Indonesian Journal of Library and Information Science
E- SSN: 2747-2140, P-ISSN: 2747-2132
Volume 6. No.2 (2025)
Doi: 10.22373/ijlis.v6i2.8427

APPLICATION OF SMART TECHNOLOGIES IN UNIVERSITY LIBRARIES TO SPEARHEAD SMART LIBRARY PROGRAM IN BANGLADESH

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Diterima: 20/09/2025
Selesai Revisi: 22/12/2025
Diterbitkan: 31/12/2025

Abstract

Libraries around the globe are now adopting emerging and innovative technologies to offer prompt and transparent library and information services to users. The application of these cutting-edge technologies harnesses libraries' efficiencies and efficacies to fulfill users' needs and requirements to a great extent. However, university libraries in Bangladesh are now leveraging the blessings of emerging technologies to keep pace with the rest of the world regarding meeting challenges in proficiently dealing with savvy library users. This paper is mainly a qualitative approach aiming to focus on the status of the application of smart technologies by university libraries in Bangladesh. Besides, the authors highlight the emerging technologies currently adopted in academic libraries. This paper provides a comprehensive understanding for researchers and policymakers regarding the application of smart technologies in university libraries.

Keywords: *Smart Library, Emerging Technologies, Internet of Things, Cloud Computing, and DSpace*

Abstrak

Perpustakaan di seluruh dunia kini mengadopsi teknologi baru dan inovatif untuk menawarkan layanan perpustakaan dan informasi yang cepat dan transparan kepada pengguna. Penerapan teknologi mutakhir ini meningkatkan efisiensi dan efektivitas perpustakaan untuk memenuhi kebutuhan dan persyaratan pengguna secara maksimal. Namun, perpustakaan universitas di Bangladesh kini memanfaatkan teknologi baru

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untuk mengikuti perkembangan dunia dalam menghadapi tantangan dalam menangani pengguna perpustakaan yang cerdas secara profesional. Makalah ini terutama menggunakan pendekatan kualitatif yang bertujuan untuk fokus pada status penerapan teknologi cerdas oleh perpustakaan universitas di Bangladesh. Selain itu, penulis menyoroti teknologi baru yang saat ini diadopsi di perpustakaan akademik. Makalah ini memberikan pemahaman komprehensif bagi peneliti dan pembuat kebijakan mengenai penerapan teknologi cerdas di perpustakaan universitas.

***Kata kunci**: Perpustakaan Cerdas, Teknologi Baru, Internet of Things, Komputasi Awan, dan Dspace*

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).

The library is an academic nerve center that 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.

2. LITERATURE REVIEW

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. Further research emphasizes how big data, blockchain, and artificial

intelligence (AI) are influencing smart libraries. For instance, Yang and Li (2019) investigated how AI-powered chatbots might be integrated into university libraries to improve user engagement and automate reference services. Achugbue et al. (2023) recommended that university libraries should expand the utility of smarter library services and step up the deployment of smart library services to enhance user access and operational efficiency. Similar to this, Kumar and Singh (2021) talked about how blockchain technology can improve library record administration, guarantee safe digital transactions, and stop data manipulation. Additionally, Hasan et al. (2022) highlighted that the advantages of smart technologies in Bangladesh include that digital literacy training is essential for both librarians and users. They contended that deploying smart technologies might not produce the intended results in the absence of adequate training and policy backing. Correspondingly, Jahan and Kabir (2023) emphasized the value of mobile applications in university libraries, which enhance information retrieval efficiency and provide remote access to academic resources. However, none of the papers covered the status of the application of smart technologies in public and private universities in Bangladesh. Besides, the state of technological usage in public and private universities, along with the challenges in adopting smart technologies, remained unaddressed in these papers.

Purpose of the Study

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

a) To discuss the smart library and its key elements
b) To identify the emerging technologies currently adopted in academic libraries
c) To highlight the challenges in adopting smart technologies

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 twenty university libraries, comprising 10 public and 10 private universities, to point out the usage of ICTs, automated library technologies, and other innovative technologies to provide prompt and transparent information services to the end users.

