

Full Length Research

Smart Libraries: Shaping the Future of Academic Digital Libraries in Nigerian Universities

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Accepted 10 September 2025

The 21st century's technological advancements have benefited all facets of human endeavour, including government, business, industry, academia, and libraries. Technology and related applications are used in modern society to improve the intelligence of the library system. This paper examines smart libraries: shaping the future of academic digital libraries in Nigerian universities. This is to guarantee that libraries are used wisely in the modern day, utilizing digital gadgets and artificial intelligence equipment. It highlights the significance of the digital library and its components that makes it easier for users to access. Additionally, it shows the types of digital libraries that can function inside the institution's setup, regardless of size. It addresses the difficulties the library faces before creating a digital library of any kind in Nigerian universities. The paper concludes that academic libraries should make sure that sufficient digital infrastructure is available for the efficient development of smart libraries as they are still technical gadgets and recommends that libraries should receive sufficient funding so they can afford to buy the cutting-edge equipment required to launch and run smart libraries.

Keywords: Smart libraries, future of libraries, academic libraries, digital libraries, Nigerian universities,

Cite This Article As: BOLOGUN, OO., OLADEJI DO., OMOTADE, AM (2025). Smart Libraries: Shaping the Future of Academic Digital Libraries in Nigerian Universities. *Inter. J. Acad. Lib. Info. Sci.* 13(5): 182-188

Introduction

Scholars and intellectuals at various phases of human growth and societal change have defined libraries using information medium, services, users, and civilization as measurements. Additionally, libraries are collections of information resources that are collected, processed, organized, stored, accessed, disseminated, and used to satisfy users' needs for reading, research, reference, and leisure. As such, libraries must be among the organizations that adapt to changes in any society. Libraries have changed over time due to the necessity to adapt, particularly in this age of rapid technological innovation (Igwe & Sulyma, 2022). Libraries are social and technological-intellectual infrastructures that are crucial components of a wider network of public services and knowledge institutions, according to Schopfel (2018), who believes that libraries will continue to be relevant in society despite technological improvements. The library is a natural setting in the public domain that serves as a hub for information growth and exchange (Usman et al., 2021). Libraries fulfilled their mandates by integrating emerging technologies into their operations and services to offer their patrons intelligent and high-

quality information services by establishing both physical and virtual hubs of knowledge production and consumption. According to Orji and Anyira (2021) libraries are among the few settings where productivity and technology coexist with human and communal values. Furthermore, it is clear that as technology advances, human acceptance of it grows, making it a vital instrument that must constantly lead the way in supplying consumers with knowledge. Not only can emerge technology speed up library services, they also make them more intelligent. Smart in the sense that using new technologies will result in services that are user-friendly and focused on the needs of the user, and when users receive high-quality service, they will choose smart libraries (Yusuf et al., 2019). Thus, this study will investigate smart libraries, the future of academic digital libraries in Nigerian universities.

Literature Review

Smart Libraries

Smart is a network that allows free access to all libraries. The term "smart library" is used in a variety of contexts as a synonym for the concept of an "intellectual library," digital library, or "virtual library." The term "smart" means flexible, adaptable, extendible, acknowledgeable, and human. A smart library is simply a library solution in a digital format; it is also a very sophisticated true multimedia streaming and digital delivery solution that is independent of device and browser (Ekere et al. 2022). The Smart Library (SL) consists of massive, cooled servers, spinning digital archives connected by digital networks, copying and distribution equipment, and no actual lending items on the shelves or books in print (Nahak & Padhi, 2019). The idea behind SL is to leverage digital technology in various software programs with the aid of the internet and intranet to provide all library services to its patrons more quickly, effectively, and intelligently (Nahak & Padli, 2019). Chu (2019) sees Smart Libraries as an evolving concept. A desirable state for "smarter" institutions, that is, more efficient, resource-friendly, flexible, sustainable, green, and socially inclusive is the integration of digital processes and informational feedback loops into the organizational infrastructure, which is made easier by "smart libraries." The term "smart" describes efficiency brought about by the application of technology and the automation of procedures to improve the working and daily environments.

Smart libraries have developed as a result of the most recent technological advancements, which enable the provision of library services by depending on complex machines that are programmed with natural intelligence to react to user requests without the assistance of librarians. Because smart libraries rely on using machines that have been programmed with human intelligence to carry out library tasks as though they were trained librarians, Orji and Anyira (2021) confirmed that smart libraries are smart. In summary, a smart library is a collection of installed hardware and software that functions as a librarian in clever ways.

