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CURRENT STATUS OF TECHNOLOGICAL INTEGRATION IN UNIVERSITY LIBRARIES IN BANGLADESH

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Abstract

Libraries around the globe are now embracing cutting-edge technologies to offer prompt and transparent library and information services to users. The integration of these technologies harnesses libraries' efficiencies and efficacies to fulfill users' needs and requirements to a great extent. However, public and private university libraries in Bangladesh are now leveraging the blessings of emerging technologies like RFID, Digital borrower IDs, Dspace, Instant Reference Service, IoT, and other smart appliances to keep pace with the rest of the world in meeting challenges in proficiently dealing with savvy library users. This study is mainly a qualitative approach to reavel the current status of integrating smart technologies in public and privateuniversity libraries in Bangladesh. The study reveals that these libraries share a unique trajectory toward smart library movement, marked by growing dependence on OPAC, ILMS, digital resources, and networked services. Considering the South Asian perspective, the smart library initiative in Bangladesh is progressing more meticulously and systematically than in Nepal, Afghanistan, and Bhutan. Nevertheless, this paper provides a comprehensive understanding for library professionals, scholars, and government officials regarding present phenomena of the adoption of emerging technologies in Bangladesh and other countries of South Asia.

Keywords: Smart Technologies, Smart Library, Internet of Things, Artificial Intelligence, DSpace, and RFID.

Abstrak

Perpustakaan di seluruh dunia kini merangkul teknologi mutakhir untuk menawarkan layanan perpustakaan dan informasi yang cepat dan transparan kepada pengguna.

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Integrasi teknologi ini memanfaatkan efisiensi dan efektivitas perpustakaan untuk memenuhi kebutuhan dan persyaratan pengguna secara maksimal. Namun, perpustakaan universitas negeri dan swasta di Bangladesh kini memanfaatkan teknologi canggih seperti RFID, ID peminjam digital, Dspace, Layanan Referensi Instan, IoT, dan perangkat pintar lainnya untuk mengikuti perkembangan dunia dalam menghadapi tantangan dalam menangani pengguna perpustakaan yang cerdas secara efisien. Studi ini terutama menggunakan pendekatan kualitatif untuk mengungkap status terkini integrasi teknologi pintar di perpustakaan universitas negeri dan swasta di Bangladesh. Studi ini mengungkapkan bahwa perpustakaan-perpustakaan ini memiliki lintasan unik menuju gerakan perpustakaan pintar, yang ditandai dengan meningkatnya ketergantungan pada OPAC, ILMS, sumber daya digital, dan layanan jaringan. Dengan mempertimbangkan perspektif Asia Selatan, inisiatif perpustakaan pintar di Bangladesh berkembang lebih teliti dan sistematis daripada di Nepal, Afghanistan, dan Bhutan. Meskipun demikian, makalah ini memberikan pemahaman komprehensif bagi para profesional perpustakaan, akademisi, dan pejabat pemerintah mengenai fenomena terkini adopsi teknologi baru di Bangladesh dan negara-negara Asia Selatan lainnya.

***Kata kunci**: Teknologi Cerdas, Perpustakaan Cerdas, Internet of Things, Kecerdasan Buatan, DSpace, RFID.*

1. INTRODUCTION

Smart devices such as smartphones, laptops, tablets, and other digital apparatus have become indispensable parts of our everyday lives. The effects and blessings of these smart technologies are adding new dimensions to students' learning process and helping them immensely to stay in touch with the academic world(Göksu, Karanfiller, and Yurtkan,2016). Besides, Smart Technologies can play crucial roles in rejuvenating information management systems. Radio Frequency Identification (RFID) tools, artificial intelligence gadgets, robotics, augmented Reality, and other smart technologies are making libraries self-sufficient and opening new doors to reassess the users' needs and requirements (Kumar and Kumar, 2019). However, within the education framework, smart technologies are reshaping contemporary issues focused on smart initiatives such as smart libraries to create a smart ambiance in smart campuses (Ekere et al, 2022). The application of the Internet of Things in libraries and information centers has brought noticeable advancement in curbing data privacy risks. Besides, it enables the librarians to streamline library operations and enhance user expertise in dealing with information delivery, check-in and check-out procedures, inventory management, and other activities to safeguard patron information (Ram, Kumar, and Pal, 2023).

Integrating modern technology, such as AI, Big Data, and RFID, can provide users with personalized experiences in libraries. Library patrons may expect necessary suggestions, interactive learning modules, and immersive instructional material (Adigun et al, 2024). Furthermore, libraries are undergoing a significant modification as they gradually adopt digital technology and move from physical to digital resources(Lahkar 2024). The library, as an academic nerve center, plays its role in promoting teaching, learning, and research by providing necessary resources to academics, researchers, and students (Azolo,2019). Besides, it is an entity dedicated to organizing knowledge and

information (Tripathi et al., 2016). However, the 'Smart Library', which assimilates cutting-edge technologies and the Internet of Things to enhance library services, efficiency, and customer experience, has gained popularity worldwide in recent years (Kumar & Malhotra, 2021; Chen & Bhuvaneshwari, 2021; IFLA, 2019).

