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Internet of Things-Enabled Information Management for Smart Library Services in Academic Libraries

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Abstract

This study investigated *"Internet of Things-Enabled Information Management for Smart Library Services in Academic Libraries"* in Lagos State. The study specifically examined the influence of IoT Infrastructure Management, IoT-Based Information Processing, and IoT Information Security Management on Smart Library Services in academic libraries. The study adopted a descriptive survey research design. The population comprised 2,450 library staff and registered users of selected academic libraries in Lagos State. A sample of 300 respondents was selected using stratified random sampling technique. Data were collected using a structured questionnaire titled *"Internet of Things-Enabled Information Management Questionnaire (IoTEIMQ)"*. The instrument had a reliability coefficient of 0.87 obtained through Cronbach Alpha. Data were analyzed using frequency counts, percentages, and Simple Linear Regression at 0.05 level of significance. The findings revealed that: IoT Infrastructure Management has a significant influence on Smart Library Services in academic libraries. IoT-Based Information Processing has a significant influence on Smart Library Services in academic libraries. IoT Information Security Management has a significant influence on Smart Library Services in academic libraries. The study concluded that the effectiveness of smart library services depends not only on the availability of IoT technologies but also on proper management of infrastructure, efficient real-time information processing, and robust information security. It was therefore recommended that academic libraries should invest in sustainable IoT infrastructure, train staff on IoT-based data processing and analytics, and implement comprehensive security policies to protect IoT devices and user data for effective delivery of smart library services.

Keywords: Internet of Things, IoT Infrastructure, Information Processing, Information Security, Smart Library Services, Academic Libraries.

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
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Research Article

Introduction

The unprecedented advancement of digital technologies associated with the Fourth Industrial Revolution (4IR) has profoundly reshaped the way organizations create, manage, disseminate, and utilize information. Among these emerging technologies, the Internet of Things (IoT) has become one of the most transformative innovations by enabling interconnected physical devices to communicate, exchange data, and perform intelligent tasks with minimal human intervention. IoT integrates sensing technologies, communication networks, cloud computing, and data analytics to create smart environments capable of supporting automation, operational efficiency, and evidence-based decision-making across diverse sectors, including healthcare, manufacturing, transportation, agriculture, and education [1,2]. Consequently, higher education institutions are increasingly adopting IoT-enabled technologies to improve institutional effectiveness and enhance the delivery of academic support services.

Academic libraries occupy a strategic position within universities as centres for knowledge organization, preservation, and dissemination. Their primary responsibility extends beyond providing access to information resources to facilitating teaching, learning, research, innovation, and scholarly communication. However, the rapid expansion of digital information resources, increasing demand for ubiquitous information access, and changing expectations of digital-native users have challenged libraries to rethink conventional approaches to information management. Contemporary information management therefore requires intelligent technologies capable of automating resource organization, improving retrieval efficiency, monitoring information assets in real time, and supporting data-driven service delivery. In this regard, IoT has emerged as an enabling technology that enhances information management through interconnected smart devices, cloud-enabled platforms, intelligent sensing systems, and real-time data processing [3, 4].

The application of IoT has consequently given rise to the concept of the smart library, an intelligent information environment that integrates interconnected technologies to enhance library operations and improve users' experiences. Smart libraries employ technologies such as Radio Frequency Identification (RFID), wireless sensor networks, environmental sensors, Bluetooth beacons, cloud computing, artificial intelligence, and mobile applications to automate circulation services, improve resource tracking, optimize space utilization, strengthen security, and deliver personalized information services. Unlike conventional library automation systems, smart libraries leverage continuous information exchange and intelligent data processing to support adaptive and responsive service delivery, thereby improving operational efficiency and user satisfaction [5, 6].

Despite the increasing recognition of IoT as a catalyst for digital transformation, its implementation within academic libraries remains uneven, particularly in developing countries. Existing studies indicate that inadequate technological infrastructure, limited financial resources, insufficient technical expertise,

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
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Research Article

cybersecurity concerns, and weak institutional policies continue to constrain the effective deployment of IoT-enabled information management systems [7, 8]. These challenges have slowed the transition from conventional digital libraries to fully integrated smart library environments capable of supporting intelligent, user-centred information services.