Sampling Techniques and the Rationality of Choosing Sample Areas

Purposive sampling has been adopted in this study to choose 20 university libraries, 10 public and 10 private, from throughout Bangladesh. The selection ensures diversity in library kinds and technical methods. Private university libraries were picked for their reasonably sophisticated ICT infrastructure and willingness to embrace smart technology, whereas public university libraries were chosen for their greater holdings and human resources. To represent a national viewpoint, libraries from different areas

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were selected. Taking institutional features and the changing demands of users in the digital age into account, this method aids in analyzing the present level of smart technology adoption in university libraries.

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)	Shahjalal University of Science and Technology (SUST) Library	https://www.sust.edu/
6.	Khulna University	Khulna University Library	https://ku.ac.bd/
7.	Islamic University, Kushtia	Islamic University, Kushtia	https://www.iu.ac.bd/
8.	University of Barisal	University of Barisal Library	https://bu.ac.bd/
9.	Rajshahi University of Engineering & Technology (RUET)	Rajshahi University of Engineering & Technology (RUET)	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/

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

The concept of a “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 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, Mercy, and Chioma, 2023). Therefore, 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.

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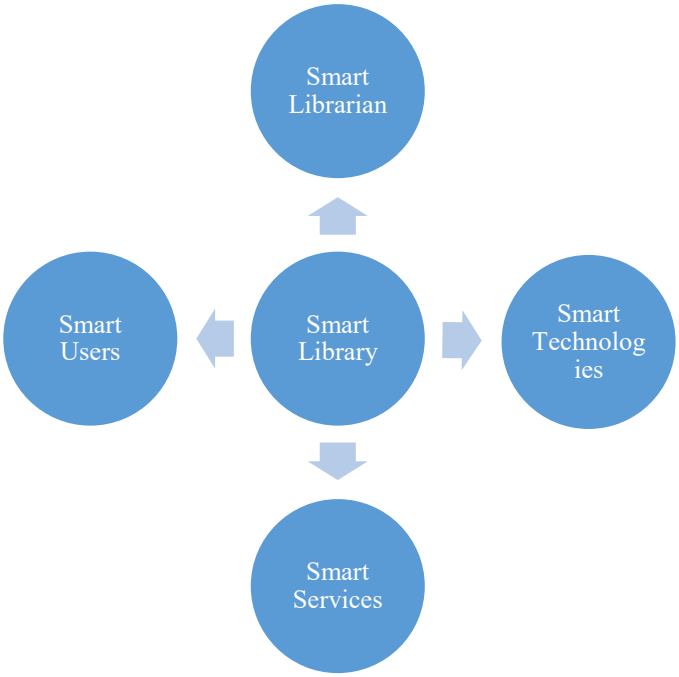

Figure1: Four Key Elements of Smart Library

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.

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.

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.

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.

Smart Technologies 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). Here are some of the notable innovative technologies widely used in libraries and information centers around the world.

Internet of Things(IoT)

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).

Radio Frequency Identification(RFID)

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).

Integrated Library Software (ILS)

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).

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OpenBiblio

It 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).

DSpace

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).

Greenstone

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

Cloud computing refers to the 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

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 (AI)

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)

Information retrieval through AI

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).

Expert System

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).

Use of Broadband Internet Connectivity

Robust broadband connectivity should be given the highest priority for ensuring quick and prompt access to the library resources. Besides, cutting-edge libraries with innovative cataloguing facilities make libraries a worthwhile place for exploring the world of knowledge and information. Visser & Ball (2013) insisted that robust Broadband Internet Connectivity is an essential element for an organization to share and receive information. Additionally, the efficiency and utility of the smart library technologies depend solely on uninterrupted and robust internet connectivity.

Apart from the above innovative library technologies, 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.

4. DISCUSSION

Status Of Smart 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.

Dhaka University Library

The Dhaka University Library provides a wide range of facilities aimed at fulfilling the academic and research requirements of its users. Included are large reading areas designed for concentrated study, effective book lending services that enable users to borrow physical materials, and an Online Public Access Catalogue (OPAC) that

simplifies access to the library's vast collection. Users enjoy the advantage of digital borrower ID cards, which allow for easy borrowing and access to digital content. The library boasts high-speed internet services, empowering users to investigate online databases, e-journals, and other vital resources. Comprehensive reference services are offered, helping users find specific information, while access to numerous print and online journals, newspapers, and reprographic services like photocopying and CD duplication further enrich the library's offerings. Moreover, the library includes a dedicated resource center for sight savers, equipped with adaptive technologies and materials aimed at assisting individuals with visual impairments.