In this age of massive globalization and the explosion of the internet and technology, the traditional roles of libraries are changing by leaps and bounds to meet the requirements of the masses (Ameen & Ullah, 2020). Library roles are no longer confined to the periphery of organizing and preserving books, non-books, journals, periodicals, and other information items. With the rapid march of time and to keep pace with the technological revolution, libraries are adopting different technologies to provide prompt and quick library services to the users (Islam,2023). Moreover, automation and digitization initiatives in libraries are taking strong shape across the globe to provide hassle-free services and ensure round-the-clock accessibility to students, teachers, researchers, and other stakeholders (Chowdhury, 2023). As the world moves closer to information superhighways, the need to introduce smart library programs becomes increasingly pertinent to library and information science specialists (Rashid, 2022). However, the paper is a qualitative approach, primarily focusing on the use of smart technologies in Bangladeshi public and private university libraries to provide prompt and quality information services to the end users. Besides, this paper also discusses the emerging technologies currently adopted in academic libraries.

This study covers the following research questions;

RQ1. What is the present scenario of technological integration in University libraries in Bangladesh?

RQ2. How far has technological integration evolved within the South Asian countries?

2. LITERATURE REVIEW

This research will play a vital role in informing and shaping plans and policies by providing evidence-based insights, identifying emerging issues, and evaluating the effectiveness of emerging technologies used worldwide in academic libraries. Besides, this study will help academics, scholars, and policymakers understand the current status of smart library initiatives in Bangladesh and its neighboring countries. In addition, this study will help the researchers and policymakers to understand the progress and differences of the library movement in Bangladesh and other South Asian countries. Furthermore, this study will be a useful guideline for university scholars, researchers, and other stakeholders to conduct further research on different aspects of emerging technologies and formulate necessary plans and policies to ensure quality education and bring innovation in research.

Related Studies

The world has been moving forward with the blessings of ICTs and other emerging technologies. To cope with the rapid advancement and implausible growth of technologies in the time of the fourth industrial revolution, libraries have been adopting

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smart technologies to offer more efficient and up-to-date information services to the smart citizens of the world. In this section, we reviewed different research papers related to our study to figure out the current phenomenon of the usage of smart technologies in libraries. Igwe and Sulyman (2022) figured out the smart library's potential benefits and revolutions in ensuring better library operations and information services to the target users. They opined that libraries can adopt emerging technologies to provide smart services facilitated by smart librarians in collaboration with other information experts. Wang et al (2018) investigated (RFID)Radio Frequency Identification, the Internet of Things, and cloud computing-based smart systems that offer specific interfaces for parcel delivery services that can assist largely in managing storage, distributing parcels, arranging transports, and so on. On the other hand, Steehler, Pettitt, Schieber, and Alexander (2022) found that smart technologies aid in handling multitasking and information overload by motivating learners to engage in technological innovations.

Zhu and Fu (2015) constructed a supply chain simulation system based on the Internet of Things (IoT) to incorporate GPS, sensors, ZigBee, and Radio Frequency Identification (RFID) technology by analyzing the system's architecture, introducing the key technology of the system implementation, and the function and process of the system. Sah (2016) demonstrated a setup of IoT for residences that allows users to regulate electric applications over smartphones or any other electronic devices with the Internet. Ekere et al. (2022) revealed that the creation and management of smart libraries face multifaceted challenges in developing countries. Idiegbeyan Ose et al. (2014) investigate how libraries in Nigeria are adopting ICTs and other smart technologies to upgrade their functions and services for users. Siddike et al. (2011) explored the culture of adopting ICTs in the university libraries in Bangladesh. They revealed that administrative complications, a lack of support from the authorities, insufficiently computer-literate staff, interrupted internet connections, financial barriers, and other issues are hindering the progress of digitization in university libraries. In another study, Alam and Islam (2011) investigated the progress of digitization and digital information systems as unsatisfactory. They identified library activities closely related to the development of bibliographic and full-text databases, hosting e-papers and metadata on the web, online searching, and downloading facilities.

However, Bhuyan and Bipasha (2023) found that Dhaka University Library is making its all-out effort to transform traditional library services into smart and digitally accessible forms with the blessings of advanced technologies. Besides, Rahman(2020) identified different tools and technologies being used to serve university stakeholders with better service quality through the concerted efforts of well-trained library professionals. For example, Yang and Li (2019) investigated how AI-powered chatbots might be integrated into university libraries to improve user engagement and automate reference services.

