Delta Journal of Computing, Communications & Media Technologies (DJCCMT)
Journal platform–https://focjournals.dsust.edu.ng

Mobile Library Services Revisited: Application, Prospects, and Challenges

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ARTICLE INFO

Article history:
Received July 2024
Received in revised form Dec. 2024
Accepted December 2024
Available online Jan 2025

Keywords:
Mobile Technology
Mobile Library Services
Academic Libraries
Nigeria

ABSTRACT

The rapid growth of the mobile technology market has prompted libraries to explore and adopt mobile solutions to enhance their services. This review examines the innovative strategies forward-thinking libraries are employing to leverage mobile devices, exploring the evolving role of librarians in utilizing these technologies. It highlights a range of mobile applications, including mobile internet access, mobile hypermedia, and SMS/text messaging, that support library functions and improve user experience. The review also addresses challenges faced by academic libraries in Nigeria, such as insufficient funding, unreliable electricity, and limited ICT skills among librarians, which hinder the adoption of advanced technologies like mobile augmented reality. To bridge these gaps, the review recommends investing in alternative power sources and upgrading telecommunication infrastructure, which are critical to promoting the growth of mobile library services and ensuring their widespread accessibility.

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https://doi.org/10.xxx.
DJCCMT112025016

1. Introduction

In the era of information overload, providing users with timely and relevant information has become increasingly complex. Mobile devices, such as smartphones and Personal Digital Assistants (PDAs), have revolutionized access to information, enabling users to retrieve data quickly and conveniently from virtually anywhere—whether at home, in the office, or while on the move. This shift has popularized the concept of "libraries in the palm," facilitated by the advancement of mobile technologies. Mobile devices now offer an efficient means of accessing remote information, transforming the way information is consumed. Many institutions and educational establishments have integrated computer-accessible electronic collections within their libraries, and smartphones have emerged as a viable alternative for accessing e-libraries (Kumbhar & Pawar, 2015: Nwankwo, 2017; Nwankwo, 2018).

Azubike (2018) and Ubogu (2021a) highlighted that digital libraries can be accessed through smartphones, providing users with an opportunity to engage with e-collections from personal devices. As personal gadgets, smartphones leverage geographic locations and search histories, enabling the delivery of more tailored and context-sensitive information and services. The rapid growth and omnipresence of mobile technology have made it an integral part of modern life, shaping new communication patterns and transforming how individuals connect with and organize information. Mobile phones have significantly altered both communication and information access, particularly in regions like Nigeria, where mobile devices have become indispensable in daily life. Nigeria was ranked first in Africa for internet usage in 2015 and eighth globally in terms of mobile phone subscriptions, with 86,436,611 internet users (Bilawar, 2015).

Verma (2014) and Ubogu (2022a) observed that Nigeria ranked 17th globally in 2015 for mobile phone penetration, with over 23.1 million cell phones in use, a figure projected to exceed 39 million by 2019. Given that a significant proportion of these mobile device users reside in higher education institutions, the incorporation of mobile information services into educational libraries in Nigeria is critical. This review explores mobile library services in Nigerian university libraries, examining the global context of mobile library services while considering the benefits, challenges, and future prospects of these technologies.

Odu and Omini (2017) asserted that the proliferation of information and communication technologies (ICTs) has accelerated access to information, compelling libraries to reassess and adapt their services in response to technological innovations. The widespread adoption of ICTs has not only changed the methods by which individuals access information but also introduced new communication channels. A key development in this technological transformation is the advent of portable devices like mobile phones, which, according to Domingo and Gargante (2016), have revolutionized library information services, replacing traditional models. Mobile technologies now enable users to communicate and retrieve data in a highly efficient and convenient manner, reshaping the relationship between libraries and their patrons and introducing new considerations for user privacy. As the educational landscape continues to evolve from distance learning ('d-learning') to e-learning, and now further towards mobile learning, these technological shifts have become central to the transformation of education systems worldwide, including in countries like India (Nalluri & Gadam, 2016).

