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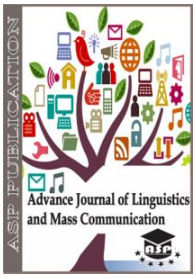

FROM TRADITIONAL TO SMART LIBRARIES: A NEW PARADIGM FOR INFORMATION ACCESS AND SERVICE INNOVATION IN DEVELOPING NATIONS

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Abstract
In this era of digital transformation, libraries are experiencing a significant transition from conventional information repositories to technologically advanced, user-centered smart environments. This paper therefore explores the concept of smart libraries, focusing on how emerging technologies are redefining the core library functions and services, especially in developing nations. It further explores the implications of these developments on information access, knowledge organization, user engagement, and library management practices. Drawing from current trends, this article provides a scholarly discuss on the impacts and challenges facing library and information professionals in developing nations in adopting smart technologies. The study concludes with strategic recommendations for fostering innovation, and reinforcing the evolving role of libraries as essential infrastructures in the knowledge society.

Introduction

The library concept is undergoing a significant transformation, evolving from a traditional repository of books arranged on shelves for readership to a technologically sophisticated, user-centered environment. This shift is largely attributable to the advent of emerging technologies, which are regarded as one of the most significant advancements contemporary science and technology have contributed to libraries. These innovations have fundamentally altered the traditional service model of libraries, enabling a technology-driven approach that allows users to access information globally and

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without restrictions. According to Mattel as cited in Schopfel (2018), the advancement in technology has positioned libraries as vital and technological-intellectual infrastructure within a broader framework of public services and knowledge institutions. Chukwueke and Onuoha (2019) identified various technologies that are instrumental in the transformation of libraries in the digital era. They are library management systems, which facilitate library automation, and radio frequency identification (RFID) systems that enhance access control, conservation, and security of print resources. Gupta and Singh (2018) further noted library bookmark applications, big data, and the Internet of Things (IoT) as some emerging technologies that enhance service delivery in libraries. Other notable emerging technologies include Augmented Reality (AR), Virtual Reality (VR), Quick Response (QR) barcode technology, cloud computing, social media applications, and Artificial Intelligence (AI) (Sheik and Olugbenga, 2019). These technologies are poised to significantly impact the access and delivery of information services by creating both physical and virtual hubs of knowledge consumption and production, thereby transforming libraries in developing nations to smart libraries.

Concept of Smart Libraries

Smart libraries represent an evolution in library services, facilitated by the integration of emerging technologies that enable the delivery of services through sophisticated machines that are programmed with artificial intelligence to respond to users' requests without the intervention of librarians. Zimmerman and Chang (2018) posited that the concept of smart library was first introduced by Aittola, Ryhanen and Ojala in 2003, and since then, libraries across the globe have been actively working to implement smart library system. According to Orji and Anyira (2021) smart libraries are smart due to their reliance on machines programmed to emulate the functions of trained librarians, thereby responding to user inquiries autonomously. In essence, a smart library comprises a combination of hardware and software designed to operate in a manner akin to that of human librarians. These libraries feature emerging technologies, including smart readers, electronic resources, intelligent environments, and eco-friendly services, alongside proficient librarians. In a smart library, all documents are stored and processed in digital formats, accessible via computers equipped with Radio-frequency identification (RFID) technology, standardized international Integrated Library Management Systems (ILMS), federated search tools, discovery tools, web-based Online Public Access Catalogs (OPAC), and standard digital software such as

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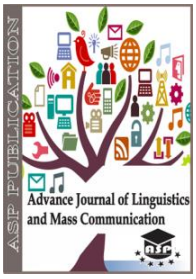

Dspace or E-Print, as well as content management systems (Nahak & Padhi, 2019).

A Smart Library is designed to operate without staff presence, allowing library users to access the facility independently. This is facilitated by technology that enables remote management of library infrastructure, including automatic doors, lighting systems, self-service kiosks, and public computers. Such advancements significantly extend library operating hours, thereby accommodating users at their convenience (Leicestershire County Council, 2021). The architecture of a smart library permits any authorized user with a computer and internet connection to access not only the library's resources but also a wide array of information available through national and international networks, without the necessity of being physically present in the library. Consequently, any library can be classified as "smart" if it allows users to access its building, resources, and services independently of library staff presence.

