Innovative Computing Review (ICR)
Volume 6 Issue 1, Spring 2026
ISSN$_{(P)}$: 2791-0024, ISSN$_{(E)}$: 2791-0032
Homepage: https://journals.umt.edu.pk/index.php/ICR

Article QR

Title:	**Systematic Review of Augmented Reality Adoption in Libraries: Benefits, Barriers, and User Engagement**
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DOI:	https://doi.org/10.32350/icr.61.04
History:	Received: January 23, 2026, Revised: February 25, 2026, Accepted: April 24, 2026, Published: June 25, 2026
Citation:	M. R. Sheikh, N. e. Sehar, and A. Asif, "Systematic review of augmented reality adoption in libraries: Benefits, barriers, and user engagement," *Innov. Comput. Rev.*, vol. 6, no. 1, pp. 51–64, December. 2026, doi: https://doi.org/10.32350/icr.61.04.
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Conflict of Interest:	Author(s) declared no conflict of interest

A publication of
School of Systems and Technology
University of Management and Technology, Lahore, Pakistan

Systematic Review of Augmented Reality Adoption in Libraries: Benefits, Barriers, and User Engagement

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ABSTRACT Augmented Reality (AR) has transformed peoples' perceptions of reality over the past few decades. In libraries, AR is changing how and what individuals perceive when consuming knowledge. The current study aimed to examine the use of AR in libraries including its advantages, obstacles, and user involvement. The study employed PRISMA standard, in which literature was compiled from five databases and the Google search engine. Furthermore, the study used 26 primary manuscripts published between 2010 and 2024. At the same time, studies have demonstrated that AR significantly increases user engagement and learning outcomes. Additionally, it also enables new ways to access relevant content in libraries, supports creative activities at makerspaces and different forms of experiential learning, as well as offers librarians a more efficient tool for library management. ShelvAR and ARLib are two AR applications that assist users in locating books. Moreover, these applications are also helpful in showing a virtual tour of the library. AR integrates devices into the real world to enhance authenticity. To employ AR in libraries more effectively, preparation, budgeting, technical expertise, understanding, and knowledge are required. The main aspects that need consideration include privacy-related matters, keeping things updated, and providing content. To sum it up, AR can convert libraries into innovative learning venues. It gets users involved by adding videos and other features, which aligns well with how people learn today. For libraries to use AR effectively, they need to plan, train their staff, and team up with others to address any problems. Future studies should examine how AR supports learning and user happiness, ensure that anyone can use it, and identify the best ways to integrate it into libraries.

INDEX TERMS Augmented Reality, applications, AR-based library services, library services, user engagement

I. INTRODUCTION

The word Augmented Reality (AR) is a combination of 'Augmented' and 'Reality'. This enhances the worth and value of the respective word by providing a combined view of our surroundings that supplements them rather than changing them [1]. Thereby, it enhances human perceptions and interactions with real-world objects by covering 3D virtual objects within the same native context [2]. Additionally, it incorporates audiovisual materials and 3D models, transforming the makeup of library collections, services, operations, and functions in a real-world environment. AR technology has transformed libraries by overlaying augmented information [3]. In 1990, Boeing researchers later developed the term "Augmented Reality", and during the 1960s, Ivan Sutherland and his team created the inaugural AR prototypes, titled "Sword of Damocles" [4].

In library services, AR has emerged as a viable technology. Moreover, libraries have

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now shifted towards user-centered services, and are also aiming to create personalized experiences for their patrons [5]. Due to the lack of awareness, knowledge, interest, and expertise, there remains a significant gap in understanding and implementing the successful integration of AR technology in library settings [6]. AR tools and applications are effectually utilized to promote the library resources and services, such as library tour guides. Moreover, 3D virtual aspects of library materials can be integrated into more creative ways [7, 8]. Technological devices, including computers, interactive whiteboards, and mobile devices, have demonstrated a considerable value in assisting librarians, students, and researchers [9]. There are three distinct types of Augmented Reality (AR) systems: GPS and Compass-based AR Systems, Marker-based AR systems, and Marker-less AR systems [10].

