offer online services through database access to users and provide regular updates or alerts on the current holdings of library collections.
- Librarians stated that the IoT can assist with automatic book renewals and enable self-service systems, including virtual “Ask a Librarian” process.

- A key constraint to IoT implementation is limited funding allocated to library services.
- Most librarians expressed concern that self-service machines and sensors may lead to job losses. This was addressed by clarifying that such applications are not intended to replace library staff, but to complement their work for more effective service delivery.
- The majority of librarians supported the use of the IoT for streamlining information services such as reference interviews and inter-library loans.
- Librarians expressed interest in the IoT, noting that it could improve service efficiency and ensure smooth library operations.
- Librarians without prior experience of the IoT in libraries indicated a willingness to receive training in its usability.

6.2.4 IoT infrastructure required to manage information services

Research Objective 4: To identify IoT infrastructure that can be used in the management of information services at the Polokwane Municipality Libraries.

The Polokwane Municipality and its eight (8) library branches operate on a unsatisfactory level of infrastructure to provide information services, and, therefore, the IoT should be implemented.

These research findings are summarised as follows:

- Public libraries in the Polokwane Municipality currently lack IoT infrastructure for easy access to information, although some librarians mistakenly believed that computer labs represented a full IoT system.
- The process of implementing the IoT is expected to be a long-term process that requires careful strategic planning.
- At present, PML provide internet access through Wi-Fi connections supported by routers and servers, which are adequate but not consistently reliable to ensure sustainable connectivity under all conditions.
- Existing infrastructure includes the Slim and Papyrus systems, landline telephones, scanners, MOU tablets and printers, which are used to deliver information services.

- The libraries do not use an OPAC, as the absences of IoT-enabled integration do not prevent the linking of all public libraries for seamless updating of information without dataset errors.
- RFDI technologies have not been introduced at PML, limiting the transformation of data and restricting access to e-books and e-journals.
- While IoT infrastructure supports the movement, tracking and security of library collections, PML still relies on manual methods to locate misplaced library items.
- IoT infrastructure has proven effective in enhancing the retrieval of information.

6.3 Conclusion based on research findings

According to Babbie (2020), the study concludes with a statement that reveals what was discovered, and that provides a clear direction for the potential focus areas of future researchers. In this section, the researcher presents a concluding statement on what was discovered regarding the implementation and utilisation of the IoT in the management of information services at the public libraries in the Polokwane Municipality.

The researcher discovered that librarians have limited knowledge of the IoT, although a few PML librarians are aware of IoT operations in libraries. Consequently, the libraries rely on traditional methods to render information services, which have negative impacts on the quality of the information services, in that the users cannot employ IoT application for fast and easy access of online databases. These challenges are also evident at the circulation desk, where “check-in and check-out” procedures are captured manually in a notebook, which is prone to human error, making it difficult for librarians to trace lost books and manage large collections effectively. Despite operating in the 21st century, PML continue to rely on manual systems that are time-consuming and demand constant librarian involvement to manage workloads and prevent overcrowding in libraries. Consequently, the manual system has become a significant barrier to the adoption of new technologies, reflecting a degree of resistance to change.

Conversely, if technological changes are embraced, PML could benefit from improved tracking of resources, enhanced security and greater online access, all of which would significantly strengthen information service delivery. Overall, the study aimed at investigating the utilisation of the Internet of Things (IoT) for the management of information services at public libraries in the Polokwane Municipality, and to propose a relevant framework for IoT implementation.

6.3.1 Legislature and policy framework for the implementation of the IoT in the management of information services at PML

This section presents the conclusion on the legislative and policy framework for the utilisation of the IoT to manage information services at the public libraries in the Polokwane Municipality. PML have an operational policy that regulates different sections in the libraries, including the reference section, archival service, circulation and interlibrary loans, as well as information services. Despite the amendments, the policy still excludes electronic information access, particularly in relation to virtual applications and databases.

Electronic access is crucial for motivating librarians to take steps towards the utilisation of the IoT at PML. For the successful implementation of the IoT, future policy amendments should incorporate guidelines for innovation while upholding the principles of effective information delivery. Such policies should provide a regulatory framework governing digital access through clear rules and procedures. Therefore, to advance IoT adoption at PML, priority should be given to align policy reviews with South African legislature that regulates and supports electronic resources in public libraries. This approach would enable more inclusive policies without creating barriers to IoT usability.

6.3.2 Usability of IoT in the management of information services

This section presents the conclusion on the usability of the IoT in libraries to support the management of “effective and efficient information services” at PML. The functionality of the daily operational activities and tasks can be greatly enhanced through the utilisation of the IoT in the libraries, which offers a user-friendly systematic approach.

An IoT-enabled system optimises access to large numbers of information resources, ensuring efficient transmission and easy retrieval of information for users anytime and anywhere, while also creating a more engaging reading environment. If adopted, IoT would enable PML to respond to users' information queries rapidly. Its interactive features, such as virtual "Ask a Librarian", can provide immediate support to meet users' information needs. By integrating the IoT, PML could surpass the limitations of manual systems, reducing the workload associated with resource tracking and minimising the reliance on labour-intensive processes.

6.3.3 User perception of librarians about the use of the IoT in managing information services

This section presents the conclusion on the user perception of librarians about the use of the IoT in the management of information information in public libraries. The majority of librarians at PML were not aware of IoT operations in libraries, although a few librarians were familiar with the potential of implementing the functionality of the IoT in the public libraries in the Polokwane Municipality.

Librarians expressed interest in the IoT primarily in relation to self-service machines integrated with "Ask a Librarian" features on library websites, which could support functions such as automatic book renewals, updates on new collections and library notifications. Certainly, the librarians substantiated that if IoT is utilised, overdue fines and lost library collection can fully be avoided with regular updates through effective notifications sent to users. They emphasised that the use of the IoT could help to prevent overdue fines and reduce the loss of library materials through regular and effective user notifications. In other words, the concept of a virtual smart library could be realised if sufficient funding is prioritised for the implementation process. Such funding would not only support the development of the necessary infrastructure, but also enable training programmes for librarians unfamiliar with IoT applications. The outcomes of these training sessions would help to address librarians' concerns by clarifying that the

IoT is not intended to replace the library workforce, but rather to enhance efficiency and improve the quality of information services.