A smart library, according to Cao et al. (2018), is an inventive fusion of cutting-edge digital and automated technology with conventional library systems to improve user experiences and expedite library operations. Smart libraries use technologies like artificial intelligence (AI), machine learning, data analytics, and the Internet of Things (IoT) to provide seamless, effective, and user-friendly services while fusing the best aspects of traditional learning environments (Bi et al., 2022; Indraj, Dominic, et al., 2024; Indraj, Naikar, et al., 2024; Jaganbabu et al., 2024; Naikar et al., 2024). Resources like books, journals, and multimedia are digitized and arranged into user-friendly databases in a smart library. Through self-service kiosks or mobile applications, automated systems manage standard procedures such as book borrowing, returns, and catalog updates (Adetayo et al., 2021). Real-time book tracking is ensured by clever features like RFID (Radio Frequency Identification) tags, and AI-powered chatbots and recommendation engines offer tailored support and recommendations according to customer preferences (More & Naikar, 2021).

Academic Digital Libraries

Paperless libraries, virtual libraries, electronic libraries, desktop libraries, polyglot libraries, libraries without frontiers, and more recently, digital libraries are some of the words that have been popular at different points in time. Broadly speaking, a digital library is a computerized system that gives users a logical way to access an ordered, electronically stored repository of data and information, a collection where all of the contents of documents are produced, transformed into a computer format that can be accessed online, and databases on the internet and information items on CD-ROM. Information repositories are stored on computer storage devices such optical discs, DVD ROM towers, and juke bases. Internet-based database that includes a library, catalog networked, computerized library system. (Dalve & Suradkar, 2018)

The size and scope of digital libraries can vary greatly, and either individuals or organizations can curate and maintain them. These information retrieval systems have the potential to share data with one another, fostering interoperability and sustainability. The digital content can be stored locally or accessible remotely over computer networks. An era of

unparalleled change in the accessibility, distribution, and consumption of information has been brought about by the digital age. Libraries, which are frequently seen as ancient establishments with roots in the printed word, are situated at the nexus of tradition and innovation in this ever-changing environment. Libraries have had to adapt to the shifting demands and expectations of their users as the world becomes more digitally connected. Aspects of this significant transformation include the shift from physical to digital formats, the incorporation of state-of-the-art technologies, and the redesign of library facilities. (Patil & Shingade, 2024)

Elements of Academic Digital Libraries

Shingade and Patil (2024), digital libraries are complex systems made up of a variety of elements and components that are intended to make it easier to store, organize, retrieve, and distribute digital resources. Digital Resources: Digital libraries are made up of a wide range of digital resources, such as text documents, e-books, academic journals, audio recordings, videos, images, maps, datasets, and more. These resources are stored in digital formats and are accessible through computers and the internet.

Content Management System (CMS): A CMS is the foundation of a digital library, allowing for the cataloging, organization, and storage of digital resources. A strong CMS guarantees effective asset management and retrieval.

Metadata: Digital libraries offer search functionality to enable users to locate resources efficiently. Advanced search options, filters, and sorting capabilities enhance the user experience and make it easier to find relevant materials.

Mechanisms for Search and Retrieval: To help users find resources quickly, digital libraries offer search capabilities. Finding pertinent content is made easier with the use of sophisticated search tools, filters, and sorting features.

User Interfaces: This is front-end elements that users interact with when they access a digital library are known as user interfaces. In order to accommodate different devices and user preferences, they should be responsive, easy to use, and intuitive.

Authentication and Access Control: To protect copyright and regulate access to specific content, digital libraries commonly employ authentication and access control systems. This ensures that only authorized users can access specific materials.

Digital Preservation: To protect digital materials throughout time, preservation techniques are essential. Preservation strategies are used by digital libraries to guarantee the long-term usability, accessibility, and integrity of digital content. Citation management tools, reference services, interlibrary loan services, and user support are just a few of the capabilities that fall under the umbrella of user services. These services offer extra value and improve the customer experience.

Collaborative Tools: To encourage user participation and engagement, several digital libraries provide collaborative features including social sharing, discussion boards, and annotation tools.

Accessibility Features: To guarantee that people with disabilities can access and utilize the materials, digital libraries should be created with accessibility in mind. Features like screen reader compatibility and multimedia content with captions may be part of this.

Security Measures: To safeguard user data and digital resources, security is essential. Digital libraries use intrusion detection systems, firewalls, and encryption, among other security measures.

Interoperability: Interoperability allows digital libraries to exchange data and resources with other systems and libraries. Platform interoperability is made possible by standardized protocols and information formats.

Analytics and Usage Statistics: To monitor user behaviour, resource usage, and other metrics, digital libraries frequently come with analytics tools. Libraries can use this data to evaluate how well their collections and services are working.

