2022

Managing smart campus and smart libraries: a look at challenges and the way forward for libraries in developing countries

Justina Ngozi EKERE Ph.D
Federal University of Technology, Owerri, uchengozi_ucngozi@yahoo.com

Oyemike Victor BENSON, Ph.D
DEPARTMENT OF LIBRARY & INFORMATION SCIENCE, FEDERAL POLYTECHNIC NEKEDE, OWERRI, ovbenson@fpno.edu.ng

Catherine Chinyere EKE
DEPARTMENT OF LIBRARY & INFORMATION SCIENCE, FEDERAL POLYTECHNIC NEKEDE, OWERRI, catherine.eke2018@gmail.com

Blessing N. EMUCHAY
LIBRARY DIVISION, FEDERAL POLYTECHNIC NEKEDE, OWERRI, blessingemuchay76@gmail.com

Managing smart campus and smart libraries: a look at challenges and the way forward for libraries in developing countries

Justina Ngozi EKERE, Ph.D

University Librarian, University Library,

Federal University of Technology, Owerri, Nigeria.

uchengozi_ucngozi@yahoo.com, justina.ekere@unn.edu.ng,

Oyemike Victor BENSON, *Ph.D*

Department of Library and Information Science,
Federal Polytechnic, Nekede-Owerri, Nigeria
ovbenson@fpno.edu.ng, bensonoyemike@gmail.com,

Catherine Chinyere EKE

Department of Library and Information Science,
Federal Polytechnic Nekede, Owerri, Nigeria
catherine.eke2018@gmail.com;

Blessing N. EMUCHAY

Central Library, Federal Polytechnic Nekede, Owerri
blessingemuchay76@gmail.com

Abstract

The paper focused on the challenges faced in creating and managing smart libraries in developing countries. The highlight of the paper are an overview of smart campuses and smart libraries; the justification for smart campuses and smart libraries. The key points for driving a smart campus and smart libraries include deep understanding of smart technological architecture; availability of smart devices and availability of smart platforms; The related technologies for smart libraries in smart campus include but not limited to cloud computing, radio frequency identification (RFID), mobile technology applications, internet of things (IoT) and wireless technology. Several challenges were identified such as unavailability of digital infrastructure, low level of partnership drive, lack of ict skills among library and information science professionals, high cost of maintenance and shortage of smart librarians. Provision of digital infrastructures, engaging in sustainable partnership initiatives, training and re-training of library and information science professionals, organizing of in-house training for library and information science professionals, recruitment of smart librarians, adequate funding were recommended.

Keywords: Smart libraries, smart campuses, developing countries, libraries

1.0 Introduction

The emerging of technology in the 21st century have been advantageous for every sector and human endeavor such as business, industries, government, academic institutions and library as well (Mishra, 2020). In contemporary society, technologies and related applications are applied in making modern education system smarter. Correspondingly, there are emerging technologies in the field of librarianship which when applied will enhance information service delivery. However, within the context of education, emerging technologies is giving birth to topical issues focused on smart activities such as smart campus and smart libraries. According to Ochola and Achrazoolou (2015), in the 21st century, technology enhanced learning (TEL) is presenting new ways to access learning in flexible formats. These flexible formats are transforming pedagogy by providing new ways to engage learners. The conventional campus is made up of an eclectic mix of buildings, including research facilities, libraries, offices, auditoriums, dormitories, classrooms, dining halls, and in this case a central steam-heating plant, industrial building chillers for air conditioning, thousands of lighting fixtures and exist lights (Shyr *et al,* 2018). The new development of information infrastructure in campus brings new opportunities to teaching and learning but also poses new challenges to traditional ways of thinking on campus (Kwok, 2015). Furthermore, many technologies are used in the smart campus development process, such as cloud computing, embedded computing artificial intelligence, biometrics, IoT technologies that are widely used on smart campuses and other smart applications (Ikrissi and Mazri, 2020). All these makes smart campus a child of necessity in educational domain.

Smart campus is a suitable and well-connected environment that aims to improve experience, efficiency and education. It uses a variety of interconnected components, smart applications and networked technology to facilitate communication, make more efficient use of resources, and improve performance, security and quality of campus services (Ikrissi and Mazri, 2020). Smart campus is a trendy application in the paradigm of the IoT. The concept of constructing a smart campus implies that the institution or universities will adapt advanced ICTs to automatically monitor and control every facility on campus (Apoorva *et al,* 2018). Nevertheless, there can be no smart campus without smart library.