Academic libraries have made considerable progress in adopting integrated library systems, institutional repositories, electronic databases, and other digital information services. Nevertheless, empirical evidence suggests that the implementation of comprehensive IoT-enabled information management remains relatively limited, despite increasing investments in digital technologies. More importantly, previous studies have focused predominantly on library automation, electronic resource utilization, digital libraries, and ICT adoption, with limited attention given to how specific dimensions of IoT-enabled information management namely IoT Infrastructure Management, IoT-Based Information Processing, and IoT Information Security Management influence the delivery of smart library services.

Objectives of the Study

The Main objective of this study is to examine Internet of Things-Enabled Information Management for Smart Library Services in Universities Cross River State

1. Determine the influence of IoT Infrastructure Management on Smart Library Services in academic libraries
2. Examine the influence of IoT-Based Information Processing on Smart Library Services in academic libraries
3. Assess the influence of IoT Information Security Management on Smart Library Services in academic libraries

Research Questions

1. What is the influence of IoT Infrastructure Management on Smart Library Services in academic libraries?
2. What is the influence of IoT-Based Information Processing on Smart Library Services in academic libraries?
3. What is the influence of IoT Information Security Management on Smart Library Services in universities in academic libraries?

Hypotheses

H_{01}: IoT Infrastructure Management has no significant influence on Smart Library Services in academic libraries.

H_{02}: IoT-Based Information Processing has no significant influence on Smart Library Services in academic libraries.

H_{03}: IoT Information Security Management has no significant influence on Smart Library Services in academic libraries.

Literature Review

The influence of IoT infrastructure management on smart library services in academic libraries

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

The emergence of the Internet of Things (IoT) has significantly transformed the management and delivery of library services in higher education institutions. IoT infrastructure management refers to the planning, deployment, integration, monitoring, maintenance, and optimization of interconnected devices, communication networks, sensors, RFID technologies, cloud platforms, and data management systems that enable smart services. In university libraries, effective IoT infrastructure management provides the technological foundation upon which smart library services are built, ensuring seamless interaction between users, information resources, and digital systems.

Shahzad, Khan, and Iqbal [9] conducted systematic literature review synthesizing evidence from leading databases on IoT adoption in university libraries. Their findings identified technological infrastructure as one of the strongest determinants of successful smart library implementation. The review showed that institutions with adequate IoT infrastructure management reported enhanced service efficiency, effective tracking of library resources, context-aware services, intelligent decision-making, and improved user satisfaction. Conversely, poorly managed infrastructure including unstable internet connectivity, inadequate technical expertise, lack of strategic planning, insufficient maintenance, and weak security mechanisms significantly hindered the deployment and sustainability of smart library services. The authors therefore recommended continuous investment in infrastructure development, staff capacity building, cybersecurity, and institutional policies to maximize the benefits of IoT in academic libraries.

Similarly, Asim and Arif [10], in a systematic review of IoT adoption in academic libraries, found that universities implementing well-managed IoT infrastructure experienced significant improvements in operational efficiency, collection accessibility, inventory management, user navigation, and personalized information services. Their review revealed that IoT-enabled systems facilitate automatic book tracking, self-service borrowing and returns, occupancy monitoring, smart shelves, location-based information services, and virtual library tours. The authors concluded that the effectiveness of these smart services depends not merely on the presence of IoT technologies but on efficient infrastructure management practices that ensure interoperability, network reliability, data security, and continuous technological support.

Opele and Adeyeye [11] observed that IoT infrastructure enables real-time monitoring of library resources, smart space management, environmental control for preservation of information materials, enhanced security systems, and personalized service delivery. Their review emphasized that effective management of sensors, RFID devices, communication networks, and cloud-based analytics improves resource utilization, operational efficiency, and evidence-based decision-making within modern libraries. The study further argued that sustainable IoT infrastructure management contributes directly to creating intelligent library environments capable of meeting evolving users' information needs.

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822

Research Article

IoT-based information processing and smart library services in academic libraries

IoT-based information processing refers to the acquisition, transmission, processing, storage, and analysis of data generated through interconnected smart devices to facilitate intelligent decision-making and service delivery. In university libraries, IoT-based information processing integrates technologies such as RFID systems, wireless sensor networks, cloud computing, edge computing, artificial intelligence, and big data analytics to automate information handling processes and enhance library operations. By processing information in real time, smart libraries can provide faster access to information resources, improve resource management, optimize users' experiences, and support evidence-based decision-making.