There are elements that make libraries smart. According to Orji and Anyira (2021) these elements are:

- ***Smart Services*** – Smart libraries are known for their smart information services which are based on artificial intelligence. By delivering smart services, the smart library fosters a digital ecosystem conducive for learning and research. As these technologies are embraced, traditional library services will undergo transformation and further development. The emergence of smart library services is a response to the evolving sophistication of information-seeking behaviors, as users increasingly require access to information at all hours. According to Nahak and Padhi (2019), smart library services are categorized as follows:
- Library Marketing & Promotion Service, Newsgroups/ Newsletter Services.
- Electronic Selective Dissemination of Information (E-SDI), Bulletin Board, Discussion Forum.
- Electronic Board Services, Atmospherics, Mash Ups, Linking different datasets.
- Ask the librarian /Contac us / Feedback Process, Webliography.
- Collaborative Digital Reference Services, Video Podcast.
- E -Document Delivery Services, Institutionalization /personalization–portals.
- RSS (Really Simple Syndication), Virtual Library Tours, Streaming Media.
- Value added, aggregator services, Open access publishing, Metadata schemas.

According to Leicestershire County Council (2021), the following services are rendered in a Smart library:

- Library materials can be borrowed, returned and renewed and payment of charges too using the self-service kiosks.

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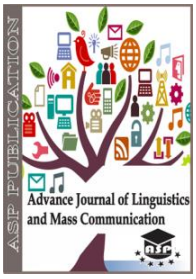

- Collect reserved items that are awaiting collection at the reservation collection point and borrow them using the self-service kiosks.
- Use the public PCs and free library internet WiFi.

However, due to the constraints of a limited workforce, libraries, especially those in developing countries are unable to fully meet this demand, prompting the adoption of smart library solutions.

- ***Smart people***– This comprise of Librarians who are actively carrying out library services in smart ways, and users who also utilize the resources of the library in smart ways. That is why Schopfel (2018) submitted that smart libraries are made for and with smart people. According to him, not only are smart library services user friendly and user-centered, they are also grounded in the vision or assumption of the smart library users an active (co)-producer of knowledge and not as a passive consumer of information. Imperatively, the smart library users are involved in creating, enhancing, and exchanging information and knowledge.
- ***Smart place*** – This element characterizes the physical space of the library, often referred to as "smart environment". In this environment, information is acquired, processed, disseminated and utilized in smart patterns.
- ***Smart governance*** – Smart governance emphasizes the community's role in recognizing the value of emerging information technologies in advancing and transforming libraries for a new environment. It involves the processes, procedures or systems deployed in delivering library services in smart ways. Smart governance in libraries encompasses features such as collaboration, cooperation, partnerships. Imperatively, through smart libraries, users become stakeholders of the library and thus take part in the library management and administration (Nahak and Padji, 2019).

Emerging Technologies for Smart Library Services in Developing Nations

The rapid technological advancement has become alarming and challenging among library and information professionals in developing Nations. These technologies come with various features, guidelines, and functions which make them thoroughly considered for driving efficient and effective library services. Based on this premise, Ramasany and Kadry (2025) noted the following as some emerging technologies that can be deployed for smart library services in developing nations.