The vision of smart library is to create an indoor living laboratory, where students and researchers can develop, test and presents smart technologies, access and analyze the collected data

to carry out both qualitative and quantitative studies also by applying different types of open source software as and when required accordingly (Khuntia Mishra & Ramesh, 2016).

Library technology as ruled by Sahoo and Panda (2019), plays a major role in providing smart library services to the library users. It ultimately saves valuable time of the user by obeying the fourth law of library science. In library applications, radio frequency identification (RFID) technology, sensors and wireless transmission networks have been applied to various services such as self-service checkout and return systems, electronic reader cards, intelligent bookshelves, intelligent monitoring of library premises, argument reality (AR) interactive picture books, physical corridors and seat reservations, in regional library alliances, real cross regional and cross-system alliance cooperation through IoT technology is becoming important (p.I). Undeniably, smart platforms provide new opportunities for promoting library and information services. Smart platforms improve the size, quality and accessible hours of library services and make it unnecessary for users to physically go to the library and use local computers to access library services.

The general objective of this paper is to present a discourse on the challenges of creating and managing smart campuses and smart libraries. The specific objectives are, to:

a. give an overview of smart campus and smart libraries;

b. highlight on the rationalization for smart libraries in smart campuses;

c. describe related technologies for smart libraries in campuses;

d. outline the challenges to effective implementation of smart libraries in smart campuses; and

e. state the way forward for driving smart libraries in smart campuses;

1.1 Smart Campus and Smart Libraries: an Overview

A smart context is a context where the human capital (and more in general each individual) owns not only a high level of skills, but is also strongly motivated by continuous and adequate challenges, while its primary needs are reasonably satisfied, i.e. Those placed at the lower levels of the Maslow's pyramid (Galego, Giovannella and Mealha, 2016). The word "smart" is commonly used to describe the ability of an object in presenting the intelligence that has been implanted in it. The word "smart" is printed on the phone to show its intelligence so as to as to support many

activities or everyday human life through various services provided (Muhamad *et al,* 2017). The term "smart" refers mainly to efficiency due to the use of technologies and to an automatization of processes to facilitate the working and everyday environment (Freyberg, 2018).Smart can be considered as very good at learning or thinking about things, showing intelligence or good judgment, or quick in action in handling problems (Kwok, 2015). The term "*smart"* means flexible, adapting extendible, acknowledging and human. The smart library is a hardware and software complex with a wide range of opportunities for searching and providing necessary information to virtual users according to their inquiries and requirements (Baryshev, 2021). Galego, Giovannella and Mealha (2016) see a "smart territory" as a digital infrastructure within the physical city to improve, among other aspects, environmental impact quality of life and economic growth. Smart territory at the long run gives birth to smart campuses and smart activities.

A Smart campus is a subset of smart city embedded with sensors and intelligent terminals on the concepts of cloud, Internet of things technology and related technologies synthesis (Nachandiya, Gambo, Joel & Davivar, 2018). The smart campus is not only about deploying campus-related services but is a broad concept that includes many electronic and physical objects that communicate and interact with each other (Ikrissi and Mazri, 2020). The architecture of smart campus based on the cloud computing and the internet of things consists of unified portal system, service support platform, data information, convergence platform, network convergence platform, as well as information standard system and security maintenance.

Smart campus is an entity of any kind that uses technology and infrastructure to support and improve its processes, so people can use them better (Sanchez-Torres *et al,* 2018). Smart campus is an idea that includes the scope modernization of smart education to develop smart classrooms. A smart campus starts with clear, reliable wired and wireless connectivity, indoors and out. Smart campus is a framework for evolvement of university campus to offer novel applications and services to the campus community through digitalization (Jurva, 2020). AbuAlnaaji, Ahmed and Saboor (2020) citing Villegas *et al* (2019) define smart campus as "an integration of three fundamental axes which includes: Data acquisition using IoT, data centralization and use of by data for the management and analysis. Here, the integration of axes allows the traditional campuses to be able to effectively manage that information generated within the campuses. Smart campus according to Jayawickrama, Sedky and Ettahali (2018), is a new idea in the development of ICT (Information and Communication Technology) within a university campus to improve the quality and performance of

the services, to reduce costs and resources consumption, and to engage more effectively and actively with its members.

Smart campus uses numerous devices such as tablets, laptops, phone, etc. and connected sensors and object which are generally designed to perform simple tasks and their components are relatively limited (Ikrissi and Mazri, 2020). A smart campus is an integrated campus environment of work, study and living based on the internet of things. This environment uses different kinds of application service system as the carrier and mixes teaching, science research, management and campus life together (Xiong, 2016). A smart campus deploys smart teachers and gives them smart tools and ongoing support to do their jobs while accessing their pedagogical effectiveness using smart evaluation forms (Abuelyaman, 2008). According to Ikrissi and Mazri (2020) smart campus services are not restricted to the academic aspect but also the campus environmental, financial and social aspects presented some potential applications of the smart campus as: Smart learning system; smart building; smart payment system; smart grid; waste and water management; smart parking system; smart library system; and tracking, security and surveillance.