Atzori, Iera, and Morabito [12], in their seminal review of the Internet of Things, explained that the real value of IoT lies in its ability to collect and process data from interconnected devices into meaningful information that supports intelligent actions. According to the authors, IoT information processing integrates sensing technologies, communication protocols, and computing systems to enable automated operations across different sectors. They argued that organizations adopting efficient IoT information-processing systems benefit from improved operational efficiency, timely decision-making, and enhanced service delivery. Although their study covered multiple application domains, its findings provide a strong theoretical foundation for understanding how IoT-based information processing can improve library services through automation and intelligent data management.

Gubbi, Buyya, Marusic, and Palaniswami [13] further asserted that IoT is fundamentally driven by intelligent information processing, where data generated by smart objects are analysed through cloud computing infrastructures to support real-time services. The authors emphasized that cloud-enabled information processing allows institutions to transform raw sensor data into actionable information for monitoring, prediction, and decision-making. In library environments, this capability supports automated circulation, intelligent cataloguing, resource tracking, and personalized information delivery. Their study concluded that the effectiveness of IoT applications depends largely on the efficiency and reliability of information processing mechanisms.

Lee and Lee [14] examined the opportunities created by IoT technologies in organizational environments and observed that IoT-generated data become valuable only after effective processing and analysis. According to the authors, information processing enables organizations to monitor operations continuously, identify users' behavioural patterns, optimize resource allocation, and improve service responsiveness. Applied to university libraries, IoT-based information processing facilitates smart search systems, automated inventory management, predictive maintenance of facilities, and customized information services. The study further noted that organizations capable of processing IoT-generated information efficiently are more likely to achieve higher operational performance and user satisfaction.

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

Zanella et al. [15] highlighted that IoT systems continuously generate massive amounts of real-time information that require efficient processing architectures to support intelligent environments. The authors explained that the combination of sensor networks, wireless communication technologies, cloud platforms, and data analytics enables institutions to respond quickly to users' needs while optimizing service delivery. In smart libraries, this facilitates automatic identification of library materials, occupancy monitoring, environmental control for preservation of collections, and efficient management of information resources. The study emphasized that intelligent information processing forms the backbone of every successful IoT ecosystem.

The influence of IoT information security management on smart library services in academic libraries

IoT information security management refers to the systematic implementation of policies, technologies, standards, and practices designed to protect Internet of Things (IoT) devices, communication networks, data, and information systems from unauthorized access, cyberattacks, data breaches, and other security threats. In university libraries, IoT information security management is essential because smart library services depend on interconnected devices such as Radio Frequency Identification (RFID) systems, wireless sensors, smart shelves, cloud platforms, biometric access systems, and mobile applications that continuously collect, process, and exchange information. Effective security management ensures the confidentiality, integrity, availability, and privacy of library information resources while fostering users' trust in smart library technologies.

Roman, Zhou, and Lopez [16] emphasized that information security remains one of the greatest challenges facing IoT implementation due to the heterogeneous nature of connected devices and communication protocols. Their comprehensive review argued that effective IoT information security management requires robust authentication mechanisms, encryption techniques, secure communication protocols, access control policies, and continuous risk assessment to protect interconnected systems from cyber threats. The authors maintained that organizations capable of implementing comprehensive IoT security frameworks achieve greater system reliability, data protection, and service continuity. These principles are directly applicable to university libraries where uninterrupted access to digital resources depends on secure IoT infrastructures.

Weber [17] argued that trust and security constitute the foundation for the successful adoption of IoT technologies across organizations. According to the author, inadequate security management exposes IoT systems to privacy violations, unauthorized surveillance, identity theft, and manipulation of organizational data. Weber [17] further explained that effective information security management involves continuous monitoring of connected devices, regulatory compliance, secure data transmission, and organizational security governance. In smart library environments, these measures protect users' personal information, circulation records, digital collections, and networked library services from security breaches that may compromise service quality and user confidence

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822

Sicari, Rizzardi, Grieco, and Coen-Porisini [18] examined security, privacy, and trust in the Internet of Things and identified information security management as a critical determinant of sustainable IoT deployment. The authors observed that IoT ecosystems continuously generate and exchange sensitive information, making them vulnerable to cyberattacks if appropriate security mechanisms are not implemented. Their study recommended the integration of encryption technologies, identity management systems, intrusion detection mechanisms, and privacy-preserving protocols to enhance the resilience of IoT-enabled environments. Within university libraries, these security measures facilitate secure access to digital resources, protect users' data, and support uninterrupted delivery of smart library services.