6.3.4 IoT infrastructure to manage information service in public libraries

This section presents the conclusion on the IoT infrastructure required for the management of information services at PML. There is a lack of knowledge of IoT infrastructure and its functionality in libraries. Interviews with IT staff and a few librarians revealed a strong interest in understanding IoT infrastructure and its application in library contexts. They highlighted several potential benefits of IoT, including cloud services, location-based services, self-service and digital shelf integration. However, despite the information provided, some librarians demonstrated misconceptions, mistakenly equating computer lab facilities with IoT services. For these librarians, access to internet browsers was seen as the definition of IoT, reflecting a lack of awareness of its transformative elements such as RFDI systems, sustainable networks and sensors.

These elements are critical, in that they support the relocation of collections, fast and accurate information retrieval, efficient communication and the prevention of duplication of information and human error in information capturing. In order to improve information services through streamlined smart technology, the PML should prioritise the adoption of IoT infrastructure to ensure accurate, reliable and up-to-date information.

6.4 Recommendations

A framework for the utilisation of IoT to deliver precise and reliable information services at PML has the potential to address the slow pace of service delivery. Proper integration of the IoT effectively support users' information requests, improves information sharing, prevents misplaced collections, highlights duplicated records and enhances security controls in the libraries. As a result, the adoption of IoT in libraries can foster an intellectual learning environment, enable efficient response to changes in library operations, provide online database access, accelerate collection tracking, and facilitate self-communicating systems. Implementing IoT systems and devices requires

understanding the technology, as well as the necessary training to manage its infrastructural elements, thereby ensuring optimal service outcomes.

The successful operation of RFDI technology and IoT sensors requires a clear understanding for their functionality to ensure accurate cataloguing, seamless resource tracking, virtual tours, library promotion services and secure management for information services. Training programmes should not only teach the practical use of IoT, but also address concerns regarding employment, clarifying that IoT implementation does not replace library staff but its inter connectivity is to offer information service seamlessly anytime.

Properly programmed and well-integrated IoT applications can enhance interconnectivity across devices while minimising vulnerabilities to unauthorised access. To achieve this, sufficient funding should be prioritised, as automating smart and efficient services can be costly. If resources such as conditional grants or equitable shares are allocated, the IoT implementation process at PML can be established to the highest standard, to ensure effective and secure service delivery.

6.4.1 Recommendation on the legislative and policy frameworks for the adoption of the IoT in the management of information services at PML

This section presents recommendations on legislative and policy frameworks that can support the utilisation of IoT in public libraries in the Polokwane Municipality. The first step for Polokwane Municipality Libraries (PML) is to recognise and align with key South African legislation regulating libraries, including the Protection of Personal Information Act (POPIA), No. 4 of 2013, South African Public Library and Information Services Bill (SAPLISB), 2012; Promotion of Access to Information Act (PAIA), No. 2 of 2000, and the Constitution of Republic of South Africa, Act 108 of 1996. Integrating IoT comprehensively into library policies facilitates the adoption of advanced technology networks and systems, ensuring open information access and availability transformation within a structured and regulated framework.

For effective implementation, stakeholders governing libraries have to collaborate as a collective team to formulate policies in support of advanced IoT applications. Such policies would enhance information and computer communication technology (ICT) infrastructure, standardise development, guide procurement processes and improve organisational capacity for the skilled utilisation of the IoT. Furthermore, periodic policy reviews should be conducted within acceptable timeframes to incorporate necessary updates, ensuring the delivery of efficient and proficient information services.

6.4.2 Recommendations on the user perception of librarians on the use of IoT in the management of information services at PML

This section presents the recommendations regarding librarians' perceptions of the use of emerging IoT technologies in public libraries in the Polokwane Municipality. Librarians familiar with IoT highlighted its advantages, including sustainable and uninterrupted network access for online collections, both inside and outside the libraries. The IoT also has the capacity to relevant information automatically for users while filtering out content that is not useful. Technologies such as RFIDs, combined with Force Sensitive Resistors (FSRs), can monitor library spaces and help users locate suitable reading areas, such as sections for fiction or other materials.

In order to ensure effective IoT adoption, structured training programmes – including workshops, seminars and online courses – should be implemented for librarians who are unfamiliar with IoT applications in library settings. Such training would equip the librarians with the knowledge and confidence to work with the IoT, clarifying that its implementation does not threaten employment. This process will foster a positive mindset towards the IoT, these initiatives would accelerate IoT utilisation, enhance access to online databases and improve overall library services delivery.

6.4.3 Recommendations on the usability of the IoT to manage information services at PML

This section presents recommendations on the usability of the IoT for the management of information services at PML. The adoption of the IoT should be prioritised to enhance

the efficiency of library activities and the delivery of information services through online platforms. The IoT offers numerous benefits, including online access to web pages, “Ask a Librarian” services, online bulletin boards, digital reference tools, online current awareness services and online document delivery services, all of which support seamless integration of IoT systems. These services shift manual operations to smart, software-driven operations ensuring 24/7 library service provision while safeguarding library resources. Interconnected networks and devices facilitate efficient information retrieval and implement protocols that protect users’ personal information. Moreover, the effective use of the IoT promotes smooth library operations, enhances access for members and reinforces ethical and responsible management of information services.

6.4.4 Recommendation on the IoT infrastructure to manage information services at PML

This section presents recommendations on IoT infrastructure for the management of information services at public libraries in the Polokwane Municipality. PML should strategically address financial constraints and resource allocation, as these are key factors that may affect successful of IoT implementation and utilisation at these libraries. Without adequate funding, the libraries will continue to face challenges in acquiring the necessary infrastructure for IoT implementation. While infrastructural elements such as RFDI systems and wireless network applications are costly, the IoT provide significant benefits to libraries. For example, near field communication (NFC) this technology enables rapid resource tracking; sensors facilitate quick information processing; and RFID systems ensure accurate updates with minimal errors, all supported by a sustainable network that maintains reliable Wi-Fi connectivity.