Whereas Achugbue et al. 2023) suggested that university libraries should concentrate on the utility of library services and the development of smart technologies to ensure prompt user access to library resources. Kumar and Singh (2021) discussed the effectiveness of blockchain technology on the library's overall development to bring administrative efficiency, guarantee safety for digital transactions, and prevent valuable data from being manipulated. Jahan and Kabir (2023) highlighted the value of mobile applications in university libraries, which boost information retrieval efficiency and provide remote access to educational resources. However, Hasan et al. (2022) addressed the advantages of smart technologies being used in libraries to foster digital literacy training programs for librarians and end-users. They opined that the application of smart technologies might not always bring desired results due to the lack of well-trained and skilled library professionals.

However, the existing body of research has largely overlooked the trend of technological integration in university libraries in Bangladesh. In particular, none of the reviewed studies have systematically examined the differences in the adoption and implementation of technologies between public and private university libraries. Moreover, the current literature lacks any comparative analysis of the status and progress of the smart library movement in Bangladesh in relation to other South Asian countries, leaving a significant research gap in both national and regional contexts.

Purpose of the Study

The main purpose of this paper is to focus on the trend of integrating smart technologies in Bangladeshi university libraries. Besides, this paper aims to achieve the following objectives.

a) To examine the differences in the adoption and implementation of technologies between public and private university libraries
b) To reveal the status and progress of the smart library movement in Bangladesh in relation to other South Asian countries

3. METHODOLOGY

The researchers applied a qualitative approach to carry out the study. They received substantive literature relevant to the study to draw a comprehensive picture of the smart library movement in Bangladesh. The researchers visited the university library websites to investigate the current status of the smart library movement reflected in library functions and services. They have selected 22 university libraries, comprising 12 public and 10 private universities, to highlight the use of ICTs, automated library technologies, and other innovative technologies in providing prompt and transparent information services to end-users. Furthermore, the study integrated a comparative overview of university libraries in selected South Asian countries, including India, Pakistan, Sri Lanka, Nepal, Afghanistan, and Bhutan, to contextualize the progress of the smart library movement in Bangladesh within the broader regional landscape.

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4. DISCUSSION

Public University Library

Sl No	Name of the University	Name of the Library	Web address
1	Dhaka University	Dhaka University Library	https://www.du.ac.bd/
2	Rajshahi University	Rajshahi University Library	https://www.ru.ac.bd/
3	Jahangirnagar University	Jahangirnagar University Library	https://juniv.edu/
4	University of Chittagong	University of Chittagong Library	https://www.cu.ac.bd/
5	Shahjalal University of Science and Technology (SUST)	SUST Library	https://www.sust.edu/
6.	Khulna University	KaziNazrul Islam Central Library	https://ku.ac.bd/
7.	Islamic University, Kushtia	KhademulHaramain King Fahad Bin Abdul Aziz Central Library.	https://www.iu.ac.bd/
8.	University of Barisal	Central Library, University of Barishal	https://bu.ac.bd/
9.	Rajshahi University of Engineering & Technology (RUET)	Rajshahi University of Engineering & Technology (RUET) Library	https://www.ruet.ac.bd/
10.	Bangladesh University of Engineering and Technology (BUET)	Bangladesh University of Engineering and Technology (BUET) Library	https://www.buet.ac.bd/
11	Hajee Mohammad Danesh Science and Technology University	HSTU Library	https://library.hstu.ac.bd/

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12	Mawlana Bhashani Science and Technology University (MBSTU)	Central Library, Mawlana Bhashani Science and Technology University	https://mbstu.ac.bd/central-library/

.Private University Library

Sl No -	Name of the University	Name of the Library	Web address
1	North South University	North South University Library	https://library.northsouth.edu/
2	BRAC University	Ayesha Abed Library	https://library.bracu.ac.bd/
3	East West University	Dr. S. R. Lasker Library	http://lib.ewubd.edu/
4	Daffodil International University	Daffodil International University Library	https://library.daffodilvarsity.edu.bd/
5	Independent University, Bangladesh	IUB Library	https://library.iub.edu.bd/
6.	University of Liberal Arts Bangladesh (ULAB)	University of Liberal Arts Bangladesh (ULAB) Library	https://www.ulab.edu.bd/library
7.	Asian University for Women	Asian University for Women Library	http://www.auw.edu.bd/library/index.php
8.	United International University	United International University Library	https://library.uiu.ac.bd/
9.	American International University-Bangladesh (AIUB)	American International University-Bangladesh (AIUB) Library	https://www.aiub.edu/library
10.	Green University of Bangladesh	Green University of Bangladesh Library	https://library.green.edu.bd/

Smart Library

Smart Library refers to the library of the next generation embedded in the advancement of information and communication technologies to disseminate prompt information service to the end users regardless of geographical barriers (Singh and Tripathi, 2023).In other words, a smart library is the amalgamation of hardware and software installed tactfully to serve as a skilled librarian (Orji and Anyira, 2021). It

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leverages modern technology to enhance its operations and services, providing users with improved information services and increased efficiency in managing housekeeping operations through the use of artificial intelligence, machine learning, the Internet of Things, and distributed computing (Iroroeavwo et al., 2023).