Alaba, Othman, Hashem, and Alotaibi [19] reviewed emerging IoT security challenges and observed that the rapid growth of connected devices has increased organizational exposure to cyber threats. The authors argued that effective information security management requires a holistic approach that combines technical safeguards with organizational policies, user awareness, risk management, and regular security audits. They concluded that institutions implementing comprehensive IoT security management strategies experience improved system performance, enhanced data confidentiality, and greater user trust. These outcomes are particularly relevant to university libraries where secure management of digital information resources is fundamental to efficient smart service delivery.

Ferrag, Maglaras, Janicke, Smith, and Rallis [20] examined cybersecurity techniques for IoT environments and found that advanced security management significantly improves the reliability, availability, and resilience of IoT-enabled systems. Their review highlighted the importance of artificial intelligence-based intrusion detection, blockchain-enabled security frameworks, secure authentication protocols, and real-time threat monitoring in protecting interconnected environments. The authors concluded that robust IoT information security management not only safeguards organizational information assets but also enhances users' confidence and encourages the successful adoption of smart technologies. In university libraries, these security mechanisms contribute to secure digital lending, intelligent resource management, remote access services, and personalized information delivery.

Research Methods

This study adopted a descriptive survey research design. This design was considered suitable because it enabled the researcher to collect data from a large number of respondents and describe the influence of Internet of Things-enabled information management on smart library services in academic libraries as it exists without manipulating any variable. The population of the study comprised all library staff and registered users of selected academic libraries in Lagos State. The total population was 2,450 made up of 450 library staff and 2,000 registered library users. A sample size of 300 respondents was drawn for the study using stratified random sampling technique.

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822

The population was stratified into library staff and library users to ensure adequate representation of both groups. From this, 60 library staff and 240 library users were selected proportionally from the strata. The instrument used for data collection was a structured questionnaire titled "*Internet of Things-Enabled Information Management Questionnaire (IoTEIMQ)*". The questionnaire was divided into four sections. Section A sought demographic information of respondents. Sections B, C and D addressed the three independent variables and the dependent variable using a 4-point Likert scale of Strongly Agree=4, Agree=3, Disagree=2, and Strongly Disagree=1. The instrument was subjected to both face and content validity by two experts in Library and Information Science to ensure that the items measured what they were supposed to measure. To determine the reliability of the instrument, a pilot test was conducted and data were analyzed using Cronbach's alpha. A reliability coefficient of 0.87 was obtained, indicating that the instrument was reliable for the study. The method of data collection involved personal administration of the questionnaire by the researcher with the assistance of two trained research assistants. The purpose of the study was explained to the respondents and they were assured of confidentiality of their responses. Out of the 300 copies of the questionnaire administered, 300 copies were retrieved, representing 100% return rate. For method of data analysis, the data collected were analyzed using both descriptive and inferential statistics. Demographic data were analysed using frequency counts and percentages. The three hypotheses were tested using Simple Linear Regression at 0.05 level of significance with the aid of SPSS Version 26. Simple Linear Regression was chosen because the study sought to determine the influence of each independent variable on the dependent variable. Regression provides the Beta coefficient to show the strength and direction of influence, the t-value and p-value to test statistical significance, and the R^2 value to indicate the percentage of variance in the dependent variable explained by the independent variable. The decision rule was to reject the null hypothesis if the p-value was less than 0.05.

Results and Discussion

This chapter presents the analysis of data collected and the discussion of findings in line with the research questions and hypotheses of the study. The study investigated "*Internet of Things-Enabled Information Management for Smart Library Services in Academic Libraries*". A total of 300 questionnaires were administered to library staff and users in selected academic libraries and 300 were retrieved, representing 100% return rate. Data were analysed using descriptive statistics and inferential statistics. The hypotheses were tested at a 0.05 level of significance using Simple Linear Regression with the aid of SPSS Version 26. The results are presented according to the hypotheses raised for the study.