Smart campus has emerged as an important concept of embedding technology in education. The internet of things (IoT) and cloud computing are the main fundamental of smart campus (AbuAlnag, Ahmed & Saboor, 2020). Smart campus is different from digital campus. The digital campus is characterized by: Technical environment (i.e. local area network, internet; Application = (Digital teaching resources, distance education, digital library and administrator of networks and management systems) – isolated systems; whereas in the smart campus, we have: Technical environment (IoT, Cloud computing, wireless network, mobile terminal, RFID); Application the smart system of sensory ability, interoperability, control capabilities, management systems (System sharing, intelligent push). To build a smart campus, it needs to build the digital infrastructure inside campus that can give services so that it will be beneficial for surrounding citizens (Apoorva *et al,* 2018).

1.2.1 Smart Library

Smart is a network enabling free access to all libraries. The term "smart library" appears in various contexts as a synonym for the concept of an "intellectual library" digital or "virtual library". The term "smart" means flexible, adaptive, extendible, acknowledge and human. Smart library is nothing but just a library solution in a digital way. It is also a very sophisticated true multimedia

streaming and digital delivery solution through a device and browser agnostic (Khuntia, Mishra & Ramesh, 2016).

Smart library is a hardware and software complex with a wide range of opportunities for searching and providing necessary information to virtual users according to their inquiries and requirements. The *Smart Library* (SL) is a library without a single physical lending item on the shelves, without books in print, library without shelves, just large cooled servers, whirring digitals archives linked through digital networks with machines for copying and distribution (Nahak & Padhi, 2019). The concept of SL is to serve all library services faster, better and smartly to its end users through digital technology in different software applications with the help of internet and intranet (Nahak & Padli, 2019). Chu (2019) sees *Smart Libraries* as an evolving concept. "Smart libraries" facilitate the integration of digital processes and informational feedback loops in the organizational infrastructure, whereby such integration is a desirable state for "smarter" institutions, i.e., more efficiency organized resource-friendly, flexible, sustainable, green, and socially inclusive. "Smart" refers to efficiency due to the use of technologies and to an automatization of processes to facilitate the working and everyday environment.

Smart library is designed to serve all library services faster, better and smartly to it's users through digital technology in different software applications (Khuntia, Mishra and Ramesh, 2016). Enterprises around the globe as observed by Jurva *et al* (2020) have been preparing their digital transition by the deployment of novel ICT and IoT systems to strengthen their operational functions on many levels. Many sectors of the society have initiated large programs to digitalize their functions (Jurva *et al,* 2020). Smart libraries aim to help every reader and user find the library information resources they want quickly, efficiently and accurately so that users can take their responsibilities, optimize the work of the entire library system, effectively shorten the time of information processing, improve the diversity of information resources and realize smart services.

3.0 Rationalization for Smart Campus and Smart Libraries in Educational Sector

The development in information and communication technologies ridicules a lot of changes in learning paradigms and creates new challenge on traditional campus at the same time (Kwok, 2015). The technological changes in building smarter learning environments will inevitably induce changes to teaching and learning practice and behaviours which in turn lead to the requirements in

modifying existing, or establishing new educational management systems to cope with the changing practice in teaching and learning as well as in administrative processes (Kwok, 2015).

The growth and the availability of the smart devices is becoming ubiquitous today and inter-networking of these devices make up what is commonly called the Internet of Things (IoT) (Jayawickrama, Sedky and Ettahali, 2018). According to Valks *et al* (2021), with smart campus tools, universities improve effective and efficient use of their spaces in the short term, by measuring the use of these spaces in real time and guiding students and employees to available spaces that match their needs.

The progress in smart technologies have influenced the educational sphere and offered opportunities for objects in our conventional campus to communicate with each other via communication technologies. The basic idea of smart campus is an effort to integrate a set of advanced intelligence technology by the university to improve the performance, the quality of the graduates, and the ease of life through the provision of information technology services that are valuable, dynamic and user-oriented to support automation and reporting in real time, not only for learning activities but covering a broader aspect, including social interaction, environment, office management, energy saving, e.t.c.. A key feature of smart campus is the rapid adaptation and reactions to change to fulfillment of user demand and the diversity of intelligence embedded in systems that support it (Muhammed, *et al,* 2017). A smart campus provides its students with reliable services anytime and anywhere access to the Internet is available.