Dimensions of Smart Libraries

A smart library is the amalgamation of smart technologies being organized and monitored on a regular basis to provide smart library services to smart users with the supervision of technologically proficient smart library professionals.

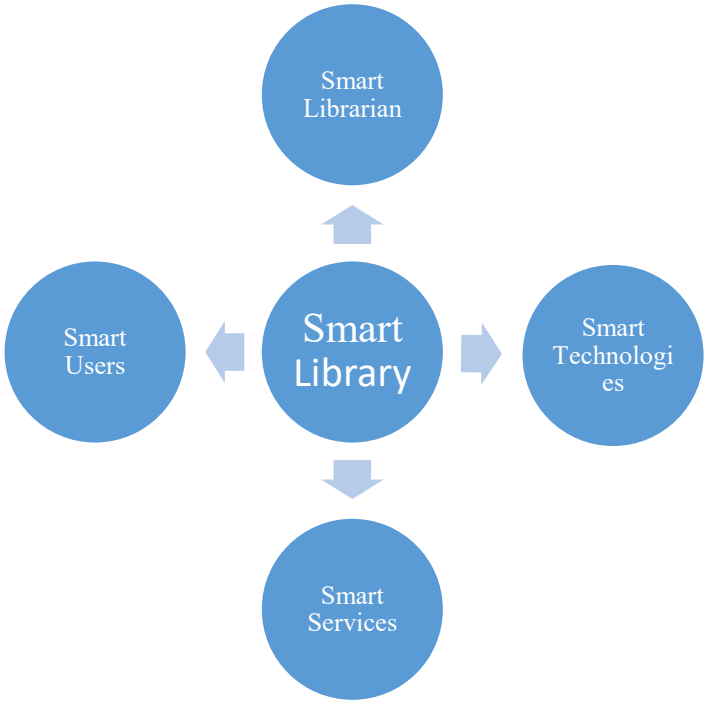

Figure1: Dimensions of Smart Libraries (Schöpfel, 2018)

1) **Smart Librarian**

Smart library professionals are the key driving force behind the success of the smart library movement. Installing smart technologies to ensure the smooth running of library functions and services is next to impossible without the supervision and guidance of a technologically sound librarian.

2) **Smart Technologies**

Libraries are now turning into information centers and research hubs due to the blessings of cutting-edge technologies. Smart Resources like the Internet of Things, Artificial intelligence-based search mechanisms and information retrieval systems, Augmented Reality, Virtual Reality, and other smart technologies can greatly serve the information needs of end users.

3) **Smart Service**

Smart library services are meant to guide users in leveraging technological advantages to fulfill their specific demands and requirements. Automation and

digitization initiatives ensure smooth library circulation systems, enhance efficiency in searching for a required document, and make the information retrieval process quick and transparent. Zhang and Liu (2024) explored that introducing the Scan to Borrow application in libraries can assist users in borrowing books by scanning the barcode. Besides, strengthening collaboration and efficiency in research and adopting Artificial Intelligence to enhance service quality can create a bright ambiance in libraries to ensure smart services to the end users.

4) Smart Users

The principal motto behind adopting smart technologies in libraries is to make users resourceful enough to evaluate their problems and take part in the decision-making process. Jagadeesha (2024) opined that a smart library user can significantly generate new knowledge and collaborate with the library staff and other users under any circumstances.

Where data or information has become ubiquitous, libraries and archive centers have to readdress their role and function in the different ecosystem (Schöpfel,2018). Smart libraries bring the solution to overcome the barriers to ensure the 'Right to Access' information superhighways and spearhead the smart library movement across the globe.

Smart Technologies Being Used in Libraries

The revolution in the world of the Internet has made broadband connections available at minimal cost. The rapid development of ICT has enabled different gadgets and devices, such as Radio Frequency Identification (RFID), infrared sensors, and other smart devices, to be useful means for communication systems and knowledge sharing beyond borders (Ukamaka and Kakiri, 2021). The application of smart and emerging technologies has significantly reshaped contemporary library systems by enhancing operational efficiency, accessibility, and user satisfaction. The term "Internet of Things" was used by Kevin Ashton, who invented Radio Frequency Identification (RFID) technology, an innovative radio communication system, first applied in Supply Chain Management. It implies a system of interconnected and interdependent equipment, responsible for storing and transferring information in the presence of a wireless network and without human involvement (Mouha, 2021; Mondal, 2021). It is needless to mention that IoT, as an innovative form of smart technology, is an advanced form of Information and Communication Technology (ICT) that makes the exchange of information, library housekeeping operations, book rental, inventory, tagging, and access control much easier with the blessings of an intelligent library management system (Makwana, 2021). On the other hand, RFID (Radio Frequency Identification) incorporates a wide range of technologies that utilize radio frequencies for the automatic identification of individuals or objects across distances from a few inches to several hundred feet (Parkash et al., 2012).In libraries, Radio Frequency Identification offers transformative potential. It enables the inventorying of large collections, often consisting of hundreds of thousands of items, in a matter of days instead of months. Additionally, it supports automated checkout and return procedures, allowing patrons to access services speedily at any time of day (Singh, 2014).