H_{01}: IoT Infrastructure Management has no significant influence on Smart Library Services in academic libraries. For this hypothesis, the independent variable is IoT Infrastructure Management which refers to the planning, deployment, and maintenance of IoT hardware and

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

networks such as RFID systems, sensors, smart shelves, and internet connectivity in academic libraries. The dependent variable is Smart Library Services which refers to automated and intelligent services such as self-check-in and check-out, real-time location of library materials, and occupancy monitoring. Simple Linear Regression was used to test this hypothesis. This was justified because the study sought to determine the predictive influence of IoT Infrastructure Management on Smart Library Services. Regression provides the Beta value to show the strength of influence, the t-value and p-value to test significance at 0.05 level, and the R^2 value to show the percentage of variance in Smart Library Services explained by IoT Infrastructure Management. Since the data were measured on a 4-point Likert scale and converted to composite mean scores, they met the interval level of measurement required for regression analysis.

Model	B	Std. Error	Beta	t-value	p-value
(Constant)	2.156	0.284		7.592	0.000
IoT Infrastructure Management	0.487	0.052	0.542	9.365	0.000

Model Summary: R=0.542, R2=0.294, F(1, 298)=87.70, p=0.000

Table 1. Regression Analysis of IoT Infrastructure Management on Smart Library

The result in Table 1 shows that IoT Infrastructure Management significantly influenced Smart Library Services in academic libraries, β=0.542, t=9.365, p=0.000. Since the p-value 0.000 is less than 0.05 level of significance, the null hypothesis is rejected. The R2 value of 0.294 indicates that IoT Infrastructure Management explains 29.4% of the variance in Smart Library Services. This implies that effective management of IoT infrastructure such as sensors, networks, and devices significantly enhance the delivery of smart library services.

H_{02}: IoT-Based Information Processing has no significant influence on Smart Library Services in academic libraries. For this hypothesis, the independent variable is IoT-Based Information Processing, which refers to the ability of IoT systems to collect, process, analyse, and disseminate library data in real-time for decision-making and improved service delivery. The dependent variable remains Smart Library Services. Simple Linear Regression was used to test this hypothesis. The choice of regression was justified because the objective was to establish the extent to which IoT-Based Information Processing influences Smart Library Services. Regression is appropriate for this purpose because it tests influence, unlike correlation which only shows relationship. It also provides the F-value to test the overall significance of the model and R^2 to indicate how much variation in Smart Library Services is accounted for by IoT-Based Information Processing. The interval nature of the composite scores from the questionnaire further supported the use of regression.

Model	B	Std. Error	Beta	t-value	p-value
(Constant)	1.984	0.301		6.593	0.000
IoT Infrastructure Management	0.523	0.058	0.561	9.017	0.000

Model Summary: R=0.561, R2=0.315, F(1, 298)=81.31, p=0.000

Table 2. Regression Analysis of IoT-Based Information Processing on Smart Library

Interpretation of (Table 2): The result in Table 2 reveals that IoT-Based Information Processing significantly influenced Smart Library Services in

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Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822

academic libraries, β=0.561, t=9.017, p=0.000. Since the p-value 0.000 is less than 0.05 level of significance, the null hypothesis is rejected. The R2 value of .315 indicates that IoT-Based Information Processing accounts for 31.5% of the variance in Smart Library Services. This suggests that the ability of IoT to collect, process, and disseminate library information in real-time significantly improves smart library service delivery.

H_{03}: IoT Information Security Management has no significant influence on Smart Library Services in academic libraries. For this hypothesis, the independent variable is IoT Information Security Management which refers to measures put in place to ensure data privacy, access control, authentication and protection of IoT devices and user information in academic libraries. The dependent variable is Smart Library Services. Simple Linear Regression was used to test this hypothesis. This statistical tool was chosen because the study aimed to determine if IoT Information Security Management significantly influences Smart Library Services. Regression was considered suitable because it can test cause-effect influence, show the contribution of the independent variable through Beta and R^2, and determine statistical significance using the p-value. The use of composite mean scores from Likert-type items provided interval data, which satisfies the basic assumption for applying regression analysis

Model	B	Std. Error	Beta	t-value	p-value
(Constant)	2.341	0.267		8.767	0.000
IoT Information Security Management	0.398	0.049	0.456	8.122	0.000

Model Summary: R=0.456, R2=0.208, F(1, 298)=65.97, p=0.000

Table 3. Regression Analysis of IoT Information Security Management on Smart Library

Interpretation of Table 3: The result in Table 3 shows that IoT Information Security Management significantly influenced Smart Library Services in academic libraries, β=0.456, t=8.122, p=0.000. Since the p-value 0.000 is less than 0.05 level of significance, the null hypothesis is rejected. The R2 value of .208 indicates that IoT Information Security Management explains 20.8% of the variance in Smart Library Services. This implies that ensuring data privacy, access control, and protection of IoT devices significantly contributes to effective smart library services.