The aim of this paper is to critically review the innovative strategies by which libraries leverage mobile technologies to enhance service delivery, and to examine the challenges and propose actionable recommendations for fostering the growth and accessibility of mobile library services in Nigerian academic libraries. The specific objectives are to:

1) Investigate the range of mobile applications—such as mobile internet access, mobile hypermedia, and SMS/text messaging—currently employed by forward-thinking libraries to support core functions and improve user experience.
2) Analyze how professional responsibilities and skillsets of librarians are changing in response to the integration of mobile technologies into library workflows.
3) Assess the key barriers faced by Nigerian academic libraries in adopting advanced mobile services, focusing on insufficient funding, unreliable electricity supply, and limited ICT competencies among staff.
4) Appraise the potential of cutting-edge mobile solutions—particularly mobile augmented reality—to further enrich academic library services.
5) Develop practical recommendations, including investment in alternative power sources and upgrades to telecommunication infrastructure, aimed at bridging current gaps and ensuring the sustainable, widespread accessibility of mobile library services in Nigeria.

1.1 Mobile Technology

Mobile technology encompasses a wide range of devices, including those found in automobiles, laptop computers, personal digital assistants (PDAs), smartphones, and cell phones. These devices integrate hardware, networking infrastructure, operating systems, and software to create an interconnected ecosystem (Nwankwo et al,2023; Victor-Ikoh et al,2022). Mobile technology serves as a communication medium for transmitting various forms of data, including speech, video, text, images, and more, through unguided transmission techniques such as radio waves, infrared, and Bluetooth. These technologies are typically embedded in handheld information technology devices or artifacts, which combine physical components, software applications, and communication messages to facilitate interaction (network services).

Mobile technology spans all cellular communication protocols, including Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA), High-Definition Multimedia Interface (HDMI), Time Division Multiple Access (TDMA), and other handheld communication plans. Due to the inherent interdependence between information and communication, mobile technology is often regarded as both an information conduit and a communication platform (Shonhe, 2019). The adoption of mobile devices provides users with a high level of convenience, adaptability, freedom, and mobility, transforming the way information is accessed and exchanged in both personal and professional contexts.

1.2 Prerequisites for Implementing Mobile Based Library Services

Mobile technology must be used in conjunction with digital technology because it is unlikely that it can deliver the essential service alone. The following requirements must be satisfied at the very least for basic implementation in an information environment, according to Ubogu and Chukwusa (2022) and Ejiroghene (2020):

a. Digital information repository
b. Classification system for digital access.
c. Digital information services dissemination
d. Accessibility of websites around-the-clock, authentication and protection have become crucial in wireless networks to prevent data being stolen or harmed.
e. Type of services to be offered on handheld gadgets and the sorts of diplomacies that can be utilized, a carefully organized possibilities analysis is essential.
f. Library's physical and virtual environments where users of portable electronics and gadgets can interact with them; and it is crucial to make the library's website, online catalogue, and catalogues responsive for mobile devices and to roll out new services whenever practical.

1.3 Skills Required for Mobile Library Services

According to Chukwusa (2021) and Moreira, Ferreira, Santos, and Durao (2017), the skills that are required to be learned and utilized by librarians who are interested in developing services that utilize handheld devices include:

a. Knowledge of handheld device hardware and software, as suggested by Create or alter material that is mobile-optimized, including databases, virtual visits, adaptive and collaborative collection homepages, and OPAC.
b. Knowledge of internet/intranet services like SMS, spam filtering, and e-mail. Learn how to safeguard privacy and security when more individualized information is released.
c. Utilizing mobile devices for library services
d. Knowledge of mobile web apps including push electronic mail, as well as search and navigation techniques for handheld gadgets.
e. The ability to communicate with operators through smart phone queries, mobile-friendly websites, and intermediary third-party customers.

1.4 Mobile Library Services and New Ways of Information Delivery

Due to improvements in mobile technology devices with diverse capabilities, scholars in India employed such gadgets for routine data demands in addition to educational purposes. (Hwang, & Chang, 2011). They developed into a vital aspect of human existence. A more sophisticated version of e-learning is mobile knowledge or M-learning. The difference is that mobile technology is being used to facilitate M-learning. For instance, Hwang and Chang (2011) noted, in India, undergraduates can get prompt evaluation and feedback from their lecturers via a mobile device. A head-on course will be improved by introducing QR codes, or rapid response codes, that connect users to supplementary content on the Internet.