The library information service of the future must be developed with a new system so as to feature useful information /knowledge and to deliver it efficiently. Moreover, if libraries do not create information and knowledge that promote library use, there will be no change in the user's perception of the library (Min, 2016).

Also, integration of smart library resources into online courses would enable students to conduct research online anywhere in the world using the library's resources provided there is internet connection. Students can have access to the campus smart library that will find, collect and synthesize relevant research information like a colleague (Chan & Chan, 2018). Yusuf, Ifijieh and Owolabi (2009) averred that users will obviously gravitate towards smart libraries when they experience quality service resulting from technology. According to Zhuang (2021), knowledge diffusion has put forward higher level requirements on the way of serving information resources in

university libraries, and the needs of readers and users have shifted from simply searching for information resources to more efficient access to information resources that meet their diverse new needs.

The library information service of the future must go beyond just providing passive and simple knowledge accumulation and become a smart library that facilitates active knowledge creation and provides services through collective intelligence (Min, 2016). It was noted further that the main reason why users do not actively respond to the information provided by libraries is that the latter have failed to create the information and knowledge needed by them.

Min (2016) posits that the change in the information environment caused by the advance of information and communication technologies has occasioned the need for new changes in the contents systems and services of libraries and data centers. Implementing smart libraries help mitigate risks. According to Khuntia, Mishra and Ramesh (2016), by participating in the program of smart libraries, libraries and information centres can demonstrate their progress in embedding cyber-safety and well-being in their library practices. As noted by Zhuang (2021), "as an important carrier of books, the difficulty of book management in libraries has increased, and the traditional manual management method is no longer suitable for the needs of modern book management, hence the need for better ways of providing library services.

4.0 Related Technologies for Smart Libraries in Smart Campus

The various technologies explained under this section can be effectively deployed for smart library services for sustainability of smart campuses.

4.1 Cloud Computing: Cloud Computing: this is a kind of internet-based computing that provides shared processing resources and data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services). Cloud computing is generally developed based on virtualization and distributed computing, parallel computing, grid computing, and powerful integrated computing. It is a model that allows access to services upon request (Service on demand), it can provide high performance scalability and elasticity. It offers high powerful data processing to be intelligently stored and used on the smart campus services (Ikrissi and Mazri, 2020).

Cloud computing is the integration of various resources extensively, and the offer of supercomputing and storage capacity which has three types of services - Infrastructure as a service platform as a service, and software as a service (Jayawickrama, Sedky & Ettahali, 2018). Cloud computing provide users and enterprises with various capabilities to store and process stored data in third -party data centers. Cloud computing has become a highly demanded service or utility due to the advantages of high computing power, cheap cost and services, high performance, scalability, accessibility as well as availability (Khuntia, Mishra & Ramesh, 2016).

Cloud computing technology is an internet based computing method through which some shared hardware resources and network information technology are made available to other computers according to demand and is a product of the convergence of computer development needs (Zhuang, 2021). Cloud computing refers to computing resources that exist in the cloud, external to an organization but accessible via the network. In other words, it is "the delivery of on-demand computing services - from applications to storage and processing power - typically over the Internet and on a pay-as-you-go basis". Examples: web-based email, data storage, and virtualized servers (Sahoo and Panda, 2019).

It is seen as the core of the realization of the Internet of things, using the cloud computing model which provides dynamic scalable virtualized resources of the computing model. It also has super storage capacity, which is also equivalent to the central nerve of the "brain" of IoT, with computing and storage capacity. IoT sensors and Internet operators interact with information through network lines and computer terminals to provide data to the cloud and receive technical services from the cloud (Zhuang, 2021).

Cloud learning occurs on the basis of cloud technology as it supports the use of software in the cloud to learn by providing data, storage and software that can be accessed in an online environment (Gupta, 2020).

4.2 ***Radio Frequency Identification (RFID):*** RFID refers to a system that transfers the information wirelessly, using radio frequency waves. It is automatic identification technology. In the library context, this system consists of smart RFID labels, hardware and software that provide libraries with more effective way of managing their data while providing greater service. RFID is an automatic technology that uses radio waves to track items by sending data to readers. The

application of RFID technology in a library can promote it's operational efficiency and precision (Sahoo and Penda, 2019).