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Open Source Integrated Library Systems (ILS), which have been designed with Comprehensive Library Management Features for Cataloging, Circulation, Acquisitions, and other functions of a library, are easing the hassle of library professionals to a great extent. At present, the most popular Integrated Library Software, like Koha, Evergreen, and NewGenLib, are receiving attention from the library experts for their enormous impact in searching the catalog, keeping track of book purchases and other expenditures, and entering MARK entries into the catalog to make an item available in OPAC (Chow and Bucknall,2012). Among the recent smart teachnologies, OpenBiblio is an open-source and freely available integrated library management system designed and modified specifically for small libraries. It offers valuable features like cataloging, Online Public Access Catalogue(OPAC), bibliography service, and circulation. Additionally, it is very popular among library professionals for its simplicity and user-friendly interface (Bwalya,2017).

When it comes to long lasting preservation of the library resources, DSpace preserves and facilitates straightforward and open access to various forms of digital materials, including text, images, videos, MPEG files, and datasets. This software package is open source and is commonly employed to establish open-access repositories for academic and published digital resources. Although DSpace encompasses functionalities that extend beyond mere content and document management systems, it is designed as a digital archiving solution that specifically addresses the ongoing requirements for the storage, accessibility, and safeguarding of digital materials (Das, 2015). Whereas, Greenstone enables collections that can be accessed via a standard web browser, providing user-friendly navigation along with robust search capabilities. Users can search the complete text of documents and select from indexes created from various sections of the materials. It also offers adaptable browsing features, allowing users to explore listed authors, titles, dates, classifications, and more (Das, 2015). Cloud computing ensures instant access to computing resources, which may include physical or virtual servers, data storage solutions, networking features, tools for application development, software, artificial intelligence-enhanced analytics platforms, and additional services delivered over the internet with a pay-as-you-go pricing model(Susnjara & Smalley,2025). Nowadays, Libraries are embracing cloud-based solutions for various services, including e-journal access management, digital library hosting, statistics tracking, integrated library system (ILS) hosting, and so on (Gonzales, 2023).

Bibliographic reference tools or reference management software, like Mendeley, EndNote, Reference Manager, Zotero, BibTeX, etc., can assist researchers, academics, and authors in combining, managing, and citing their sources. These tools can automatically format references and bibliographies in different styles, saving time and guaranteeing precision (D. Samuel Gottesman Library,n.d). Artificial Intelligence, or AI, introduces libraries to the digital era. It transforms the traditional atmosphere and enhances the library's capability to fulfill the ever-changing needs of end users. Library and information centers around the globe are now using AI technology to enhance accessibility and streamline procedures for state-of-the-art services around the clock (Mandal, 2024) Additinally, Information Retrieval(IR) is one of the key functions of a

library for organizing and managing knowledge. At present, Artificial Intelligence technology is employed throughout the novel Information Retrieval process to offer standard library services. This process includes comprehending user inquiries, organizing and structuring information, and delivering customized outcomes that are more pertinent and precise compared to conventional search techniques (Mandle, 2008).

An expert system, which is a set of programs and a popular branch of Artificial intelligence technology, can manipulate encrypted knowledge in order to solve problems within a specified area that entails human expertise. However, with the growth of powerful and affordable computers, libraries are now trying to implement expert systems for accomplishing classification, cataloguing, collection development, reference services, information services, indexing, and other important operations effectively(Muqueem, 2014). Underpinning all these smart technologies is the critical requirement of robust and uninterrupted broadband internet connectivity, which ensures quick access to library resources and determines the overall efficiency and effectiveness of smart library services by enabling seamless information sharing and retrieval (Visser & Ball, 2013). Last but not least, innovative library technologies like Application Programming Interface, E-Granthalaya 4.0, Data Analytics, Smart Kiosks, New Media, Web 2.0, Geographic Information Systems (GIS), Mobile Technologies, and many other emerging smart technologies are creating a paradigm shift in leveraging the blessings of prompt library and information services.

Integration of Technologies in Bangladeshi University Libraries

There is a slow and steady growth of smart technologies in Bangladeshi academic libraries. The researchers have visited the web pages of some of the country's famous university libraries to reveal the present scenario of smart technology usage.

RQ1. What is the present scenario of technological integration in University libraries in Bangladesh?