By allocating portions of the budget through sources such as sponsorships, government grants, infrastructure investments, fundraising, community support and donations, the implementation of IoT at PML can achieve significant and successfully.

6.4.5 Recommendation on the proposed framework for the use of the IoT to manage information service at PML

This section presents a recommendation on the framework for leveraging the IoT to deliver and manage effective and efficient information services at PML. The framework is designed to address common challenges, such as limited virtual connectivity to databases, which often prevents user from accessing up-to-date information required to complete research and academic assignments on time. When integrated with IoT systems, databases provide users with reliable, high-quality of information accessible from any location. IoT-enabled search engines that can filter and deliver access to scholarly books, articles and periodicals through user-friendly web applications.

Furthermore, the framework envisions the use of cutting-edge IoT technologies such as intelligent digital shelves, wearable devices and virtual library cards, which can assist library users in locating needed collections quickly and easily. Beacon software can also play a significant role by promoting library services, highlighting new acquisitions and simplifying the management of checked-out items.

Collectively, these applications demonstrate how the IoT can transform the public libraries in the Polokwane Municipality into user-friendly and technologically advanced information service environments. The next section is dedicated to the discussion of the recommended framework for IoT implementation for the management of information services at PML, in order to achieve Research Objective 5 of the study.

6.5 Recommended framework for IoT implementation in the management of information services in public libraries at Polokwane Municipality

The central aim and final outcome of the study was to recommend an IoT framework that can be employed in the public libraries at the Polokwane Municipality for the effective management of information services. The framework suggested as the final outcome of this study aligns with Research Objective 5: *Recommend a framework for the use of the IoT in the management of information services at the Polokwane Municipality Libraries.*

The purpose of the recommended framework is to demonstrate how the IoT can be applied in information services by integrating the essential components of IoT, including

RFDI technologies and systems, filtered with wireless sensor networks (WSNs) and near field communication (NFC). The suggested framework, which is illustrated in Figure 6.1, is designed to deal with the current situation at the PML and the way they should deliver and manage their information services.

Despite the continued use manual systems to manage paper-based collections, the integration of the IoT can systematically extend library collections to manage information electronically through automated processes. In other words, adopting automated information services will eventually phase out the reliance on manual systems in libraries.

By adopting IoT technologies, libraries can prevent issues such as misplaced books, insecure networks, missed renewal notifications and errors in data capturing. As a transformative wireless tool, RFDI enables effortless tracking, identification and recovery of misplaced resources. Similarly, NFC transaction software – integrated with users' mobile devices and library computer systems – can provide convenient updates on book renewals, reserved items, profile creation and users' transaction history. In addition, wireless sensor networks can remotely track library resources, accurately that determine book locations on shelves and store historical data in cloud storage to provide comprehensive information management.

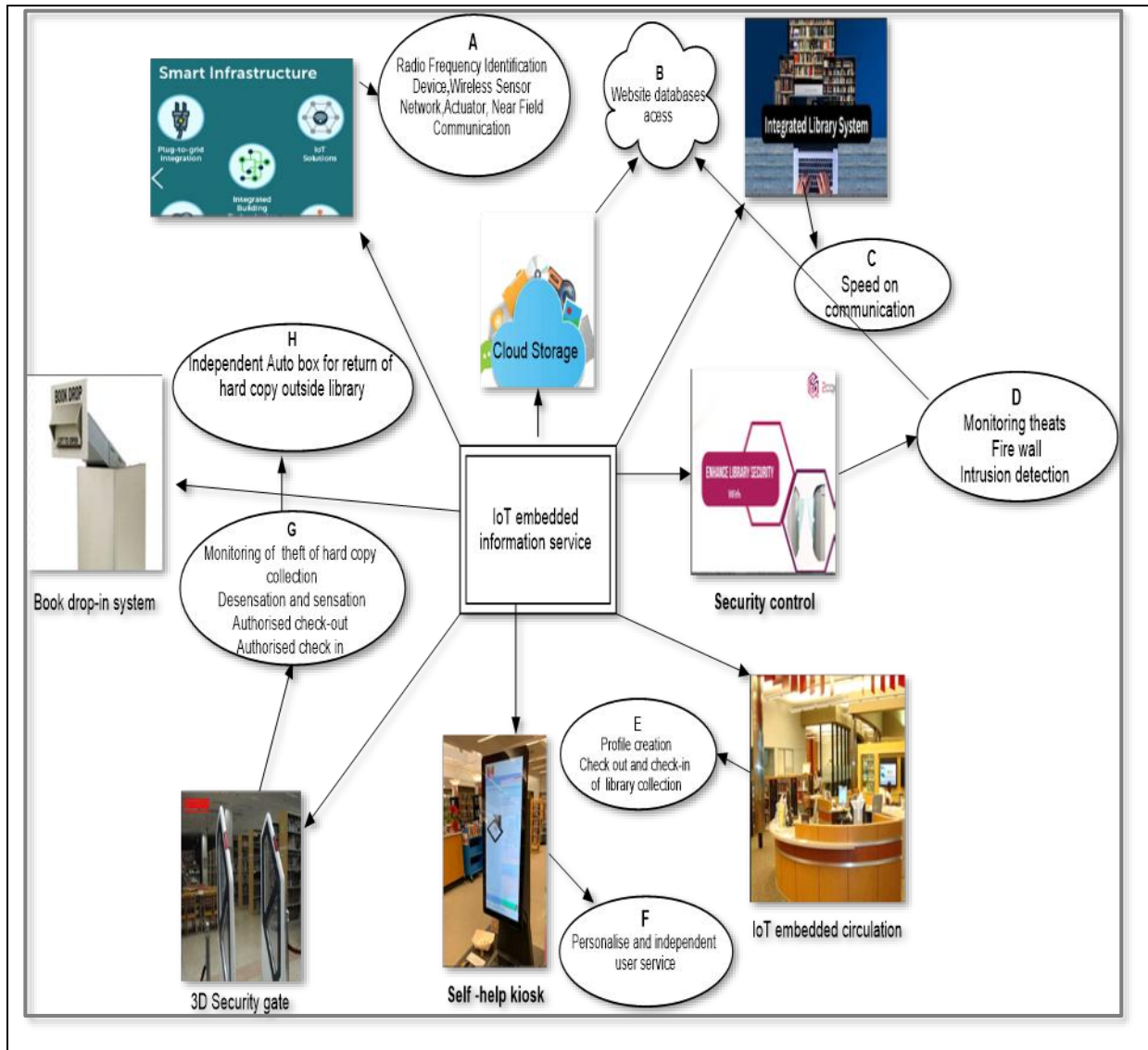


Figure 6.1: Framework for the utilisation of the IoT to manage information services at PML