Digital Rights Management (DRM): To ensure adherence to intellectual property rules, DRM systems are used to handle copyright and licensing limitations for digital materials.

Mechanisms of Feedback: User reviews, ratings, and surveys are examples of feedback methods that give patrons the chance to offer suggestions and assist libraries in enhancing their offerings. In the digital age, digital libraries are essential for promoting research and education, easing information access, and conserving cultural heritage. They are always changing as technology does.

Types and Examples of Academic Digital Libraries

Kunjam&Chawda (2020). explained the types of academic digital libraries and how to access them as follow:

Stand-alone Digital Library (SDL): This is a fully computerized version of the standard classical library. Simply said, SDL is a library with digital resources (i.e., electronic, scanned, or digitized). The content is centralized and localized, and the SDL is self-contained. It is actually a computerized version of the traditional library that has been enhanced by the advantages of computerization. The Israeli K12 Portal Snunit (<http://www.snunit.k12.il>) and the Library of Congress (LC) and its National Digital Library (NDL) (<http://www.loc.gov>) are two examples of SDLs.

Federated Digital Library (FDL): This is a federation of multiple separate SDLs that are connected on the network and arranged according to a shared theme. A networked library with a transparent user interface is created by combining multiple independent SDLs into an FDL. The several heterogeneous SDLs are linked together through communication networks. Since the various repositories use different metadata formats and standards, interoperability is the main obstacle to building and maintaining an FDL. The Networked Digital Library of Theses and Dissertations (NDLTD) (<http://www.ndltd.org>) and the Networked Computer Science Technical Reference Library (NCSTRL) (<http://www.ncstrl.org>) are two examples of FDLs.

Harvested Digital Library (HDL): This is a virtual library allowing summary access to similar material distributed around the network. A HDL maintains only metadata with pointers to the holdings that are “one click away” in Cyberspace. By definition, an information specialist (IS) harvests (converts into summaries) the material stored in the libraries. A HDL, on the other hand, is subject-focused, finely grained, and has typical DL features. The IS, which is also in charge of annotating the library's items, maintains its rigorous quality control and offers a wealth of library services. Section 3 goes into greater detail about the HDL harvesting model. The Virtual Library (<http://www.vlib.org/>) and the Internet Public Library (IPL) (<http://www.ipl.org/>) are two examples of HDLs.

Examples of Some Academic Digital Libraries and How to Access Them.

- i. LOC - Library of Congress American Memory (<http://memory.loc.gov/ammem/>)
- ii. NSDL - National Science DL (<http://nsdl.org>)
- ii. IPL - Internet Public Library (<http://www.ipl.org>)
- iv. CDL - California DL (<http://www.cdlib.org>)
- v. ADL – Alexandria DL (<http://www.alexandria.ucsb.edu>)
- vi. BL - British Library (<http://www.bl.uk/>)
- vii. NZDL – New Zealand DL (<http://www.nzdl.org/>)
- viii. Einstein Archives Online (<http://www.alberteinstein.info/>)
- ix. IEEE Digital library – (www.ieeedl.com)
- x. ACM Digital library – (www.acmdl.org)
- xi. Networked Digital Library of Theses and Dissertations (NDLTD)-(<http://www.ndltd.org>)
- xii. ArticleCentral.com! (<http://www.articlecentral.com/>)

Importance of Academic Digital Libraries

Dalve and Suradkar (2018) described the importance of digital libraries as follow:

Implementation of I.T. environment

It is a significant factor in the context of library information technology, which can be a potent ally in enhancing education and, consequently, competence for full employment through the integration of computer technology with communications, digital imagery, full-motion video, and sound. But libraries will need to adapt in order to accomplish this. Education and competence are being improved by the shift from traditional to digital.

2. Speed

We feel that speed increases as we move from traditional to digitalization concepts, and this speed element may be recognized in terms of office worker or student/user functioning. The user can access information more quickly thanks to digitization. A digital library gives users access to resources. The most recent information is available to the user in a digitalized environment. The user has access to a higher number of datasheets. Through a digital library, the user can also access information from around the world.

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4. Supporting Power

According to the digitalization concept, a greater variety of materials are supported by the digital library. Additionally, it improves the capacity to handle huge datasheets.

5. Space Power

The space power is increased by the Digital Library. It indicates that we are developing a portable material system. As technology advances, so does portability. For instance, a DVD system or compact disk reduces and stores larger data. Thus, there isn't a storage issue.