1) Public University Libraries

Public university libraries across Bangladesh, including Dhaka University, Rajshahi University, BUET, Jahangirnagar University, Chittagong University, Shahjalal University of Science and Technology (SUST), Khulna University, Islamic University Kushtia, University of Barisal, Rajshahi University of Engineering & Technology (RUET), Hajee Mohammad Danesh Science and Technology University (HSTU), and Mawlana Bhashani Science and Technology University, are increasingly integrating digital and smart technologies to enhance academic and research support for their users. Common facilities include spacious reading areas, effective lending services, Online Public Access Catalogues (OPAC) for remote and efficient resource discovery, and digital borrower ID systems that streamline access to both physical and electronic materials.

The robust internet connectivity across these academic libraries facilitates users with e-books, e-journals, virtual databases, and other intellectual resources, while

computerized or integrated library management systems develop circulation, inventory control, and organizational efficiency.

Several institutions, such as Rajshahi University, have embraced cutting-edge technologies like RFID to improve lending and inventory management, whereas other universities, including HSTU and Mawlana Bhashani Science and Technology University, are progressing toward e-library environments through integrating ILMS, Institutional Repositories, and extensive access to e-resources. The adoption of specialized software and up-to-date Braille Printers through a modern and international standard Resource Center for the physically challenged users with Braille Books and sufficient computers has given the Dhaka University library a unique identity in Bangladesh. Furthermore, specialized services, such as reference support, reprographic services, cyber centers, and resource centers for visually impaired users, demonstrate a collective commitment to inclusivity, efficiency, and modernization, positioning these public university libraries as evolving knowledge hubs aligned with contemporary education-oriented needs and requirements.

2) Private University Libraries

Renowned private universities in Bangladesh have increasingly incorporated smart technologies in their libraries to improve information services, research support, and user experience. North South University launched country's first RFID-based computerized university library using the KOHA Integrated Library Management Software, allowing web-based circulation, self-check and book-drop services, RFID tracking, automated alerts, and access to audiovisual and full-text digital resources. In the same way, Ayesha Abed Library of BRAC University embraced RFID technology, introduced a Drupal-based website and SMS services, and maintains an institutional repository while also providing Turnitin access to ensure research integrity. On the other hand, Dr. S. R. Lasker Library of East West University emphasizes digital scholarly communication through institutional repositories, an online catalogue, and innovative services such as WhatsApp-based instant reference support and SciSpace-assisted literature review.

Daffodil International University Library offers round-the-clock e-library facilities, maintains a DSpace-based institutional repository, provides access to a wide range of e-book and e-journal publishers, and supports efficient information retrieval through OPAC. Additionally, the libraries of Independent University of Bangladesh, University of Liberal Arts Bangladesh, Asian University for Women, United International University, American International University Bangladesh, and Green University of Bangladesh are extensively equipped with OPAC systems, digital borrower ID cards, high-speed internet connectivity, automated management systems, and extensive access to e-books, e-journals, audiovisual materials, archives, and open-access resources. Collectively, these initiatives reflect a growing commitment among private universities in Bangladesh to adopting smart library technologies that improve operational efficiency, expand digital access, and foster a supportive atmosphere for training, learning, and research.

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3) Comparative Analysis between Public and Private University Libraries

Generally, public university libraries, due to their long institutional histories and large user bases, primarily focus on ensuring broad access to academic resources and necessary services. They usually provide OPAC-enabled catalog access, digital borrower ID cards, high-speed broadband internet connection, and computerized or integrated library management systems to support circulation, inventory control, and administrative efficiency. On the other hand, a number of public universities, such as Rajshahi University, have begun applying advanced technologies like RFID, the pace of technological adoption is often constrained by budgetary limitations, bureaucratic procedures, and infrastructural challenges. Consequently, public university libraries tend to emphasize inclusivity, affordability, and service continuity, including specialized facilities such as resource centers for visually impaired users, cyber centers, and reprographic services.

Likewise, private university libraries usually demonstrate a faster and more flexible approach to technological innovation, driven by competitive academic environments, institutional autonomy, and stronger financial investment. Many private universities have embraced RFID-based automation, self-check and book-drop systems, web-based and mobile-enabled services, institutional repositories, plagiarism detection tools, and 24/7 e-library access. Libraries at institutions such as North South University, BRAC University, and Daffodil International University highlight user-centric and research-oriented services, including instant reference support through digital platforms, extensive access to licensed e-resources, and advanced discovery tools that enhance scholarly communication and research productivity.

In spite of these differences, both public and private university libraries in Bangladesh share a common trajectory toward smart library movement, marked by growing reliance on OPAC, ILMS, digital coolection, and networked services. Public libraries contribute significantly to the national knowledge infrastructure by serving large and diverse academic communities, while private university libraries often act as innovation leaders by piloting emerging technologies and service models. Together, they play complementary roles in strengthening the higher education and research network of Bangladesh, increasingly alleviating the digital divide and bringing library services into line with global standards of academic librarianship.