Rajshahi University Library

To improve its operations and user experience, Rajshahi University Library is advancing its integration of Internet of Things (IoT) technology. One important use is the implementation of Radio Frequency Identification technology (RFID), which brings new life to the lending of books and inventory management procedures. Besides, the library automates the check-in and check-out processes by attaching Radio Frequency Identification tags to books, which significantly reduces user wait times and improves inventory management accuracy. Furthermore, the library's extensive collection is made more accessible via its Online Public Access Catalogue (OPAC), which allows patrons to quickly search for and locate materials from any internet-connected device. The library offers digital borrower ID cards that facilitate the seamless borrowing of both electronic and physical resources to improve customer convenience further.

Bangladesh University of Engineering and Technology (BUET) Library

The Bangladesh University of Engineering and Technology Library offers convenient access to its vast collection of books, journals, and scholarly resources through its Online Public Access Catalogue (OPAC), which enables users to search and discover materials easily and remotely. In order to expedite the borrowing procedure and provide efficient access to both digital and physical resources, the library also employs a digital borrower ID system. For the community at Bangladesh University of Engineering and Technology that is focused on study, high-speed internet throughout the library guarantees that patrons may connect to a variety of digital resources, such as e-books, scholarly journals, and specialized databases. An automated library management system also manages important operational duties, including user monitoring, inventory control, and book lending, increasing administrative effectiveness and service speed.

Jahangirnagar University Library

With an emphasis on technology-enhanced resources, the Jahangirnagar University Library is committed to assisting its campus community's academic endeavors. It offers digital borrower ID cards for smooth resource access and administration, as well as an Online Public Access Catalogue (OPAC) for simple content searches. Users may study a wide range of digital resources, such as databases and e-journals, using high-speed internet access. The library is a key resource for staff and students in their academic endeavors because of its computerized system for inventory tracking and resource management, which further improves operational efficiency.

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Chittagong University Library

Chittagong University Library serves as a key academic hub by integrating digital technologies into its offerings. With an (OPAC) Online Public Access Catalogue, users can remotely search the library's extensive collections, which include physical and digital materials. Digital borrower ID cards streamline borrowing, and high-speed internet access supports academic research by connecting users to digital resources, including e-books and scholarly journals. Additionally, the library uses automated resource management to handle inventory and lending processes efficiently, creating a user-friendly environment that aligns with modern educational needs.

Shahjalal University of Science and Technology (SUST) Library

(SUST) Shahjalal University of Science and Technology Library enhances academic access through smart technologies, making resources available to students and faculty. Effective catalog searches are made possible by the(OPAC) Online Public Access Catalogue, and a seamless borrowing experience is made possible by digital borrower IDs. Research efforts are supported by access to a wealth of e-resources and fast internet. In an academic institution that is heavily reliant on technology, the library's use of an automated management system allows it to efficiently manage inventory and resource circulation, cutting down on wait times and increasing operational efficiency.

Khulna University Library

Khulna University Library provides comprehensive support to students and faculty by integrating digital tools into its services. Digital borrower ID cards make it easier to borrow and return materials, while the Online Public Access Catalogue provides remote access to search library resources. Users may easily access a variety of online databases and publications thanks to high-speed internet. The automated resource management system improves customer service and inventory control, enabling the library to more effectively and efficiently satisfy the needs of its academic community.

Islamic University Library, Kushtia

Islamic University Library in Kushtia is committed to fostering an accessible, tech-savvy learning environment. Digital borrower IDs expedite the borrowing process and facilitate resource access, while the(OPAC) Online Public Access Catalogue system facilitates effective material searches. Research is made easier by high-speed internet, which gives users access to a wealth of digital resources, including e-books and online journals. The computerized circulation and inventory management system at the library facilitates effective day-to-day operations, guaranteeing a seamless experience for all patrons and meeting the changing demands of the academic community.

University of Barisal Library

The University of Barisal Library leverages smart technologies to serve its students and faculty effectively. Digital borrower IDs provide a simplified borrowing experience, and the (OPAC) Online Public Access Catalogue makes it simple to access the library's contents. The availability of e-resources, such as academic databases and online journals, facilitates study when a high-speed internet connection is available.