(Source: Researcher's design 2025)

The following sections present the various stages involved in the proposed IoT framework for PML.

6.5.1 Stage1: Embedded information connecting objects and devices

This proposed framework commences with IoT embedded information service that connects objects and devices to enable access to information sources in two formats: electronic resources and hard copy, paper-based library materials.

The process ensures that information is protected, and secured, to reach users seamlessly through the integration of smart infrastructure, cloud storage, IoT-based library systems, security controls, IoT-embedded circulation, self-service kiosks, 3D security gates and automated book drop systems for smooth information services.

In PML, smart infrastructure forms the first and most critical stage, in that it incorporates essential technologies such as smart RFIDs, wireless sensor networks, actuators and near field communication (NFC) systems. These IoT-enabled devices connect through Bluetooth and Wi-Fi, that are supported by wireless sensor applications integrated into computerised systems that maintain sustainable networks for information exchange. RFID tags on digital shelves, combined with NFC, can detect misplaced books and automatically alert librarians to return them to the correct locations. This computerisation, enhanced with actuator and RFID software, supports virtual libraries where users can remotely browse library collections. Implementing such smart infrastructural tools through IoT not only assists users with adaptive learning systems, but also enhances advanced search capabilities integrated with electronic platforms, ensuring access to information anytime, anywhere.

6.5.2 Stage 2: Cloud storage configured through dynamic servers

The second stage in the IoT framework involves cloud storage, configured through dynamic servers with large capacity to host and manage digital information. Cloud storage introduced digital libraries accessible remotely from any geographic location. It enables user to access a wide range of e-resources, including/such as multimedia files, e-books, e-publications, e-journals and extensive databases such as Web of Science. Furthermore, cloud storage facilitates information exchange between librarians and users through online forums and social media platforms, thereby automatically promoting information services and extending the reach of information delivery.

6.5.3 Stage 3: IoT-integrated library systems

The third stage in the framework involves IoT-integrated library systems, which are equipped with network devices such as software applications, sensors and radio

frequency identification devices (RFID) technologies. These components automatically facilitate and control communication and improve the speed and efficiency of information exchange. The core objective of this IoT ecosystem is to analyse, collect and enhance delivered information continuously, ensuring seamless circulation across various IoT domains. The outputs of IoT-integrate library systems pro-actively to benefit users with feature such as self-service stations and automated shelving, which ensure that items are easily located and retrieved, thereby saving users valuable time in the library. Furthermore, the integration of IoT into library systems streamlines operational processes for information services while incorporating encrypted security that measures to protect data security.

6.5.4 Stage 4: Security controls

The fourth stage of the framework involves security controls, which ensure the protection of information services through the utilisation of IoT technologies. Security is crucial for safeguarding library collections and maintaining the integrity of information resources. These security controls include daily monitoring with protocol identifiers (IPs), which alert security personnel of any suspicious online activity that may compromise/damage information. Access is centralised through authorisation systems that require secure login credentials to open access to information. This protocol extends across library resources to facilitate the safe exchange of information between users. Internet search restrictions are enforced through automated logging systems, which limit access to sensitive content and provide additional protection against data loss, unauthorised access/malicious intrusion. Security controls are designed to block a cyber threat that includes firewalls, intrusion detection systems, encryption and antivirus software. These measures serve as protective gateways that prevent untrusted entities or malicious software from compromising databases, thereby ensuring that users have safe and reliable access to valuable information.

6.5.5 Stage 5: IoT-embedded circulation

The fifth stage in the framework involves IoT-embedded circulation, which is sometimes regarded as controversial, due to its role in creating and maintaining users' profile

records. This stage simplifies key library functions such as issuing and returning library items, notifying users of overdue materials and updating of user cards. With the support of RFID technology, IoT-embedded circulation enhances connectivity by enabling virtual check-outs and reservations through mobile applications. In other words, if a book is in demand, users can conveniently reserve it online. The creation of user records with secure credentials also ensures that both hardcopy materials and e-resources can be accessed seamlessly, as the system automatically recognises and verifies users' identities.

6.5.6 Stage 6: automated self-help service kiosks

The self-help service kiosk represents the sixth stage in the IoT framework, featuring an automated terminal that enables the automatic and independent “check-in and check-out” of library materials. These kiosks are equipped with RFID readers and barcode scanners, which facilitate the identification and management of books and other media resources. User experience is enhanced through secured authentication methods such as PINs and library card codes, allowing transactions to be conducted virtually without assistance from the librarians. Borrowing hardcopy materials involves simple interactions with the touch screen, guiding users step-by-step to check out or return library items, pay fines, review loan histories, or renew borrowed materials. Receipts for these transactions can either be sent electronically to a user's mobile device or printed directly at the kiosk. By incorporating IoT into self-service kiosks, libraries improve their operational efficiency, minimise long queues and empower users with greater privacy and independence in managing their own information needs.

6.5.7 Stage 7: 3D security gate operating with radio-wave device readers

The 3D security gate, which represents the seventh stage in the framework, operates with radio-wave device readers that collect information from RFID tags embedded in library hardcopy collections. The 3D gate acts as anti-theft systems that detect any attempt to remove items without proper check-out. Each gate is configured with a unique identifier that communicates with the library server to verify whether a check-out has been authorised. RFID tags are discreetly embedded inside the books, serving as

theft prevention tools. During the check-out process, the tag is automatically deactivated, while upon return, the tag is reactivated to restore full security functionality.