RFID is a combination of radio-frequency-based technology and microchip technology. The information contained in microchips in the tags affixed to library materials is read using radio frequency technology, regardless of item orientation or alignment (Krishnan, Hemalatha and Giridharam, 2018). The technology works through thin smart labels, which placed on the side cover of each book in a library's collection Manual interactions are not needed for RFID-tag reading. RFID allows an item, for example a library book, to be tracked and communicated with by radio waves. This technology is similar in concept to a cell phone. RFID systems is used in libraries for book identification, for self-checkout, for anti-theft control. These applications can lead to significant servings in labour costs, enhance customer service, lower book theft and provide a constant update of collections of books. It increases the speed and efficiency of book borrowing, returning and monitoring, and thus free staff from doing manual work so that they could be used to enhance user-services task. However, the efficiency of this system is depending upon the information to be written in tag. To obtain best performance, RFID readers and RFID tags must be of good quality (Jachav *et al,* 2017).

RFID technologies has redefined various library related services and made every patron's jobs easier and efficient, from the patrons to the library professionals, as compared to conventional technologies like barcode. The main aim for today's libraries in adopting RFID is the need to increase efficiency and reduce cost (Krishnan, Hemalatha, and Giridharam, 2018). RFID in the library is not a threat if best practices guidelines followed religiously, that it sleeps up book borrowing and inventories and frees staff to do more user-service tasks (Krishnan, Hemalatha & Giridharam, 2018). The uses of RFID in libraries includes reduces staff stress, increase efficiency, track and locate items quickly, easier circulation, promote self-check-in and check-out activities.

RFID has the added advantage that it can also provide security for the range of different media offered in libraries. The technology can also improve circulation and inventory control, which helps-allocate human and financial resources. In other words, libraries can relieve their professional employees of routing work and operational tasks (Krishnam, Hamalatha & Giridharan, 2018).

4.3 ***Mobile Technology Applications:*** A mobile app can help to engage library patrons and ultimately increase library relevance. It is an ideal way to get patron's attention (Sahoo and Panda,

2019). Mobile devices now represent the majority of internet traffic. Goggle reports that over half of searches come from mobile devices (Breeding, 2018). According to Sahoo and Panda (2009), mobile applications for information seeker have grown up tremendously with the growth of mobile technology. In which case, libraries are adopting mobile technology to present their services and resources. A mobile app can help to engage library patrons and ultimately increase library relevance. It is an ideal way to get patron's attention (Sahoo and Panda, 2019). The benefits of mobile technology are: mobile apps will allow libraries to connect with patrons on the move; it can provide a wide array of library services to users like view and access library account; search library catalog; give alerts on latest news, events, and notices via sms; provide access to a variety of library resources and database; single window search facility; original document search; and qr codes for quick access of library catalog and important links.

4.4 Internet of Things (IoT): Internet-of-things technology has changed the educational landscape by allowing educators and administrators to turn data into actionable insights (Shyr *et al,* 2018). The birth of the Internet of things is the inevitable product and wisdom crystallization of the development of the Internet to a certain stage of world economic and social development and is a new technological revolution in the field of information technology (Zhuang, 2021). The IoT is a new effective communication medium for advertisement and information dissemination to promote a variety of concepts (Tu *et al,* 2017 in Shyr *et al*, 2018). The IoT signifies a technological revolution that represents the future of computing and communication, its development depends on dynamic (Shyr et al, 2018). Abdi (2018) defines IoT as a "network that consists of different objects which has the capability to organize things automatically, it also has ability to share information and give reactions and actions towards the environment. The Internet of Things is a service of science and technology, using sensor devices to connect objects and computer terminals, through computer control to achieve automatic and intelligent objects, and to achieve the goods and goods information by the Internet to pass and express, is the internal outward extension and expansion of the network, and is the user side of the exchange of information and communication between goods and good network (Zhuang, 2021).

The Internet of things provides "connected devices" and "smart devices by the internetworking of different physical devices, vehicles, buildings, etc embedded with various electronics, software, sensors, actuators and network connectivity that enables different objects to communicate (Benisha *et al,* 2019). Internet of things is new technology. It generally refers to the communication between

things like technological devices sensors, actuators and people with unique identities. Internet of things improves day to day activities of the users by minimizing the time things to be done (Addi, 2018). IoT is a technology that advances at a rapid pace based on the automation of tasks, for this reason, analyzing the design principles for cloud environment is necessary as well as taking advantage of known technologies such as sensors and standards, like W3C semantic sensor network ontology, a service provision scenario that can generate smart campuses (Sanchez- Tomes, *et al,* 2018).