Furthermore, an automated system oversees the circulation and inventory procedures, guaranteeing that library operations are effective and responsive to patron demands, promoting a positive learning and research environment.

Rajshahi University of Engineering & Technology (RUET) Library

RUET Library is designed to meet the research demands of engineering students and faculty by integrating digital and smart technologies. Its Online Public Access Catalogue (OPAC) system provides convenient search capabilities, and digital borrower IDs simplify resource access. High-speed internet connectivity enables users to explore digital resources, such as academic journals and databases. Automated resource management helps maintain the organization of physical and digital collections, reducing manual tasks and enabling the library to serve as an efficient, user-focused research environment.

North South University

Among the country's most reputable private universities, North South University has started implementing smart technologies in its library to offer better information services. According to the information available on the library's website, North South University has initiated the country's first Radio Frequency Identification (RFID) based automated university library by incorporating the KOHA Integrated Library Management System, which supports MARC21, web based online lending and receiving, browsing audio visual materials, searching full text online books, tracking circulation system, maintaining Radio Frequency Identification (RFID) self check and book drop records, auto email alert services, and so on. The users can issue and return books with the help of Self Check and Book Drop machines.

BRAC University

The Ayesha Abed Library of BRAC University is one of the automated and smart libraries that introduced the Radio Frequency Identification System in Bangladesh. In addition, this library completed its new Drupal-based website (a free and open source content management system) in 2012 and introduced SMS services for the end users. However, the library has an institutional repository for the preservation of research materials and making them easily available and accessible. Moreover, it provides access to Turnitin for the assessment of the originality of any documents.

East West University

Dr. S. R. Lasker Library of East West University maintains institutional repositories to collect, preserve, and disseminate digital resources for academics, researchers, and other stakeholders to encourage scholarly communication. Besides, the library introduced an Instant Reference Service through WhatsApp along with SciSpace Literature Review to provide prompt reference queries and research assistance to scholars and academics. Furthermore, the online cataloguing system of the library helps users to search and retrieve information quickly and efficiently.

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Daffodil International University

Daffodil International University Library provides e-library facilities to ensure round-the-clock information services. Maintaining an institutional repository with the DSpace repository software package makes the library a unique hub for offering smart library services for scholars and other stakeholders. Besides, the library stores 47 e-books and e-journal publishers in its database to guide researchers in their fields of research with numerous articles, books, and other items of knowledge. Moreover, the library assists the end users in searching for information promptly and user-friendly through the Online Public Access Catalog.

Independent University of Bangladesh (IUB)

IUB library is equipped with robust internet connectivity and 67 network-activated Computers to offer e-books, e-journals, and other open-access materials to students and academics. The library also possesses 4339 audiovisual materials and preserves Internship reports in electronic forms like CDs & DVDs based on the requirements of different disciplines of the university. The library archive of IUB preserves official records, various artifacts, and other important documents like photographs, university publications, records from various disciplines, and yearbooks.

University of Liberal Arts Bangladesh (ULAB) Library

The ULAB Library is dedicated to enhancing the academic experience of its students and faculty through the integration of advanced technologies. With an Online Public Access Catalogue (OPAC), users can conveniently search the library's collections, which include books, journals, and digital resources. The library employs digital borrower ID cards to streamline the lending process, ensuring quick access to materials. High-speed internet connectivity allows users to access a vast range of online databases and e-journals essential for research. The library's automated management system enhances operational efficiency, allowing staff to focus on providing excellent user support while maintaining a well-organized collection.

Asian University for Women Library

The Asian University for Women (AUW) Library plays a crucial role in supporting its academic community by incorporating modern technologies into its services. The library features an OPAC system for easy navigation of its resources, including both physical and digital materials. Digital borrower IDs facilitate a streamlined borrowing process, while high-speed internet access connects users to a wealth of online resources, including scholarly articles and e-books. The library employs an automated resource management system to efficiently handle circulation and inventory, creating a user-friendly environment that fosters research and learning among students and faculty.

United International University Library

The United International University (UIU) Library enhances academic engagement through its integration of smart technologies. The library's online public catalogue (OPAC)allows users to easily search and locate various materials, while digital borrower ID cards provide a convenient borrowing experience. High-speed internet ensures that users can access a broad array of digital resources, including academic

journals and databases, which are vital for effective research. An automated management system further streamlines library operations, making it easier for staff to manage collections while improving user services, ultimately supporting the university's mission of academic excellence.