Hamad, Farajat, and Hamarsha (2018) claimed that administrative responsibilities, including monitoring attendance and academic progress, may additionally be done via mobile devices. Two-dimensional barcodes, also referred to as fast response codes, are referred to by the trademarked name quick response code (QR code). In comparison to a standard barcode, two-dimensional in-nature QR codes can store several hundred times more data or information. QR code readers use mobile devices, computers, and tablets to scan codes created by QR code printers. A QR code can store data in any direction, both horizontally and vertically, including records, scripts, hyperlinks, connections, almanac information, and communication reports. Tel Dei (2020) and Ubogu (2022b) noted that a significant number of academic libraries worldwide, including those in India, the United States, and Europe, had incorporated QR codes into their regular library administration activities. Some of the most popular uses of QR codes in libraries include scheduling group study rooms, scheduling library audio tours, advertising and promotional materials, linking from print to electronic journal holdings, offering an electronic replace for physical books, promoting online audiovisual resources, embedding video help, and offering an electronic alternative for physical books.

1.5 Mobile Devices Used in Libraries

A Personal Digital Assistant (PDA), sometimes known as a handheld PC, is a portable computer used to manage personal information. PDAs have effectively been superseded by the quick uptake of powerful smart phones, particularly those executing iOS and Android. Nowadays, almost all PDAs come equipped with an Internet connection feature. Because it features an electronic film display, a PDA has a web browser. Acoustic capabilities are included in a large number of copies, making it feasible to use them as phones and portable media players. The majority of PDAs use Wi-Fi, commonly referred to as broad-area networks, to connect to the Internet, intranets, and extranets. PDAs occasionally use touch screen technology in place of buttons. The phrase "personal digital assistance" has lately been utilized again in the technology sector. The phrase is most frequently used to describe voice-recognition software that replies to customer inquiries (Sabah, 2016).

In addition to being a specific type of mobile phone, smart phones double as portable computers. They differ from other phones in that they have more sophisticated hardware and widely adopted mobile operating systems that enable expanded software, Internet (plus network surfing above mobile broadband), and software functionality (with music, film, cameras, and betting), in addition to standard telephone features like voice calls and text messaging. Numerous MOS integrated circuit (IC) chips, a lot of hardware that can be used by the software, such as a magnetometer, proximity sensor, indicator, and gyroscope, as well as the ability to support Bluetooth or cable navigation, are frequently found in smart phones. In order to transfer calls between places, cell phones use a network of low-powered radio masts, each of which has its own topographical region (called a "cell") and a unique processing address. Cell phones are wireless

telephones that provide widespread access to portable phone service. One of a wireless phone's auxiliary features is internet access (Hwang & Chang, 2011).

Portable CD players that can read and play MP3 audio files from CDs are known as MP3 CD players. When these players' first components were released, they were frequently a more affordable alternative to hard drive or flash-based players. Due to their sluggish rotational disk speeds, CD players are more susceptible to file skipping or other misreads when subjected to uneven acceleration (shaking) during playback. However, compared to players who use hard drives, player mechanics may be more robust and less prone to irreparable damage (Roy, Das, & Majumdar, 2016). A huge library will necessitate the usage of multiple CDs because a CD can only hold about 700 MB of data. However, some more advanced devices can read and playback recordings on larger-capacity DVDs. Some of them can even replay and show filmed content, such as movies (Kari, 2019).

A tablet computer, sometimes known as a tablet computer, is a mobile device that integrates a touch screen display, a rechargeable battery, and a mobile operating system in a single, thin, and flat container, according to Ubogu (2020). Tablet computers perform the same tasks as conventional personal computers; however, they lack some contribution and production capabilities. Modern tablets feature diagonally measured screens of 7 inches (18 cm) or larger and may or may not allow cellular network connection, which is the only difference between them and modern smart phones. Instead of using the mouse, track pad, and keyboard present on bigger computers, gestures made with a finger or a digital pen are used to manage the touch screen display. Physical keyboards are a distinguishing feature of portable computers (Zha, Zhang, & Yang, 2016).

According to Parvez (2011) and Ubogu (2019), schedule and brochure tablets lack physical keyboards and instead accept text and other input via a virtual keyboard that is displayed on their touch screen displays. Accessibility is impacted by the design of mobile services and devices. Libraries will need to deal with these concerns as reading becomes more widely available to different cultures and as mobile technology develops.