Smart Library Movement in South Asia

The idea of a smart library to provide equal opportunity for every citizen is becoming popular in India. Public libraries are expected to play pioneering roles in transforming government schemes like Startup India or Skill India to facilitate research opportunities for the younger generations (Tripathi et al.., 2016). The main emphasis of the smart libraries lies in the mission to implement Smart Cities to build satellite towns of larger cities and renovate existing mid-sized 100 cities all over the country to encourage replicable area-based urban development enterprises. Concerning the fulfillment of the smart city mission, the transformation of Indian public libraries has prioritized infrastructure, physical space, enriching the content, services, and digital space to revitalize smart libraries for catering skills and competencies to leverage the

benefits of Information and Communication Technologies (Kulkarni and Dhanamjaya, 2017). Recently, the government of India has taken significant initiatives to implement "Digital India" and a good number of Indian libraries are adopting smart technologies to mitigate the digital divide among the young generations to act as smart citizens of the state (Shah and Bano, 2020). In addition, Indian library professionals are embracing Artificial Intelligence (AI) technologies to enhance the library's capacity to offer prompt and precise information service to the end users (Subaveerapandiyan and Gozali, 2024). It is no more wonder that the traditional form of libraries is changing across the globe with time and Pakistan is no exception. Being a developing nation, the adoption of smart library programs has been loaded with various problems like insufficient financial support, technological deficiencies, unskilled human resources, and non-cooperation from universities and other institutions (Hussain and Ahmad, 2021). As the libraries of advanced countries are entering the 4th Industrial Revolution, Pakistani libraries are now passing the preparation phase on the way to implementing the Internet of Things, Big Data, Artificial Intelligence, Virtual Reality, Blockchain Technologies, and other emerging digital technologies to cope with the developed and developing nations (Hussain, 2023). Some university libraries are using a limited number of Internet of Things technologies like check-in and check-out systems, smart air conditioners, smart security doors, smart hand sanitizer machines, and automatic fire alarms despite the lack of funding, technical staff, and inertia of the university authorities in rendering better library services (Asim at al.., 2022). The picture of the digitization process or the adoption of smart library initiatives at the university level is disappointing in Nepal. Manandhar (2023) revealed that very few university libraries deliver information services through websites. She added that academic libraries are not showing enthusiasm to include all the library facilities on the websites. Nevertheless, the majority percent of the libraries in Nepal operate a hybrid system. After completing a degree in Library and Information Science, graduates seek training to enter library professions and this trend marks the weakness of library-oriented education in Nepal (Nyoupane and Nyaichyai, 2023). During the last couple of decades, libraries have shifted towards the automation of their systems and services despite the non-availability of suitable library software that hinders the normal flow of computerized library systems in Sri Lanka (Talagala and Gamage, 2003). Nowadays, the automation of libraries in Sri Lanka has become a common phenomenon to keep pace with the rapid hike in the 4th Industrial Revolution. However, a great number of libraries are still far away from implementing smart library programs along with the inclusion of big data technology, machine learning, artificial intelligence, virtual reality, augmented reality, and the internet of things as enablers of Industry 4 in this 21st century (Warnasooriya, 2022).

Afghanistan is a war-ravaged country in Asia where the education system has virtually been demolished due to foreign invasions. Henceforth, the reformation of the educational infrastructure has become the government's uppermost precedence. The libraries of Afghanistan have started implementing the Integrated Library System (ILS) to develop a digital library environment at the university level (Han and Rawan, 2007). The existing libraries are failing to meet the information needs of Afghan academics, researchers, students, and other stakeholders due to insufficient resources,

transparency, and efficiency in collecting, processing, storing, and disseminating knowledge and information. Information scientists and library experts emphasize a web-based library system over traditional forms of libraries to ensure secure, efficient, and user-friendly library facilities for all (Gharanai and Paracha, 2016). However, To keep pace with the rest of the world, digitization of the libraries is essential, and the steps towards a digital Bhutan got started with the inclusion of computers and other smart technologies in libraries to provide quality information services to the citizens of the state (Dorji, 2014). At present, academic libraries are transitioning toward online-based integrated library systems using Koha. Most of the libraries are operated by Library Assistants without prior training or library-related academic qualifications (Wangdi, S. and Dorji Tamang, 2023).

Smart Library Movement In Bangladesh In Relation To Other South Asian Countries

RQ2. How far has technological integration evolved within the South Asian countries?