Implementing AR technology in library settings presents numerous challenges. These include a lack of awareness, inadequate training, limited IT expertise, the need for cost-effective devices, security concerns, as well as the requirement for suitable hardware and software and robust information capabilities. As AR hardware evolves, applications would also pose new challenges, including financial constraints that hinder the introduction of AR in libraries for novel services [7]. There is a need to study AR technology in order to develop an appropriate concept aligned with user wants and expectations, to prevent usability difficulties [11]. The rationale for the absence of user evaluation in AR could be due to a lack of guidance on evaluating the AR experience, organizing experiments, identifying relevant methods, employing empirical methods, and interpreting results.

This research aimed to determine the impact, benefits, problems, and user involvement of libraries' use of AR technology. To achieve the objectives, 26 AR-based research publications were analyzed in the literature.

A. STUDY OBJECTIVES

The current study aimed to address the following research objectives:

- To assess the implementation/adoption of AR in libraries.
- To evaluate the benefits of AR implementation/adoption in libraries.
- To identify obstacles to the adoption of AR in libraries.

II. METHODOLOGY

The research employed the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) approach. “PRISMA is utilized for the reporting of reviews and the evaluation of randomized trials, however, it may also serve as a foundation for reporting systematic reviews”. There are four processes in PRISMA. These include identification, screening, eligibility, and inclusion [7]. A Systematic Literature Review (SLR) methodology was employed to establish the research objectives. The four steps utilized to perform this SLR included: planning, selection, extraction, and completion. The following steps are discussed in detail below.

A. STEP 1: PLANNING

In this step, six scientific databases and Google Scholar were used to search for articles on the adoption of AR in libraries. The databases included Emerald, Google Scholar, IEEE, LISTA, Scopus, and Wiley Inter Science. Articles published in peer-reviewed journals were accessed. Various filters were employed via advanced search

options to refine the results. The articles were searched using a year range of 2010-2024.

Relevant research was conducted on the adoption of AR in libraries, its influence, challenges, benefits, and user involvement. Different keywords were used to find articles relevant to the research objectives. The phrase search option was also employed to prevent any extraneous materials from affecting the authenticity of the recovered literature. The subsequent terms and keywords were employed to identify the most suitable core studies for the investigation. These are mentioned as follows:

"Augmented reality" or "AR technology" or "mixed reality". Furthermore, these keywords and terms also included "libraries" or "library services" or "academic libraries" or "public libraries".

These also included "AR applications" or "augmented reality in libraries" or "AR-based library services" or "barriers to adopting AR in libraries" or "AR implementation in libraries" or "impact of AR on user engagement in libraries" or "AR's influence on library services" or "AR user engagement in libraries".