Challenges before Academic Digital Libraries

1. **Cost Limitation:** It is more expensive in the beginning to set up a digital system in a traditional library system.
2. **Skill person:** We want a skilled individual to develop and maintain digital systems if we wish to
3. **Effect of Technology:** Impact of Technology: Both hardware and software have advanced in recent years. The digital library is entirely reliant on computers and telecommunications. The digital system should adapt to new technologies as they become available.
4. **Security issue:** The main issue with our digital systems while they are online is security. Preventing unwanted access and preventing viruses from infecting the data is a huge effort.
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Smart Libraries Shaping the future of digital Academic Libraries

Kumar and Chikkamanju (2024) identified the following smart libraries technologies for shaping the future of digital academic libraries.

Cloud Computing: Anything involving the delivery of hosted services via the internet as opposed to direct access from a desktop or internal server is referred to as cloud computing. It offers location-independent network connectivity and allows for internet access for several users. In order to provide quicker innovation, more flexible resources, and economies of scale, cloud computing involves delivering computer services such as servers, storage, databases, networking, software, analytics, and intelligence through the internet.

Pressure Pad Sensor: Wi-Fi technology enables the pressure pad sensor, which is made up of a thin sheet sensor pad and is connected to a processing unit that records and manages the system. In order to increase the collection of books in specific stacks and provide adequate information, pressure pad sensors in the aisle beneath the floor are used to record the movement of users in that aisle on a regular basis. These sensors also connect to the library's energy system to reduce energy loss.

Magic Mirror: A technology called a "magic mirror" might be installed in libraries to detect the title that a patron is holding, suggest more library resources, discuss relevant events, and provide a preview of the books. As technology develops, magic mirrors find many uses. It includes a camera, a sensor, and Wi-Fi-enabled computer-human interaction. It delivers

a variety of information, including location recognition, content assessment, and comparable content. Additionally, the database contains the user review information. This system will become widely used very quickly, and it will be crucial to apply cutting-edge techniques to create user interfaces that are easy to understand.

Wireless Sensor Network: A wireless sensor network is a collection of spatially distinct and specialized sensors used to track and document an object's physical state and arrange the information gathered in one central location. Recent developments in wireless communications and low power integrated circuits have enabled low power small devices for remote sensing applications effectively available and reasonably priced. Combinations of these elements have made it more feasible to use a sensor network made up of many intelligent sensors, which allows for the gathering, processing, analysis, and sharing of important data collected in a range of settings.

Radio Frequency Identification: Library administration uses this service. It makes it possible for books to be checked in and out on their own. Books and student ID cards are both equipped with RFID tags. The library database already has information about the students and the books. The student's full information appears after scanning his ID card. The book is assigned to that specific pupil when the details are obtained by scanning the book. Security doors guard the entire system, preventing users from accessing it without first scanning their RFID tags.

Wireless Technology: One of the wireless technologies is Wi-Fi, an IEEE 802.11 standard that is being utilized more and more, particularly on campuses and businesses, to give numerous devices access to the internet. Due to their excellent performance, inexpensive network, and straightforward technical installation, Wi-Fi connections offer users free Internet access (Ikrisi and Mazri, 2020). ZigBee is a brand name for another type of wireless technology. The IEEE 802.15.4 standard is also the basis for this. It is typically used to build personal area networks with devices and applications that need secure networking, modest data rates, and long battery life. It is frequently employed in control and monitoring applications where price, power efficiency, and data reliability are essential.

Conclusion

Academic libraries should make sure that sufficient digital infrastructure is available for the efficient development of smart libraries as they are still technical gadgets. The administration of the library and the leaders of the parent institutions can work together to accomplish this by implementing long-term cooperative programs with agencies or institutions that specialize in high technology. Data and information can now be visualized because to the widespread use of digital tools. For smart libraries, this has created new opportunities. The current generation demands clever, environmentally friendly, and sustainable information systems, which necessitates rapid focus. Libraries and information centers must successfully implement digital technology in order to improve the quality of their services in this new era of information technology.

Recommendations

The following recommendations are hereby made:

1. Libraries should receive sufficient funding so they can afford to buy the cutting-edge equipment required to launch and run smart libraries.
2. Rather than viewing ICT devices as a rival that will force them out of business, librarians should view them as tools that facilitate the efficient and successful delivery of information services.
3. Librarians should improve their ICT proficiency in order to boost their self-assurance in interacting with ICT resources, navigating them, and making the most use of them to provide information services.
4. To implement the ICT infrastructures needed for advanced library services, librarians should cooperate and work with other information practitioners and stakeholders.
5. To stay competitive and address the challenges posed by the globalization of the information landscape, librarians should constantly improve their abilities.

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