6.5.8 Stage 8: Automatic book drop-in system

The final stage in the framework involves the automatic book drop-in system, which provides a convenient service for users returning hardcopy library materials outside, but near, the library premises. This system enables returns at any time, including after library hours, ensuring that users are not restricted by operating schedules. The drop-in system operates without requiring direct librarian intervention. It is equipped with automated controls and sensor-based software capable of identifying users, recording check-in details, noting the time of return and capturing the title of the book. Therefore, the proposed framework demonstrates how the utilisation of IoT in managing both hardcopy and electronic library services ensures that information reaches users efficiently and effectively, enabling them to achieve their goals anytime and anywhere.

6.6 Implications of research for theory, policy and practice

The study identified several challenges that point to the need for PML to adopt the IoT in their libraries, including low-bandwidth internet, insufficient infrastructure and limited database access to web applications. These challenges have significantly contributed to the inefficiency of information services and have prevented them from achieving satisfactory levels of performance.

In order address these shortcomings – experienced internally and increasingly felt externally – the study recommends targeted resolutions aimed at improving information services across the eight PML branches.

Several core library functional functions traditionally perform manually, such as tracking misplaced books, shelving and correcting misclassified items that can be addressed effectively through IoT connectivity. IoT facilitates access to online databases, movable shelves and automated cataloguing of classified materials, enabling easier and more accurate information retrieval. The migration to IoT-based systems also allows for encryption, standalone website applications, self-communicating self-service kiosks and

enhanced circulation desk functions, including reference interviews and real-time user identification through sensor networks.

If implemented as recommended, IoT adoption at PML may lead to reliable, responsive and high-quality information services. Furthermore, this study contributes both theoretically and conceptually to the field of Library and Information Science – particularly in terms of the utilisation of the IoT in the management of information services.

6.7 Theoretical and practical contributions and reflections

The research findings emphasise the key issues of information services; particularly the gaps arising from system usability, user perceptions and infrastructure development. The study highlights the importance of systematically integrating the IoT into libraries through policy, ensuring enhanced information for geographically dispersed communities. Such integration enriches users' experiences, supporting online learning and reading programmes, while mobile access to the library accounts empowers communities to become more informed.

Library Automated Management System (LAMS) technology, combined with infrastructure development and positive user perceptions, plays a critical role in delivering electronic information services. Automated systems enable efficient operations; facilitate structured information delivery; and promote the effective utilisation of the IoT. In other words, when guided by user perceptions, the development and implementation of IoT software components can maintain a more dynamic and up-to-date information service compared to traditional methods.

Furthermore, when adapted to modern technology, Dr. Ranganathan's Five Laws of Library Science provide a strong foundation for policies regulating web-based information systems, while enhancing IoT capabilities. The IoT positively impacts information service delivery by enabling interconnectivity, remote monitoring and robust protection of library resources, thereby supporting the vision and mission of library and

information services. Practical implications for PML include incorporating the IoT into library policy, securing funding for infrastructure development, organising targeted training for librarians, and engaging in ongoing research to advance the use of the IoT in their public libraries. These measures will ensure that PML remain proactive in adopting innovative technologies mitigating potential risks associated with IoT implementation.

6.8 Suggestions for further research

The investigation of the utilisation of the IoT for managing information services at public libraries in the Polokwane Municipality was successfully guided by the findings derived from the research objectives of the study, which subsequently informed the following suggestions to assist libraries in achieving these objectives in a scientific and evidence-based manner:

- The policy and legislative framework for using the IoT for the management of information services at Polokwane Municipality Libraries (PML) was evaluated.
- The usability of the IoT in the management of information services at the PML was examined.
- User perception of librarians regarding the use of IoT for the management of information services at PML was assessed.
- IoT infrastructure that can be used in the management of information services at PML was identified.
- A framework for the use of the IoT in the management of information services at PML was proposed.

Various library tasks can be upgraded and enhanced through the application of the IoT, offering effective solutions to the challenges identified at PML. Transitioning from manual systems to IoT-enabled processes to provide users with more reliable and accessible information. Consequently, this study recommends the adoption of the IoT at PML to improve the management of their information services. Furthermore, future research on IoT utilisation can be extended to national level and special libraries, as well as information centres such as archives and museums, to enhance the speed of

accessibility of information to users. The integration of the IoT in libraries has the potential to strengthen interactions between users and librarians, transform and improve information service delivery and management, enhance user experiences and develop the technical skills of library staff.

6.9 Final conclusion

In conclusion, the study found that public libraries in the Polokwane Municipality rely on hard-copy collections to deliver information services to their users. However, to provide more dynamic and accessible electronic information, these public libraries should adopt IoT technologies for active information service delivery. Currently, library operations and information services are conducted manually, requiring librarians and user to retrieve books (hard copies) on shelves physically. Misplaced collections demand additional self-reading, which is time-consuming and labour-intensive which is not easy as hard labour is practiced by librarians and users to retrieve on shelves. Therefore, it is recommended for the Polokwane Municipality Libraries (PML) to utilise IoT to enhance virtual access, allowing users to access and retrieve information anytime and from any location without time constraints. Smart library systems, incorporating IoT elements such as RFID tags, can facilitate the easy location of misplaced books and improve security for library collections.

The optimisation of physical space can be achieved, providing designated reading areas for users, while IoT-enabled circulation systems that can automate “check-in and check-out” processes efficiently. Moreover, IoT integration supports automatic access to e-books and e-journals, virtual marketing of library services, inter-library loans, timely updates of new library collections and automated notifications of overdue items and/or fines. In essence, reliable information services play a crucial role in addressing broader social challenges such as crime, poverty, health conditions, teenage pregnancy and the lack of knowledge in communities. Therefore, the Polokwane Municipality Libraries should prioritise the utilisation of the IoT in the management of their information services, ensuring that they are both effective and efficient.