- ***Artificial Intelligence (AI)*** –AI is the cornerstone of smart library services, offering innovative ways to improve efficiency, user engagement, and information accessibility. AI is engineered to perform a variety of tasks, including but not limited to speech recognition, learning, planning, perception, logical reasoning, and problem-solving. The algorithms

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integrated within AI systems enable them to predict outcomes, adapt to new information, make autonomous decisions, engage in continuous learning, and exhibit forward-looking capabilities in motion and perception (Saleh, 2019). These attributes render AI a valuable asset for enhancing smart library services. Furthermore, AI enhances smart library services in developing nations in various ways such as automated cataloguing and classification were AI algorithms can automatically categorize and index vast collections of digital and physical resources, thereby reducing human workload and increasing accuracy in organizing materials. AI can also be programmed to deliver information to users at designated time without requiring intervention from librarians. Imperatively, in developing countries where resources are limited and the demand for information access is growing, AI can extend services to remote communities through digital platforms, compensate for the shortage of skilled librarians by automating routine tasks, and supporting lifelong learning and digital literacy through more responsive and user friendly services

- ***Radio Frequency Identification (RFID):***RFID is a modern technology adoptedin libraries to enhance security and provide innovative services. it is a wireless technology primarily used for automatic identification by utilizing radio waves to detect, track, and identify various objects and people (Pal and Sharma, 2017).Its main components include a reader (or interrogator) and a radio frequency (RF) transponder that transmits data via electromagnetic waves. Additionally, RFID systems can store data on tags (transponders), allowing information to be written and updated. This means that data stored on RFID chips can be read and modified remotely. The information stored on RFID can be accessed and transferred using machine readable devices for different applications.

- ***Cloud Computing*:** Cloud computing is a developing technology that provides libraries with the ability to offer unlimited or continuous services to users. It is a highly adaptable model that enables libraries to create or develop their own applications, which can then be accessed by other libraries via the internet, while also offering a shared computing platform (Dastagiri and Kumar, 2017). According to Alizahed and Hassan (2013), cloud computing is a virtual platform that is user-friendly and allows on-demand access to shared computing resources such as storage, servers, networks, applications, and services, which can be quickly launched and implemented with minimal involvement from management or service providers.

- ***Internet of Things (IoT):*** The IoT represents an advanced phase of the internet that establishes a global communication network connecting humans and machines. It creates a worldwide infrastructure aimed at transforming fundamental aspects of human

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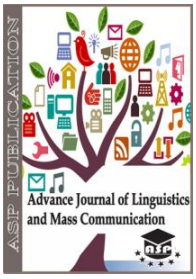

life, including library and information services. Emerging as a powerful technology, IoT integrates devices across various fields. These devices are interconnected to form specific functional systems and use nodes (sensors) to transmit information to users or other devices via the internet. IoT nodes are embedded in industrial machinery, mobile devices, medical equipment, and wireless sensors. The availability of affordable and intelligent devices leads to IoT networks being described as smart systems (Ramasany and Kadry, 2021), making them suitable for providing smart library services in developing nations.

- ***3D Printing:*** 3D printing technology has evolved from a layer-by-layer manufacturing process that creates three-dimensional (3D) structures directly from computer-aided design (CAD) files. This innovative technology has emerged as a versatile tool, opening up new opportunities and offering promising possibilities for libraries aiming to enhance printing and publishing efficiency. It has transformed the information industry in developing nations and altered production workflows. Additionally, 3D printing is increasingly utilized for mass customization and the production of various open-source designs across knowledge-based fields (Shahrubudin et al., 2019).
- ***Big Data:***Big Data refers to the development and application of technologies that deliver the right information to the right user at the right time from an ever-expanding volume of data in society. Originating from major web companies, Big Data offers a solution that enables users to access massive databases in real time. It encompasses a set of methods and technologies for analyzing complex datasets. The key characteristics of Big Data include velocity, veracity, volume, variety, and value (Riahi and Riahi, 2018).

Impact of Smart Libraries in Developing Nations

The impact of smart libraries in developing nations cannot be overemphasized. Generally, smart libraries facilitate systematic development of collections, stores, and organize information and knowledge in digital formats and provide easy access to information and knowledge in various locations with the aid of emerging technologies. According to Nahak and Padhi (2019), smart libraries are giving edge to library operations and service delivery in the following ways:

- ***Smart libraries support the extension of library operating hours and services:*** A smart library consists of various interconnected technologies that share data and information resources. This connectivity enables libraries in developing nations to extend its service hours, making it more accessible for users to visit at their convenience.
- ***Smart library facilitates access to information:*** The smart library contains in its holdings, information materials from different

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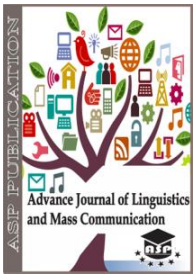

sources in different electronic formats which have been packaged, coded and arranged in ways they can be easily tracked and retrieved by users.