American International University Bangladesh (AIUB) Library

The AIUB Library is committed to fostering a technology-enhanced learning environment for its students and faculty. It features an online public catalogue (OPAC) that allows for efficient searching of library holdings, including books, journals, and electronic resources. The library employs digital borrower ID cards to simplify the borrowing process, ensuring users can access materials quickly. With robust internet connectivity, users can easily access numerous online databases and e-journals crucial for their academic research. The library's automated resource management system enhances the efficiency of operations, allowing for effective inventory management and improved user services, aligning with AIUB's commitment to academic success.

Green University of Bangladesh Library

The Green University of Bangladesh Library is dedicated to providing a modern, resource-rich environment for its academic community through the integration of smart technologies. With an Online Public Access Catalogue (OPAC), users can search the library's extensive collections with ease. Digital borrower IDs streamline the borrowing process, ensuring quick access to both physical and digital materials. High-speed internet access enables users to connect to a wide range of online resources, including e-books and academic journals, supporting their research needs. The library's automated management system enhances operational efficiency, enabling staff to deliver improved support services and create a conducive atmosphere for learning and research.

Challenges in Adopting Smart Technologies

Bangladesh has made substantial progress in ICT-oriented information service delivery to its citizens, and libraries are continually adopting emerging technologies to meet the information needs of their users. However, the overall progress is not highly satisfactory. There are several issues related to the successful installation of smart technologies that are slowing down the progress of digital libraries in Bangladesh (Shuva, 2014). Here are some key factors that need to be considered while adopting smart technologies in libraries.

Sufficient Funds

The adoption of smart technologies in university libraries requires a lump sum of money. Besides, the installation and maintenance costs of these technologies are obviously a challenging issue for many universities in Bangladesh.

Infrastructural Facilities

The infrastructural facilities, while adopting smart technologies, must encompass necessary hardware and software resources for providing better information services to

the students, teachers, and other scholars. These facilities are crucial for attaining the academic success of a university library.

Expert LIS Specialists

The success of the application of smart technologies in university libraries depends largely on the expertise of library and information science (LIS) specialists. They play important roles in managing, customizing, and troubleshooting library systems and services.

Change Management

Switching from a traditional library system to a smart technology-based system depends on the library staff's mindset toward change. This process involves a positive attitude of the library professionals in planning, implementing, and reinforcing massive change in the library system and services.

User Experience

The users have to be familiar with the use of smart technologies. Libraries need to train users on how to access information services through smart technologies. Besides, the library professionals must ensure that the users can interact with the systems easily.

Administrative Support

Administrative support in the application of smart technologies encompasses the tasks and duties that library professionals have to perform to ensure the library's housekeeping operations, organizing e-resources, managing effective communication, and other crucial functions of a university library. The growth of an academic library depends on the support of the university administration to a great extent.

Security and Privacy Issues

University libraries may face significant security and privacy issues due to the dependency on interconnected technologies like AI, RFID, Cloud Computing, and IoT appliances that have the possibility of data breaches. Therefore, library professionals need to build robust security measures to protect the library's data and information from being stolen, distorted, and hacked by cybercriminals.

Apart from the above challenges, llibrary professionals must focus on eliminating digital divide to implement smart library initiatives. Therefore, librarians have to provide adequate user training and support to bridge digital divide, and ensure all the stakeholders of a university get the benefits from the smart technologies (Adhikari and Paswan,2024).

5. DISCUSSIONS & CONCLUSIONS

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, abundant setting and ensure the varied needs of their academic community by leveraging smart technologies like 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 none of the respondent libraries have introduced self-service kiosks and Information Literacy (IL) instruction yet.

In a study, Igwe and Sulyman (2022) show that technological barriers, expert librarians, technophobia among the staff, poor power supply, and lack of sound ICT infrastructure hamper the progress of Smart Library initiatives. Similarly, this study highlights the challenges that Bangladeshi university libraries are facing while adopting smart technologies. Further research needs to be carried out to reveal the strengths and weaknesses in the application of smart technologies in university libraries in Bangladesh. 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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