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ANNEXURES

Annexure A: Turnitin similarity index

Similarity Report	
PAPER NAME	AUTHOR
Final Dissertation for Mothapo Lebetsi.docx	LEBITSI MOTHAPO
WORD COUNT	CHARACTER COUNT
50493 Words	303098 Characters
PAGE COUNT	FILE SIZE
200 Pages	1.2MB
SUBMISSION DATE	REPORT DATE
Aug 2, 2025 8:41 AM PDT	Aug 2, 2025 8:52 AM PDT
● 17% Overall Similarity The combined total of all matches, including overlapping sources, for each database. • 8% Internet database • 15% Publications database • Crossref database • Crossref Posted Content database • 10% Submitted Works database	

Annexure B: Ethical clearance

	
College of Human Sciences_CREC	
Date: 23/10/2024	NHREC Registration # : (Rec-240816-052) Ref #: 3264 Name: Ms Lebital Mothapo Student #: 57553165
Dear: Ms Lebital Mothapo	
Decision: Ethics Approval from 23 October 2024 to 22 October 2025	
Researcher: Ms Lebital Mothapo P O Box 533, Tholongee 0734 Polokwane 57553165@mylife.unisa.ac.za 0764791792	
Supervisor: Dr Mashile Modiba modibmt@unisa.ac.za	
Utilisation of Internet of Things for Management of Information Services at Polokwane Municipality libraries in Limpopo Provinces of South Africa	
Qualification: Master's in Information sciences (dissertation/chapters)	
Thank you for the application for research ethics clearance by the College of Human Sciences_CREC for the above-mentioned research study. Ethics approval is granted for one year.	
The low-risk application was reviewed by the College of Human Sciences_CREC on 23 October 2024 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The proposed research may now commence with the provisions that: 1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics. 2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Human Sciences_CREC. 3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application. 4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.	
Page 1 of 2	

Annexure C: Permission to conduct research



CITY OF
Polokwane
NATURALLY PROGRESSIVE

Enq: Ms MSC Rasebotje
Tel: 015 290 2701
Email: ConnyR@polokwane.gov.za
Date: 22 July 2024

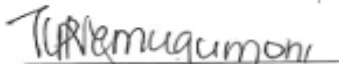
To: The Lecture in Human Geography
School of Biology and Environmental Sciences
Private Bag X 11283
Mbombela
1200

Dear Sir/Madam,

RE: CONFIRMATION FOR MOTHAPO LEBITSI TO CONDUCT RESEARCH POLOKWANE MUNICIPALITY

1. The above matter refers,
2. This letter serves to confirm that Mothapo L has been granted permission to conduct research at Polokwane Municipality as per research topic titled: **"Utilization of Internet of things for Management of Information Services at Polokwane Municipality Libraries (PML) in Limpopo Province of South Africa.**
3. Please note that the findings emanating from the research must be shared with the municipality before they can be published.

Kind Regards,



MS. THUSO NEMUGUMONI
MUNICIPAL MANAGER

OFFICE OF THE MUNICIPAL MANAGER

- P.O BOX 111 POLOKWANE, 0700
- CIVIC CENTRE, CNR LANDDROS MARE & BOOENSTEIN STREETS
- POLOKWANE, 0699, SOUTH AFRICA
- TEL: +27 15 290 2106
- FAX: +27 15 290 2106



Annexure D: Informed consent

I, _____ (participant name), confirm that the person asking for my consent to take part in this research has told me about nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and I understand the study as explained in the information sheet.

I have had sufficient opportunity to ask questions, and I am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications, conference proceedings, and that my participation will be kept confidential unless otherwise specified.

I agree to the recording and note-taking during the interview.

I agree to answer all questionnaires provided.

I will receive a signed copy of the informed consent form.

Participant Name & Surname.....

Participant Signature.....Date.....

Researcher's Name & Surname.....

Researcher's signature.....Date.....

Annexure E: Questionnaire guide

UTILISATION OF INTERNET OF THINGS IN THE MANAGEMENT OF INFORMATION SERVICES AT POLOKWANE MUNICIPALITY LIBRARIES IN LIMPOPO PROVINCE OF SOUTH AFRICA

I am Mothapo Lebitsi, currently studying at University of South Africa (UNISA) master's degree in information science conducting research study titled as: ***Utilisation of Internet of things in the management of information services at Polokwane Municipality Libraries in Limpopo province of South Africa.*** The purpose of the study is to investigate the utilisation of Internet of things (IoT) for management of information services at Polokwane Municipality Libraries (PML). However, it is envisioned that the findings of this study will help the researcher to finalise a valuable research project by writing recommendations that can benefit public libraries. Taking part, you will not experience any negative consequences by completing this research survey and there are no risks the participant will be subjected to during the survey. Any identifying information that is obtained in connection with this survey will remain confidential and will be disclosed only with your permission or as required by law.

Participation will be guided by a drafted questionnaire prepared for the study which will be distributed to different PML employees who serve for management of information services. The research questionnaire will be administered to avoid participants copying each other's answers as well as to maintain anonymous status. The questions prepared for participants will examine librarians' perceptions, usability and outline legislative frameworks that suit utilisation of IoT for management of information services at PML. The participant who takes part in this data collection survey will have to answer the questionnaire with honesty and dedication. As a result of the honesty expressed when answering the questions, it will help to achieve the outlined objectives of the study without doubt. For more information about data collection, contact Mothapo Lebitsi: cell number 076 479 1792 or 57553165@mylife.unisa.ac.za or Dr Mashilo Modiba at 012 433 4752 or modibmt@unisa.ac.za Or Research Ethics Chairperson (REC) Prof K Khan at khankb@unisa.ac.za or 012 429 6540. Thank you for taking part in this

COMPLETE THIS QUESTIONNAIRE AS GUIDED BELOW

1. Please put a cross (x) in the box that describes your response; if need be, explain where space is provided.
2. Use “N/A” for not applicable questions; please answer all questions.
3. If writing space is not enough, please use a separate page and write the question number next to the answer.
4. The consent form is attached to this question; please make sure that you sign the form as provided.