- ***Smart library eliminates geographic/location barriers:*** Their collections are distributed across various locations regardless of distance, allowing users to access them freely as long as regulatory policies or guidelines are not violated.
- ***Smart libraries promote space efficiency:*** They require minimal physical space for setup while being capable of storing collections ranging from millions to billions of items with ease.
- ***Smart libraries are cost-effective:*** Although the initial investment in technology can be substantial, the high quality, convenience, and exceptional services provided justify the expense.
- ***Smart libraries enhance the visibility of library services:*** By offering new and engaging experiences, smart libraries encourage users to share positive feedback, promote the library, and recommend it to others.

Challenging Factors of Smart Libraries in Developing Nations

Generally, and in developing nations, smart libraries are created to address technological advancements and shifts. The successful implementation is likely to be hindered by several issues, including insufficient training of library staff, differing ICT policies and infrastructure across countries, continuous technological changes before fully utilizing current systems, and network outages. Additional challenges facing smart libraries in developing nations according to Igwe and Sulyman (2022) include:

1. ***Technology Oriented*:** The effective and seamless operations of smart libraries in developing nations rely heavily on the use of emerging technologies. Consequently, these libraries face challenges due to the reliance on emerging technologies such as 3D printers, artificial intelligence, and cloud computing to make smart libraries function. This becomes a challenge for libraries in developing nations.
2. ***Insufficient technological expertise among librarians:*** Utilizing emerging technologies for smart library services in developing nations demands up-to-date ICT skills, knowledge, and competencies, which many librarians responsible for managing and operating smart libraries in these nations lack.
3. ***Unreliable power supply:*** Smart libraries require a consistent and stable power source since their efficient functioning depends on technology. Therefore, inadequate power supply presents a significant obstacle to their operation in developing nations.
4. ***Data privacy and security concerns***: Uploading information to the internet and cloud platforms makes it challenging for libraries in developing nations to

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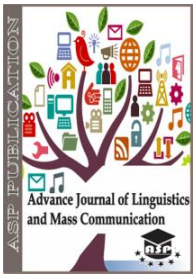

safeguard their own data as well as that of their users.

5. ***Fear of technology:*** Many librarians in developing nations are uncomfortable with ICT devices because they fear these technologies might replace their jobs. This mindset hinders the adoption and sustainability of new ICT-based services within these libraries.

Conclusion and Recommendation

The advent of smart libraries in developing nations has transformed library services and operations by enabling the creation, organization, preservation, conservation, distribution, accessibility, and utilization of library information resources through emerging technologies. These technologies have shifted library models from a just-in-case approach to a just-in-time approach. This transformation allows libraries to deliver services to users quickly, efficiently, and intelligently, resulting in extended operating hours, increased visibility, and the removal of time and location constraints.

However, smart libraries in developing nations face certain challenges that hinder their ability to surpass the services offered by traditional libraries. Based on the findings of this paper, the following recommendations are made:

1. Libraries in developing nations need sufficient funding to afford the latest technologies necessary for establishing and running smart libraries.
2. Librarians in developing nations should see ICT devices as tools that enhance the delivery of information services, rather than as threats that could jeopardize their jobs.
3. Librarians in developing nations ought to improve their ICT skills to build confidence in using these emerging technologies effectively for providing information services.
4. Librarians in developing nations should collaborate with other information professionals and stakeholders to develop the ICT infrastructure needed for advanced library services.
5. Librarians in developing nations must continually update their skills to stay competitive amid the challenges posed by the globalization of the information environment.

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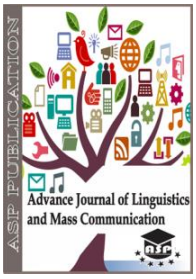

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