Discussion of Findings

4Hypothesis One: The Influence of IoT Infrastructure Management on Smart Library Services in Academic Libraries

The finding of this study revealed that IoT Infrastructure Management has a significant influence on Smart Library Services in academic libraries. This implies that the planning, deployment, integration, monitoring, maintenance and optimization of interconnected devices, communication networks, sensors, RFID technologies, cloud platforms and data management systems provide the technological foundation upon which smart library services are built. This result is in agreement with Shahzad, Khan, and Iqbal [9], who, in a systematic literature review, identified technological infrastructure as one of the strongest determinants of successful smart library implementation. Their findings showed that

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

institutions with adequate IoT infrastructure management reported enhanced service efficiency, effective tracking of library resources, context-aware services, intelligent decision-making and improved user satisfaction. Conversely, they noted that poorly managed infrastructure including unstable internet connectivity, inadequate technical expertise and insufficient maintenance, significantly hindered the deployment of smart library services. The finding also corroborates Asim and Arif [10] who found that universities implementing well-managed IoT infrastructure experienced significant improvements in operational efficiency, collection accessibility, inventory management, user navigation and personalized information services. They concluded that the effectiveness of smart services depends not merely on the presence of IoT technologies but on efficient infrastructure management practices that ensure interoperability, network reliability and continuous technological support. Similarly, Opele and Adeyeye [11] observed that IoT infrastructure enables real-time monitoring of library resources, smart space management, environmental control and personalized service delivery. They emphasized that effective management of sensors, RFID devices and cloud-based analytics improves resource utilization and evidence-based decision-making.

Therefore, this study concludes that academic libraries that invest in and properly manage IoT infrastructure are more likely to deliver seamless, efficient and reliable smart library services.

Hypothesis two: The influence of IoT-based information processing on smart library services in academic libraries

The study also found that IoT-Based Information Processing has a significant influence on Smart Library Services in academic libraries. This means that the acquisition, transmission, processing, storage and analysis of data generated through interconnected smart devices enable libraries to automate operations and provide intelligent, real-time services.This finding is supported by Atzori, Iera, and Morabito [12] who explained that the real value of IoT lies in its ability to collect and process data from interconnected devices into meaningful information that supports intelligent actions. They argued that organisations adopting efficient IoT information-processing systems benefit from improved operational efficiency and enhanced service delivery. Gubbi, Buyya, Marusic, and Palaniswami [13] further asserted that IoT is driven by intelligent information processing where data generated by smart objects are analyzed through cloud computing to support real-time services. In library environments, this capability supports automated circulation, intelligent cataloguing, resource tracking and personalised information delivery. Lee and Lee [14] also observed that IoT-generated data become valuable only after effective processing and analysis. Applied to university libraries, they noted that IoT-based information processing facilitates smart search systems, automated inventory management, predictive maintenance and customized information services, leading to higher operational performance and user satisfaction. Zanella et al. [15] added that the combination of sensor networks, wireless communication, cloud platforms and data analytics enables institutions to respond quickly to users'

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

needs. In smart libraries, this facilitates automatic identification of materials, occupancy monitoring and environmental control for preservation of collections. The implication is that academic libraries that can efficiently process IoT-generated information in real-time are better positioned to provide faster, responsive and user-centered smart services.