SECTION 1: RESPONDENT PROFILE

1.1 Gender

Female	
Male	

1.2 Age Group

18–30	
31–40	
41–50	
50 and above	

1.3 Educational Level

Matric	
Certificate	
Diploma	
Degree	
Postgraduate diploma/honours	
Masters	
PhD	

1.4 Job title

Library Assistant	
It Clerk	
It Practitioner	
Librarian	
Senior Librarian	
It Manager	
Other, specify	

1.5 Occupied experiences in current position

0–2 years	
3–5 years	
6–7 years	
8–10 years	
11 years+	

SECTION 2: LEGISLATIVE FRAMEWORKS AND POLICY USED IN THE LIBRARY

2.1 Do the library have a specific policy used for information services?

Yes	
No	

2.1.1 If yes, how does the policy address information service?

2.1.2 If no, how do you deal with issues confronted with related to information services?

2.2 Do Polokwane Municipality Libraries (PML) have a policy that public libraries can use for management of library collection?

Yes	
No	

2.2.1 If yes, how does the policy support management of library collection?

2.2.2 If no, is PML aware of the need of policy that can support management of library collections? _____

2.3 What is the purpose of having the policy within the PML (tick relevant answer?)

Information protection	
Efficient communication	
Track of physical resource	
Adequate up-dated information	
Other: Specify	

2.5 Which of the SA legislature is used to manage electronic/digital information sources at PML? (Tick the relevant answer)

The Constitution of the Republic of South Africa (Act 108 of 1996)	
Protection of Information Act (No. 84 of 1984)	
National library of South Africa (No. 2 of 2000)	
South African Public Library and Information Service Bill (2010)	
The Promotion of Access to Information Act (No. 2 of 2000)	
Copyright Act (No. 98 of 1978)	
National Council for Library and Information Services	
Other: Specify	

2.6 How does the SA legislature in public libraries assist to provide users with electronic/digital information service? (Tick relevant answer)

Web technology	
ICT development	
Access to information	
Other: Specify	

2.6 Do PML often review its policy for reliable information service within the library?

Yes	
No	

2.6.1 If yes, how regularly is library policy reviewed and evaluated? (Please elaborate)

2.6.2 If no, what are the reasons for not reviewing library policy?

2.7 What gaps exist within the PML policy that can assist in the adoption of IoT with the Libraries?

2.8 Do you think different perspectives about IoT can be considered and added to library policy for effective electronic information services? (Please elaborate)

SECTION 3: USABILITY OF INTERNET OF THING IN A LIBRARY

Note: The **Internet of things** is a system that interrelates with mechanical, computer devices, digital machines, and objects, or people through unique identifiers (UIDs) and human to human and mostly computer interference are not needed as advanced networks can transfer data on its own (Nag & Nikam 2016)

3.1 Are you using IoT at PML to manage information services in your library?

Yes	
No	

3.1.1 If yes, how do you use IoT to provide information service?

3.1.2 If no, in your opinion what do you think should be done to make IoT easy to use to provide information services?

3.2 Please explain how simple it can be as library employee to work with IoT tool to provide information services?

3.3 How accurate and fast can users access information service using IoT?

3.4 What is PML doing for users to access information using IoT effectively and efficiently?

SECTION 4 LIBRARIANS PERCEPTIONS ABOUT INTERNET OF THINGS

4.1 As a library employee dealing with information services, do you know more about IoT in the public library?

Yes	
No	

4.1.1 If no, what makes it difficult to know more about IoT for provision of information services?

4.1.2 If yes, please explain how useful IoT can IoT be used to provide for information services?

4.2 Are you willing to learn more about IoT in public libraries?

Yes	
No	

4.2.1 If yes, what training can you recommend for learning about IoT?

Workshops	
Online educational programme	
Seminar meeting	
Other, specify	

4.2.2 From 4.2.1 why do you think this kind of training can be effective learning about IoT?

4.2.3 If no, what negative factors affect learning about IoT at the library?

4.3 Based on answer provided on 4.2.3 what are other constraints that might hinder the PML to adopt IoT?

4.4 In your own opinion, do you think PML need IoT to manage information services? (Please elaborate)

SECTION: 5 INTERNETS OF THINGS INFRASTRUCTURE IN A PUBLIC LIBRARY

Please note that: In a public library the topmost infrastructure development executed by IoT must comprise smart digital shelves, virtual library, real-time data requests, library smart cards, and mobile devices to locate books. This infrastructural development within the library is modernised and makes the public libraries' service move quickly and smoothly (Purkin 2019).

5.1 Is there any IoT infrastructure used for provision of information service in the library?

Yes	
No	

5.1.1 If yes, which infrastructure is used in your library for provision of information services at the library? (Tick relevant answer)

RFDIs	
Sustainable network	
Sensor Application Layer	
Actuator	
Wireless sensor network	
Near field communication	

5.1.2 If no, please list the infrastructure used at the library for provision of information services?

5.2 In your opinion, what does IoT infrastructure utilise for management of information services in public libraries? Please rate the following statements below by 1 Agree; 2 Unsure; and 3 Disagree and give a reason.

STATEMENT	1	2	3	Reason
5.2.1 IoT infrastructure is effective in retrieval information				
5.2.2 IoT infrastructure helps with movement of physical material and security				
5.2.3 IoT infrastructure increases work performance				
5.2.4 IoT helps track location of library resources				
5.2.5 IoT with the element of RFDIs transform data quick				
5.2.6 IoT sustainable networks is maintained at library				

5.4 What are other elements of IoT infrastructure needed that can make library manage electronic information services efficiently?