IoT is a structure in which objects, people are provided with exclusive identity and the ability to relocate data over a network without requiring two-way handshaking between human-to-human or human-to-computer interaction. The Internet of Things (IoT) is a complex network that connects millions of devices and people with multiple services and objectives, through multi -technology, multi-protocol, and multi-platforms. IoT is a promising technology for the future with the development of the new generations of internet and with millions of devices getting connected to the Internet every day (Benisha *et al,* 2019). IoT is a new technology that is used for the interconnection of the devices to sense and monitor devices remotely.

Beneficially, the Internet of things (IoT) can help to provide big data about use patterns: by collecting real-time data on space utilization, users can make better use of current spaces and real estate managers can make better decisions about long-term demand (Valks *et al,* 2021). Internet of things is an ideal emerging technology to influence the patrons by providing new evolving and efficient services faster and more convenient (Gupta, 2020).

4.5 Wireless Technology

One of the wireless technologies is WiFi which is an IEEE 802.11 standard that is increasingly used, especially in enterprises and campuses with the aim of providing internet access to many devices. WiFi connections and provide free Internet access to users due to high performance, low-cost network and simple technical implementation (Ikrissi and Mazri, 2020). Another form of wireless technology is known and referred to as ZigBee. This also is based on IEEE 802.15.4 standard. Generally, it is used to create personal area networks with applications and devices that require a long battery life, lower data rate and secured networking. It is often used in monitoring and control applications whose data reliability power - efficiency, and affordability are crucial).

Wireless sensor networks (WSN) are composed by sensor nodes distributed to collect information. The constant flow of data handled in the wireless environment makes the system vulnerable to attacks at different levels (Sanchez-Torres *et al,* 2018).

However, sensor networks must have a QoS is the ability to guarantee that the required service for the network is supported, although it can also be seen as the ability of the network to customize the treatment of specific classes of data. The characteristics that a network must meet to offer quality of service (QoS) to a network of sensors are: priority; periodicity; term; availability; reliability; confidentiality; security; latency; variation and recovery of failures.

5.0 Challenges to Effective Implementation of Smart Libraries in Smart Campus

There are several challenges that limit effective implementation of smart libraries in the digital environment. The challenges predominantly experienced in developing countries include:

a. Shortage of smart librarians: evidence abounds that most library staff working in libraries found in developing countries are not fully digital compliant. The crux of the matter is that implementation of smart libraries requires the services of smart librarians. Smart librarians are librarians with the requisite skills and knowledge needed to navigate the digital terrain and manipulate digital tools with the aim of delivering information services to people within the digital environment. A smart librarian have full combination of technological tools management and information management and remain a driving force in the creation and management of smart libraries.

b. High cost of implementation: the implementation of smart libraries in smart campuses is cost intensive, more over it is no news that libraries are grossly underfunded in most developing countries. This apparently affects the implementation processes negatively. The cost of acquisition and installation of digital infrastructure needed for smart library within smart campuses is costly, except with intervention from external bodies and non-governmental organizations interested in educational development.

c. High cost of maintenance: beyond the availability of digital infrastructure for development of smart libraries is the problem of high cost of maintenance. Lack of maintenance culture due to poor administration processes or lack of requisite manpower need for full maintenance has in no small measure contributed negatively to the creation and management of smart libraries. It takes to

presence of smart librarians in the smart libraries to effectively manage smart libraries in developing countries.

d. *Lack of ICT skills among library and information science professionals:* the truth remain that most library and information science practitioners do not possess the even the basic ICT knowledge therefore engaging them fully in the implementation process of smart libraries without equipping them first with the requisite knowledge may hinder the process. It is still surprising that most library staff is yet to embrace technology and change the narrative in this present dispensation.

e. *Low level of partnership drive:* librarianship from time immemorial is a multidisciplinary profession but it is disheartening to note that librarians and library administrators hardly explore this window of opportunities; rather they are gripped with the fear of going extinct whereas the prospects are higher now than ever. The low level of partnership drive between librarians and other related professionals will have negative effects on the implementation process of smart libraries. Librarians should leverage on the fact that they can partner with expertise from other related disciplines in creating a suitable platform for managing and creating smart libraries.

f. *Unavailability of digital infrastructure:* the unavailability of digital infrastructure in our campuses may in no small measure affect the implementation process of smart libraries. Technologies remain the key driver in the implementation process, in situation where the basic digital infrastructure cannot be provided either due to high cost base on foreign exchange rate or other factors, then creating and managing smart libraries will be affected negatively especially in developing countries.

g. *Inadequacy of fund:* unavailability of fund to procure the basic digital infrastructure, install them and train the staff to a great extent will affect the possibilities of creating and managing smart libraries in developing countries.