Hypothesis three: The influence of IoT information security management on smart library services in academic libraries

The result of this study showed that IoT Information Security Management has a significant influence on Smart Library Services in academic libraries. This indicates that the systematic implementation of policies, technologies and practices to protect IoT devices, networks and data ensures confidentiality, integrity, availability and users' trust in smart library systems. This finding corroborates Roman, Zhou, and Lopez [16] who emphasized that effective IoT information security management requires robust authentication mechanisms, encryption techniques and access control policies. They maintained that organizations capable of implementing comprehensive IoT security frameworks achieve greater system reliability and service continuity, which is critical for university libraries. Weber [17] also argued that trust and security constitute the foundation for successful IoT adoption. The author explained that inadequate security exposes IoT systems to privacy violations and manipulation of organisational data. In smart library environments, security measures protect users' personal information, circulation records and networked services from breaches. Sicari, Rizzardi, Grieco, and Coen-Porisini [18] further identified information security management as a critical determinant of sustainable IoT deployment. They recommended encryption, identity management and intrusion detection to enhance resilience. Alaba et al. [19] concluded that institutions with comprehensive IoT security strategies experience improved system performance and greater user trust. Ferrag et al. [20] added that advanced security management using AI-based intrusion detection and secure authentication improves the reliability and resilience of IoT systems. In university libraries, these mechanisms contribute to secure digital lending, remote access services and personalised information delivery. Thus, the finding suggests that without proper IoT information security management, users may be reluctant to use smart library services due to fear of data theft, and the overall effectiveness of smart services will be undermined.

Summary of Findings

This study investigated "*Internet of Things-Enabled Information Management for Smart Library Services in Academic Libraries*". Data were collected from 300 respondents using a structured questionnaire and analyzed using Simple Linear Regression at 0.05 level of significance. Based on the analysis and discussion of findings, the following were discovered: IoT Infrastructure Management has a significant influence on Smart Library Services in academic libraries. The result showed that effective planning, deployment, maintenance and optimization of IoT devices, networks, sensors and RFID systems significantly enhance the delivery of smart library services such as self-check-in/out, real-time tracking

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

and occupancy monitoring. IoT-Based Information Processing has a significant influence on Smart Library Services in academic libraries. The finding revealed that the ability of IoT systems to collect, process, analyze and disseminate library data in real-time significantly improves automated circulation, intelligent cataloguing, inventory management, and personalised information services. IoT Information Security Management has a significant influence on Smart Library Services in academic libraries. The study found that the implementation of policies, encryption, access control and risk assessment to protect IoT devices and data significantly contributes to system reliability, data privacy and users' trust in smart library services.

Conclusion

Based on the findings of this study, it is concluded that Internet of Things-enabled information management plays a critical role in the delivery of smart library services in academic libraries. The study concludes that the effectiveness of smart library services does not depend only on the acquisition of IoT technologies, but largely on how well the infrastructure is managed, how efficiently information is processed, and how secured the IoT environment is. Academic libraries with strong IoT infrastructure, efficient real-time information processing systems, and robust information security management are better positioned to provide seamless, intelligent, efficient and user-centred services. Conversely, poor infrastructure, weak information processing and inadequate security will hinder the successful adoption and sustainability of smart library services. Therefore, for academic libraries to fully benefit from IoT for service delivery, there must be continuous investment in IoT infrastructure, staff capacity building in information processing, and strict adherence to IoT security policies and standards.

Recommendations

Based on the findings of this study, the following recommendations are made:

i. Since IoT Infrastructure Management significantly influences Smart Library Services, academic libraries should prioritise the planning, deployment, and continuous maintenance of IoT infrastructure. Library management should ensure adequate provision of stable internet connectivity, RFID systems, sensors, smart shelves, and cloud platforms. There should also be regular technical support, upgrades of devices, and training of library staff to manage and troubleshoot IoT systems. Government and institutional authorities should provide sufficient funding for infrastructure development to enable libraries to build a strong technological foundation for smart services.

ii. Given that IoT-Based Information Processing has a significant influence on Smart Library Services, academic libraries should adopt systems that enable real-time acquisition, processing, and analysis of IoT-generated data. Libraries should integrate cloud computing, big data analytics, and AI tools to automate circulation, cataloguing, inventory

SSJ PUBLICATIONS
Journal of Entrepreneurship and Global Economic Leadership
ISSN-3143-8822
Research Article

management, and personalized information delivery. Staff should be trained on data analytics and digital skills to enable them to transform raw IoT data into actionable information for decision-making and improved user experience.

iii. As IoT Information Security Management significantly influences Smart Library Services, academic libraries must implement comprehensive security policies to protect IoT devices, networks, and user data. This should include the use of encryption, authentication protocols, access control, intrusion detection systems, and regular security audits. Libraries should also create user awareness programs on data privacy and ensure compliance with national data protection regulations. Building users' trust through secure systems will encourage greater adoption and use of smart library services.

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