Network	
Server	
Website	
Computerisation	
Other, please specify	

5.5 In your opinion, what can be done at PML to implement IoT infrastructure for management of information services?

Annexure F: Interview guide

UTILISATION OF INTERNET OF THINGS IN THE MANAGEMENT OF INFORMATION SERVICES AT POLOKWANE MUNICIPALITY LIBRARIES IN LIMPOPO PROVINCE OF SOUTH AFRICA

ANSWER THIS INTERVIEW QUESTIONS AS GUIDED BELOW

1. As participants responded to questions asked only.
2. Please note that the interviews are reordered.
3. Take your time to recall and reply to follow-up questions
4. Make sure you have signed the attached consent form.

SECTION 1. INTERVIEW DETAILS

- 1.1. Interviewer: _____
- 1.2. Date: _____
- 1.3. Time: _____
- 1.4. Place: _____
- 1.5. Type of interview: _____

SECTION 2. PERSONAL INFORMATION

- 2.1 Please describe your gender. _____
- 2.2. What is your highest qualification? _____
- 2.3. What is the position you occupy at the library? _____
- 2.4. What key performance role do you perform at library? _____
- 2.5 What is your work experience within the library?

SECTION 2: LEGISLATIVE FRAMEWORKS AND POLICY IN LIBRARY

- 2.1 Do the library have a specific policy used for information services?

2.1.1 If yes, how does the policy address information services?

2.1.2 If no, how do you deal with issues confronted with related to information services?

2.2 Do Polokwane Municipality Libraries (PML) have a policy that public libraries can use for management of library collection?

2.2.1 If yes, how does the policy support management of library collections?

2.2.2 If no, is the PML aware of the need of policy that can support management of library collection?

2.3 What is the purpose of having the policy within the PML?

2.4 Which of the SA legislature is used to manage electronic information sources at PML?

2.5 How does the SA legislature in public libraries assist to provide users with electronic information service?

2.6 Does the library often review its policy for reliable information service within the library?

2.6.1 If yes, how regularly is library policy reviewed and evaluated? (Please elaborate)

2.6.2 If no, what are the reasons for not reviewing library policy?

2.7 What gaps exist within the PML policy that can assist in the adoption of IoT with the Libraries?

2.8 Do you think different perspectives about IoT can be considered and added to library policy for effective electronic information services? (Please elaborate.)

SECTION 3: USABILITY OF THE INTERNET OF THING IN A LIBRARY

Note: Internet of things is a system that interrelates with mechanical, computer devices, digital machines, and objects, or people through unique identifiers (UIDs) and

human to human and mostly computer interferences are not needed as advanced networks can transfer data on its own (Nag & Nikam 2016).

3.1 Are you using IoT at PML to manage information services in your library?

Yes	
No	

3.1.1 If yes, how do you use IoT to provide information service?

3.1.2 If no, in your opinion what do you think should be done to make IoT easy to use to provide information service?

3.2 Please explain how simple it can be as library employee to work with IoT tool to provide information services?

3.3 How accurate and fast can users access information service using IoT?

3.4 What is PML doing for users to access information using IoT effectively and efficiently?

SECTION 4: LIBRARIANS PERCEPTIONS ABOUT INTERNET OF THINGS

4.1 As a library employee dealing with information service, do you know more about IoT in the public library?

4.1.1 If no, what makes it difficult to know more about IoT for provision of information services?

4.1.2 If yes, please explain how useful IoT can IoT be used to provide for information services?

4.2 Are you willing to learn more about IoT in public libraries?

4.2.1 If yes, what training can you recommend for learning about IoT?

4.2.2 From 4.2.1 why do you think this kind of training can be effective learning about IoT?

4.2.3 If no, what negative factors affect learning about IoT at the library?

4.3 Based on the answer provided on 4.2.3, what are other constraints that might hinder the PML to adopt IoT?

4.4 In your own opinion, do you think most of the task done at PML does not need IoT for management of information?

SECTION: 5 INTERNETS OF THINGS INFRASTRUCTURE IN A LIBRARY

Please note that: In a public library the topmost infrastructure development executed by IoT must comprise smart digital shelves, virtual library, real-time data requests, library smart cards, and mobile devices to locate books. This infrastructural development within the library is modernised and makes the public libraries' service move quickly and smoothly (Purkin 2019).

5.1 Is there any IoT infrastructure used for provision of information service in the library?

5.1.1 If yes, which infrastructures are used for provision of information services at the library?

5.1.2 If no, please list the infrastructure used for provision of information services?

5.2 In your opinion, what does IoT infrastructure utilise for management of information services in a public library, please rate the following statement below by 1 Agree; 2 Unsure; 3 Disagree and give a reason? From (5.2.1 to 5.2.7)

5.2.1 IoT infrastructure is effective in retrieval of information.

5.2.2 IoT infrastructure helps with movement of physical material and security.

5.2.3 IoT infrastructure increases work performance.

5.2.4 IoT helps track location of library resources.

5.2.5 IoT with element of RFDIs transforms data quickly.

5.2.6 IoT sustainable network is maintained at library.

5.3 What do you think are other elements of IoT infrastructures needed that can make library manage electronic information services efficiently?

5.4 In your opinion, what can be done at PML to implement IoT infrastructure for management of information services?

Annexure G: Editing certificate

Lucia Geyer

Writer ~ Courseware Developer ~ Copy-Editor ~ Proofreader

Master's in Library & Information Science

CERTIFICATE OF EDITING

I hereby certify that I, E.M. (Lucia) Geyer, have edited the following Master's dissertation:

Candidate/Researcher

Ms Lebetsi Mathopo

Student number 57553165

Thesis Title

*The Utilisation of the Internet of Things in the Management of Information Services at Polokwane
Municipal Libraries in the Limpopo Province of South Africa*

The editing exercise includes:

- Formatting;
- Structuring;
- Language editing and correcting;
- Attentive proofreading; and
- Bibliographic control: checking of text references and bibliographic entries in the reference list.

This dissertation has been edited to the best of my professional ability, drawing on my expertise in the English language, my extensive academic experience in Information Science and my work as an academic editor.

I cannot accept responsibility for any editorial suggestions and/or recommendations that the candidate has chosen not to incorporate, nor for modifications made to the manuscript after submission.



16 September 2025

EM (Lucia) Geyer

Email: lgeyer@gmail.com