1.5 Mobile Library Services

Libraries can offer a diverse kind of mobile services to their users as listed by Singh and Mahajan (2014):

i. Online Public Access Catalogs (OPACs) for mobile devices: Libraries are making their OPACs available through websites that are responsive to mobile devices. Users can look up library locations and hours by using the mobile OPAC on the New York Public Library Mobile Beta website
ii. Mobile apps: Some libraries have developed mobile apps for Smart phones. For example, the District of Columbia Public Library has developed an iPhone app that includes a mobile OPAC, the ability to place items on hold, and information on the hours and locations of local libraries.
iii. Mobile collections: Libraries are collaborating with third-party content providers to deliver audio books, e-books, audio language courses, streaming music, films, images, and other multimedia to mobile devices. Overdrive is available on a variety of mobile devices, including a BlackBerry Smartphone app.
iv. Mobile library instruction: some libraries make library instructional materials and resources available via mobile platforms. For library researchers on the go, East Carolina University, for example, offers a podcast series called "Research First Aid"
v. Mobile databases: The National Library of Medicine's PubMed for Handhelds is a mobile web portal.

vi. SMS notifications for libraries: Many libraries use SMS for a variety of purposes, including notification of items available for pickup, due date reminders, information about the accessibility of library resources, delivery of request numbers and locations.
vii. SMS Reference: Some libraries offer "text-a-librarian" services, which are ideal for quick answers to simple questions.

1.6 Advantages of Implementation of Mobile Technology in Libraries

Shonhe (2019) identified the following as advantages of mobile technology in libraries:

i. User-friendly Help: Users who are already familiar with their own devices and technologies have easier time accessing information and do not need orientation or preparation. SMS, instant messaging, web browsing, and email are popular ways for mobile phone users to communicate. The majority of these features come standard with mobile devices or are included as part of the data plan bundle option. Users can use the installed devices to browse the internet, download, and access information as they deem fit.
ii. Personalized service helps: When users require specific information or resources that are not available in the library, they contact library staff. They are no longer expected to visit the library during normal business hours to meet all of their information needs. They use remote access to search the library's online catalogue, use subject guides or databases, access the full text of articles from web-based e-resources, browse an electronic journal, fill out an inter-library lending form, ask a librarian a reference question, or borrow an e-book.
iii. Accessibility of accessing information: Users who are unable to visit the library in person will benefit greatly from having access to information at any time and from any location. Access to information implies unrestricted access to all citizens, which reflects the citizens' interests. It also refers to the method and mode of making information available to the public by providing various options for making information and information services available to the public. Accessibility can be defined as the ability to use the functionality and benefits of libraries. Distance and transportation, building design, assistive technology, relevant and usable resource content, appropriate resource format, and the languages of the resources and staff are all factors to consider. Acceptability refers to two interconnected issues. First, inquirers may be hesitant to accept a particular source as credible because they suspect it lacks cognitive authority. Second, the inquirer may be unwilling to accept the source's evidence because it represents something unwelcome and contradicts other beliefs, a condition known as cognitive dissonance.
iv. Time-saving: Users save time by not waiting in line to renew/reserve books at the library transaction counter. It saves time for users. They do not need to come to the library because they can check the position of accessible resources, reserve their resources, and so on using the library OPAC from their mobile receivers.
v. User Participation: Libraries can improve their online catalogues be it a Digital Audio Player (DAP) or a Portable Media Player (PMP). Other file formats supported by most players besides MP3 include Windows Media Audio (WMA), Advanced Audio Coding (AAC), Vorbis, FLAC, Speex, and Ogg. The library enhances the interactivity of its mobile-based website by including chat rooms, blogs, social interfaces, and other features.
vi. Location Awareness: Mobile contact enables libraries to provide location-based services and content by utilizing the capabilities of a Global Positioning System (GPS). Using maps and navigational software, libraries can direct users to a specific document or service. They can use the

library from any location on the planet. All that is required is an active internet connection, access to the library's website, and a mobile smart phone. A single library resource can be accessed via various mobile phones.

vii. Access to Print-disabled Users: Mobile communications aid in the oral delivery of services to visually impaired and physically disabled users.

viii. Interactive Capabilities: While away from the library, users can use the mobile Web to quickly access information and interact with library personnel to obtain precise references.

ix. Limitless Access: All online resources accessible via their desktop are also accessible via their mobile devices.

x. Direct communication with instructor: Scholars have traditional correspondence with a class instructor when preparing schedules, revolving in digital projects, and distributing information such as URLs, lecture plans, and academic requirements.