7.0 Conclusion and Recommendations

The study has presented a discourse on the challenges faced in creating and managing smart campuses and smart libraries in developing countries. The bottom line of this paper is that librarianship as a profession is now in the technological age driving towards fourth industrial revolution where high tech is the driving force of every sectors. Nevertheless, creating and managing smart libraries are not without challenges which include low level or inadequacy of digital infrastructure, high cost of maintenance, lack of ICT skills among library professionals, low level of partnership drive.

In line with the discourse, the following recommendations were made:

1. ***Provision of digital infrastructures***: The key force driving smart campuses and smart libraries remain technological devices, therefore, library managers should ensure that adequate digital infrastructure are provided for effective creation and management of smart libraries. This can be achieved through collaborative effort. Heads of libraries in conjunction with heads of parent institution can engage in sustainable collaborative programmes with hi-tech institutions or agency. According to Abdulla and Esmaeel (2018), smart services require considering several strategic factors including the technical infrastructure, information and communication technologies available to the service to be provided and the access of the end users so the service and ease-of-use as well as the availability of other factors such as the rapid spread of smart devices and the high quality of mobile networks and the increasing demand for smart applications, high efficiency.

2. ***Engaging in sustainable partnership initiatives:*** The fundamental truth is that librarianship is a multidisciplinary profession and librarians must be ready to accept that fact and start engaging in sustainable partnership initiative that will provide the right platform for smooth implementation of smart libraries. In this knowledge age, it is imperative that library and information professionals take advantage of the multidisciplinary nature of the profession and change the narrative and create the future desired for the profession

3. ***Training and re-training of library and information science professionals:*** Library and information professionals should explore training and retraining as strategies for acquiring ICT skills. In view of this, various online platforms such as conferences, workshops, webinars can now be explored by librarians in the acquisition of ICT skills.

4. ***Organizing of in-house training for library and information science professionals***: In house training and workshops can be maximized as avenues for training librarians on new development in the profession such as the creation of smart libraries.

5. ***Recruitment of smart librarians:*** Smart librarians with smart skills should be recruited for effective transition from analogue to digital to smart library. Smart librarians will provide smart platforms for actualizing the creation and management of smart libraries. However, resources personnel's or facilitators can be pulled from ICT-related discipline.

6. ***Adequate funding of library development:*** Provision of adequate funding is a major determinant of the success of creating and managing smart libraries, especially in developing countries. Acquisition of digital infrastructure and retraining of library staff is not feasible without the commiserate fund provided. Heads of libraries must embrace lobbying and advocacy in order to attract funding and development of libraries

References

Abdi, A. (2018). Designing smart campus using Internet of things. *International Journal of Computer Science Trends and Technology (IJCST), 6(3),* 109 - 116

Abdulla, M. A. & Esmaeel, A. M. (2019). Providing information through smart platforms: an applied study on academic libraries in Serudi universities. *Journal of Education, Society and Behavioural Service, 30 (4),* 1 - 24.

Abnelayaman, E. S. (2008). Making a smart campus in Saudi Arabia: viewpoint. *EDUCAUSE Quarterly*, 2, 10 -

AbuAlnaaji, K., Ahmed, V. & Saboor, S. (2020). A strategic framework for smart campus. Proceedings of the International Conference on Industrial Engineering and Operations Management, Dubai, UAE, March 10-12, 2020

Apoorva, D. *et al* (2018). Smart integrated campus using IoT. *International Journal of Electrical, Electronics and Computer Systems, 6 (1),* 163 - 165.

Baryshev, R. A. (2021). From electronic to smart library systems; concept, classification of services, scheme of work and model. *Journal of Siberian Federal University, Humanities and Social Sciences,* 14 (3), 426 - 443. Doi: 10. 17516/1997-1370-0732

Benisha, M., Surya, A., Kumar, M. V. & Livingston, L. M. M. (2019). Smart librarian management system using IoT. Available online at: http://heb.nic.in/cass.studies.

Breeding, M. (2018). Smarter libraries through technology: the growing trend for shared technology infrastructure. *News and Analysis in Library Technology Developments, 38 (6),* 1 - 8.

Chan, H. C. Y. & Chan, L. (2018). Smart library and smart campus. *Journal of Science and Management,* 11, 543 - 564.

Chu, C. M. (2019). From smart to smarter libraries. MIT Capstone Conference, University of Pretoria and the Carnegie Corporations of New York

Galego, D., Giovannella, C. & Mealha, O. (2016). Determination of the smartness of a university campus: the case study of Aveiro. 2nd International Symposium "New Metropolitan Perspectives" strategic planning, spatial planning, economic programs and decision support tools, through the implementation of Horizon/Europe 2020. ISTH2020, Reggio Calabria (Italy), 18 -20 May 2016.