The smart library movement in Bangladesh can be considered as gradually progressing but uneven, compared to South Asian countries. University libraries demonstrate a slow yet steady integration of smart technologies, with noticeable differences between public and private institutions. Public university libraries have largely focused on foundational digital services, such as OPACs, integrated library management systems, e-journal access, institutional repositories, and, in a few cases, RFID adoption, while also emphasizing inclusivity through specialized services for users with physical disabilities. However, their pace of technological transformation remains constrained by funding limitations, administrative inertia, and infrastructural disparities. In contrast, private university libraries in Bangladesh are comparatively more advanced, having adopted RFID-based automation, cloud-hosted ILS platforms, institutional repositories, 24/7 e-library services, AI-assisted reference tools, and innovative user engagement mechanisms such as SMS and WhatsApp-based services, reflecting stronger institutional commitment and financial flexibility

When viewed in a broader South Asian context, Bangladesh occupies a middle position in the smart library landscape. India clearly leads the region, driven by strong national initiatives such as Digital India and the Smart Cities Mission, widespread adoption of ICT, and the growing application of Artificial Intelligence in library services, positioning Indian libraries at an advanced stage of smart transformation. Pakistan shares similarities with Bangladesh in facing financial, technical, and human resource challenges, although Pakistani libraries are still largely in a preparatory phase with limited IoT implementation. Nepal lags behind both Bangladesh and Pakistan, with minimal web-based services and weak professional training structures, resulting in slow progress toward smart libraries. Sri Lanka demonstrates moderate advancement, where library automation is common, but the adoption of advanced smart technologies such as AI, IoT, big data, and immersive technologies remains limited. Afghanistan is at an early rebuilding stage, focusing primarily on basic ILS implementation to establish digital library environments amid severe resource constraints, while Bhutan is

transitioning steadily toward web-based systems like Koha but faces shortages of trained library professionals.

Bangladesh's smart library movement is progressing more systematically than Nepal, Afghanistan, and Bhutan, is broadly comparable to Pakistan, but remains significantly behind India and, to some extent, Sri Lanka. The country shows promising developments, especially in private universities, but lacks a cohesive national policy framework, large-scale funding mechanisms, and regionally benchmarked strategies that could accelerate the transformation toward fully integrated smart libraries across all higher education institutions.

5. CONCLUSION

Kumar and Kumar (2019) show that the use of technologies in libraries, such as Radio Frequency Identification (RFID) Tools, Robotics, AI-based gadgets, and software, makes libraries self-sufficient and gives them the ability to think for themselves, which opens a new door that is going to transform our library system. However, this study reveals that public and private universities have ushered in an era of automation and digitization by introducing a Radio Frequency Identification (RFID) based automated university library and incorporating the KOHA Integrated Library Management System. These universities foster an inclusive and resourceful environment, ensuring the varied needs of their academic community by leveraging smart technologies such as Public Access Catalogues (OPACs), digital borrower ID cards, high-speed internet services, online databases, e-journals, and other vital resources. In another study, Hussain and Ahmad (2021) found that Pakistani university libraries are adopting Integrated Library System (ILS), Closed Circuit Television (CCTV) cameras, Radio Frequency Identifications (RFID), Self service kiosks, Digital repositions of e-books, theses, and archival records, Library websites, Online resources, databases, and Information Literacy (IL) instruction. Nevertheless, the outputs of this study reveal that almost none of the respondent libraries have introduced self-service kiosks and Information Literacy (IL) instruction yet.

Public university libraries are increasingly integrating digital and smart technologies to enhance academic and research support for their users. Common facilities include spacious reading areas, effective lending services, Online Public Access Catalogues (OPAC) for remote and efficient resource discovery, and digital borrower ID systems that streamline access to both physical and electronic materials. Among the specialized services, such as reference support, reprographic facilities, cyber centers, and resource centers for visually impaired users, to demonstrate a collective commitment to inclusivity, efficiency, and modernization, positioning these public university libraries as evolving knowledge hubs aligned with contemporary academic needs. In contrast, private universities have embraced RFID-based automation, self-check and book-drop systems, web-based and mobile-enabled services, institutional repositories, plagiarism detection tools, and 24/7 e-library access. Despite some differences, both public and private university libraries in Bangladesh share a common trajectory toward smart library development, marked by increasing reliance on OPAC, ILMS, digital resources, and networked services.

In the South Asian context, Bangladesh occupies a middle position in the smart library landscape. India clearly leads the region, driven by strong national initiatives such as Digital India and the Smart Cities Mission, widespread adoption of ICT, and the growing application of Artificial Intelligence in library services, positioning Indian libraries at an advanced stage of smart transformation. Pakistani libraries are still largely in a preparatory phase with limited IoT implementation, and Nepal lags behind both Bangladesh and Pakistan, with minimal web-based services and weak professional training structures, resulting in slow progress toward smart libraries. However, Bangladesh's smart library movement is progressing more systematically than Nepal, Afghanistan, and Bhutan. Besides, the country shows promising developments, especially in private universities.

Cheung et al (2025) suggest that potential data confidentiality and safety issues, and any moral consequences of using smart technologies, need to be taken into consideration for libraries in Hong Kong. They also advocated for the training of library professionals and taking precautionary measures against the potential risks of security breaches or privacy defilements. However, future research on the potential threats, security concerns, ethical considerations, and other issues regarding smart technologies will help university libraries cope with the recent developments of smart library initiatives to a great extent in Bangladesh.

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