2. Barriers To Mobile Based Library Services in Nigeria

Current mobile devices are limited by their internet connection speed, slow processing, and limited storage capabilities. One of the most significant barriers is mobile devices' insufficient memory. A vital issue in a successful Mobile library is describing how much and what category of information is appropriate, and how skill or the medium affects the information displayed.

Shonola, et al (2016) stated the following as barriers to mobile library services in libraries:

i. Design of the format: Due to the limitations of small screen size, content designed for a desktop processor may not be suitable for a mobile device. Mobile display content should be divided into smaller segments, and information should be reorganized. Text, image, graphic, and table sizes, as well as the size and physical location of pop-up windows, will all need to be redefined.

ii. Separate the content from the format: A successful mobile library must be compatible with a wide range of devices. In other words, it should be device independent. This issue could be solved by separating the content from the format and attempting to broaden the capabilities and flexibility of web browsers.

iii. Display models: Because display models for different operating systems and browsers differ, choosing a display model is a significant challenge for library professionals. We should use a programme to determine whether the device is a portable PC or a mobile device. The system then chooses the appropriate style sheet and display model to specify the page's appearance.

iv. Lack of a standard: Existing technological constraints, as well as current operating systems and web browsers, pose a challenge to mobile library creators. They currently lack the capability and flexibility to properly display an application on all devices. Developers of mobile libraries should follow a standard to ensure that content is properly displayed on devices.

v. Handling of PDF documents: The majority of mobile libraries include links to Adobe PDF learning resources. There is, however, a problem with PDF support on Blackberry devices. A Blackberry user cannot view a PDF document in a web browser. Documents commonly found on the mobile library site are reorganized into HTML for viewing on a Blackberry to avoid this problem.

vi. Handling of multimedia file types: This is a significant challenge for future development because the mobile library site contains links to various audio and video files. The use of flash, shockwave, java applets, and other plug-ins is required for large and difficult-to-study materials. The model being tested has an issue with audio/video support, and all of these may not work on all mobile devices.

vii. Privacy: Another pressing issue with mobile technology in the library is privacy. There is a risk that client practice information will be rummaged through and browbeaten by law enforcement officials and those who commit identity theft. Mobile knowledge is changing the relationship between libraries and their users, both by expanding services and posing new privacy challenges to readers.

viii. Lack of staff awareness and familiarity: Setting up text signals, for example, necessitates methodological knowledge from staff who understands how the library organization structure generates reports. This also includes staff or advisers who can assist in establishing a border with a Sim Card Modem or a suitable service to distribute those notices as manuscript signals.

Other issues identified include bandwidth issue, insufficient funding, technophobia and a lack of a good maintenance culture (Chukwusa, 2020; Chukwusa, 2019; Chukwusa, 2015; Chukwusa, 2014; Shorunke, Ajayi and Akintola,2014) Unsustainable technology strategy and policy, a digital gap, inadequate IT training programme and power supply were equally listed as challenging issues.

3. Solutions to the Challenges

Kumar (2017) identified the following solutions to issues raised by mobile library services:

i. By offering training sessions and professional development opportunities, you can educate staff, build local expertise, and promote discussion.

ii. Organize public lectures or include such information on their websites, blogs, or newsletters.

iii. Expert knowledge of mobile devices must permeate the profession rather than remaining in the hands of recent library school graduates.

iv. Create a strong foundation of knowledge about mobile services within your organization.

v. Defend users against deceptive content agreements with third-party providers.

Ejiroghene (2020) and Ubogu (2021b) asserted that libraries should analyze and make sound decisions, such as assisting with staff education, experimenting with new funding models, and willing to compromise on traditional information delivery models. They must protect themselves from dubious third-party content agreements. They should inform users about the thousands of free mobile books available through initiatives like Project Gutenberg. This will create opportunities to educate staff, establish local expertise, and encourage dialogue through training sessions and professional development options. Lectures or discussion groups may be held, or such information may be found on their websites, blogs, or newsletters (Ubogu, 2012).

As the use of mobile technology grows, library staff will need to learn and use it in order to serve library users wherever they are. In doing this, libraries will face management, funding, and training challenges to meet this demand. Expert technical knowledge, on the other hand, must permeate the entire profession (Saravani & Haddow, 2017).