Gupta, A. (2020). Internet of things based book tracking system for smart library. *International Journal of Computer Science and Mobile Computing, 9 (7),* 12 - 18

Ikrissi, G. & Mari, T. (2020). A study of smart campus environment and its security attacks. The international Archives of the photogrammetry, remote sensing and spatial information science,

5th international conference on smart city Applications, 7-8 October, 2020, virtual satrambolu, turkey

Jadhav, C., J. *et al* (2017). Smart library management system using RFID technology. *International Research Journal of Engineering and Technology,* 4 (5), 2831- 2834

Jayawickrama, U., Sedky, M. & Ettahalio, O. (2018). A smart campus design: data-driven and evidence-based decision support solution design. ICDSST - Promothee Days 2018 Proceedings - The EWG – DSS 2018. International Conference on Decision Support System Technology & Promothee Days 2018, Heraklion, Greece, 22 - 25 May, 2018.

Jurva, R., Matinmikko-Blue, M. Niemela, H. & Hanninen, T. (2020). Smart campus 5G and IoT network preparations for operational mode: specification to deploy data and network management. ITS Online Event, 14 – 17 June, 2020, International Telecommunications Society (ITS), Calgary. http://hdl.handle.net/10419/224860/

Khuntia, S. K., Mishra, M. & Ramesh, D. B. (2016). Applicability of information technology in libraries with a step ahead to smart library in 21st century. *Indian Journal of Library Science and Information Technology*, 1 (1), 22 - 25.

Krishnan, S, Hemalatha, P. & Giridharan, S. (2018). A study on smart library management system. *Asian Journal of Applied Service and Technology (AJAST), 2(1),* 269 - 274.

Kwok, L. (2015). A vision for the development of i-campus. *Smart Learning Environments, 2(2),* 1-12; DOI: 10.1186/540561-015-0009-8.

Min, B. (2016). Improvement of smart library information services system for Saas-based Cloud Computing Service. http://dx.doi.org/10.5392/IJOC.2016.12.4.023

Muhamad, W., *et al* (2017). Smart campus features, technologies and applications: a systematic literature review; 2017 International Conference on Information Technology Systems and Innovation (ICITSI), Banding, October 23-24

Nachandiya, N., Gambo, Y., Joel, N.B. & Davwar, P. (2018). Smart technologies for smart campus information system. *Asian Journal of Research in Computer Science, 2 (2),* 1-7; DOI: 10.9734/AJRCOS/2018/450S1

Nahak, B. & Padhi, S. (2019). The role of smart library and smart librarians for e-library service. 12th International CALBER 2019. KITT, Bhubaneswar, Odisha 28 - 30 November, 2019.

Ochola, J. E. & Achrazoglou, G. J. (2015). Maximizing opportunities: smart learning spaces smarter interactions and collaboration. *Journal of Education and Human Development 4 (1),* 121 - 132. DOI: 10.15640/jehd.v4n1a12

Sahoo, S. & Panda, K. C. (2019). Library technology solutions for smart libraries: a comparative study of IIT Delhi and IIT Bombay Library System. 12th International CALIBER - 2019

Sanchez-Torres, B. *et al* (2018). Smart Campus: Trends in cybersecurity and future development. *Revista Facultad de Ingenieria 27 (47),* 93 - 101.

Shyr, N., Zheng, L., Lin, C., Lin, C. & Hsieh, W. (2018). Application of an energy management system via the Internet of things on a University campus. *EURASIA Journal of Mathematics, Science and Technology Education. 14(5)*, 1759 - 1765. https://doi.org/10.12973/ejmste/80790.

Valks, B. *et al* (2021). Towards a smart campus: supporting campus decisions with Internet of things applications. *Building Research and Information, 49 (1),* 1 - 20.

Xiong, L. (2016). A study on smart campus model in the era of big data. *Advances in Social Science, Education and Humanities Research, 87,* 2nd International Conference on Economics Management Engineering and Education Technology (ICEMEET 2016).

Yusuf, F., Ifijieh, G. & Owolabi, S. (2019). Awareness of internet of things and its potential in enhancing academic library service delivery in a developing country. Library Philosophy and Practice (e-journal). 2831. https://digitalommons.unl.edu/libphilprac/2831

Zhuang, Y. (2021). Optimization of the personalized service system of university library based on Internet of things technology. *Wireless Communications and Mobile Computing.* https://doi.org/10.1155/2021/5589505.