3.1 Secure Sustainable Funding and Public–Private Partnerships

Inadequate budgets remain a primary impediment to acquiring mobile platforms, maintaining network infrastructure, and training staff. Studies recommend that federal and state governments ring-fence library funding for ICT, while libraries explore partnerships with telecommunications firms, NGOs, and development agencies to co-finance mobile initiatives (Kifordu et al, 2019; Nwankwo & Kifordu, 2019). For example, Etebu and Zacchaeus (2020) found that “adequate funding” and enhanced collaboration were critical enablers of innovative library services in Nigeria, and they urged government agencies to boost allocations for ICT infrastructure

3.2. Deploy Alternative Power Solutions

Erratic electricity undermines the reliability of mobile-based services. Leveraging solar-inverter systems can provide libraries with uninterrupted power for servers, Wi-Fi hotspots, and charging stations. Ogo, Omosekejimi, and Ebhonu (2021) demonstrated that librarians in South-West Nigeria were highly aware of solar-inverter technology and recommended that "university library management should allocate fund for the acquisition and installation of solar-inverter technology" to ensure round-the-clock electronic services

3.3. Build ICT and Mobile-Technology Competencies

Limited digital literacy among librarians and support staff constrains mobile service delivery. Continuous professional development—through workshops, certification programs, and peer-mentoring—can close this skills gap. Onakoya et al. (2023) found that while ICT skills among reference librarians were moderately high, structured training and retraining were essential to maintain competence in emerging technologies

3.4. Upgrade Telecommunications Infrastructure

Poor network coverage and outdated campus Wi-Fi limit mobile access to library resources. Libraries should advocate for campus-wide high-speed broadband, collaborate with network providers to install additional cell towers or signal boosters, and invest in enterprise-grade routers and access points. Shehu and Gabasa (2019) specifically recommended "provision of up-to-date telecommunication devices" as a way forward for mobile library services in Nigerian academic institutions

3.5. Adopt Strategic Planning and Policy Frameworks

The absence of coherent mobile-service policies and roadmaps leads to ad hoc initiatives. Libraries need to integrate mobile-first approaches into their strategic plans, defining clear objectives, performance metrics, and governance structures for mobile app development, content curation, and user support. Kari's (2020) assessment emphasized that empirical insights into user and staff attitudes should inform policy advocacy and implementation, urging libraries to "fully integrate mobile technologies in their services and practice"

3.6. Foster Cross-Sector Collaborations

Peering with academic departments, technology startups, and international library bodies (e.g., IFLA, UNESCO) can accelerate knowledge transfer and resource sharing. Etebu and Zacchaeus (2020) identified "risk-taking" and "collaboration" as key drivers for library innovation, recommending partnerships that bring in both technical expertise and seed funding

3.7. Pilot and Scale Emerging Mobile Technologies

To keep pace with global trends, libraries should experiment with augmented reality (AR) for on-site navigation, QR codes for quick resource links, and AI-driven chatbots for 24/7 reference support. Recent reviews of AR in library services call for effective budget planning to cover hardware, software licenses, and training, ensuring these immersive tools are deployed sustainably.

4. Conclusion

The ascent of mobile technology has transformed library services, empowering institutions to extend learning, teaching, and research beyond traditional walls. As mobile networks become increasingly affordable and reliable, libraries must prioritize seamless, responsive web platforms and tailor their digital offerings to smartphone and tablet users. By embracing mobile-first strategies, academic libraries can deliver truly 24-hour access to catalogs, digital collections, and interactive services—meeting the evolving expectations of on-campus, distance, and online students alike.

In Nigeria, however, systemic hurdles—limited funding, erratic electricity, and gaps in ICT proficiency among librarians—continue to impede the deployment of advanced mobile innovations such as augmented reality. University leadership can close these divides by investing in alternative power solutions (solar

back-up, inverters) and upgrading campus telecommunications infrastructure. Equally important is a commitment to professional development: equipping librarians with the technical skills and strategic vision to manage and promote mobile applications effectively.

By addressing both the technological and human dimensions of mobile service delivery, Nigerian academic libraries will not only enhance service quality but also broaden their reach, inclusivity, and impact. In doing so, they position themselves at the vanguard of a fully mobile-accessible future—where library resources are available anytime, anywhere, to inspire and support diverse learning communities.

Acknowledgements

Conflict of Interest

The authors declared no conflict of interest.

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