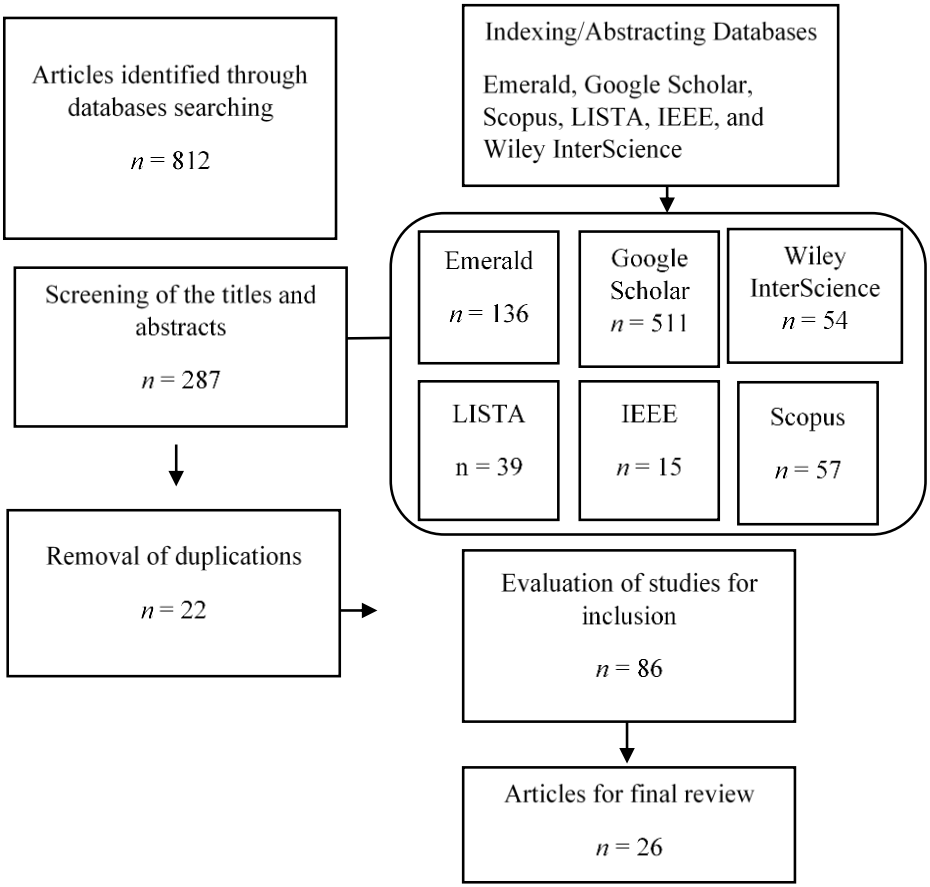

FIGURE 1. PRISMA flow diagram

B. STEP 2: SELECTION

Eight hundred and twelve retrieved papers shown in Figure 1 were verified using five scientific databases and one academic search engine to ensure accuracy and relevance. This method involved rigorous inspection of the titles, language, genre, and substance of selected articles to identify the most relevant seminal research papers. Table 1 outlines the inclusion and exclusion criteria.

C. STEP 3: EXTRICATION

The procedure for extrication entailed skimming the title and the abstract, skimming the introduction and conclusions, skimming the whole text, deleting duplicates, and quality evaluation (QA). The searched articles were assigned a score for each category. The score mapping comprised the alternatives of "yes", "no", "partially", and "not at all". Articles that addressed the specific criteria received a score. An appropriate score was required for the papers to be included in the current study. This technique aided in the selection of the most appropriate documents to conduct the SLR on the topic under investigation.

TABLE I

INCLUDED AND EXCLUDED PAPERS

No	Included Papers	Excluded Papers
1	Papers published in the English language.	Documents not published in the English language.
2	Papers addressing the research aims of the study.	Documents that do not align with the study's aims.
3	Research articles published between 2010 and 2024.	Research papers published before 2010.
4	Papers covering important study variables.	Papers not covering the major concepts of the study.
5	Only research papers that have been peer-reviewed.	Conference proceedings, books, book chapters, gray literature, dissertations, magazine articles, institutional reports, newspaper articles, and institutional newsletters.
6	Research papers were published in these databases: LISTA, Wiley Inter Science, Emerald, IEEE, Google Scholar, and Scopus.	The publication of papers in institutional repositories, blogs, search engines, and social networking websites was not covered.
7	Articles that match the study's topic.	Research papers did not match with study's topic.

D. STEP 4: COMPLETION

The final phase involved confirming the legitimacy of the retrieved studies. The benefits, challenges, effects, and user engagement associated with AR adoption in libraries were categorized after examining the selected documents. Finally, 26 selected papers were identified that were related to the adoption of AR in the library setting. Figure 1 shows the procedure for selecting the articles.

III. RESULTS

A total of 26 primary studies were gathered through the search process. The following sections outline the outcomes of PRISMA in line with the research objectives. Articles on AR adoption in library settings were largely published in Emerald and Google Scholar (as shown in Fig. 2). The majority of relevant papers were obtained from these sources because they publish articles related to AR.

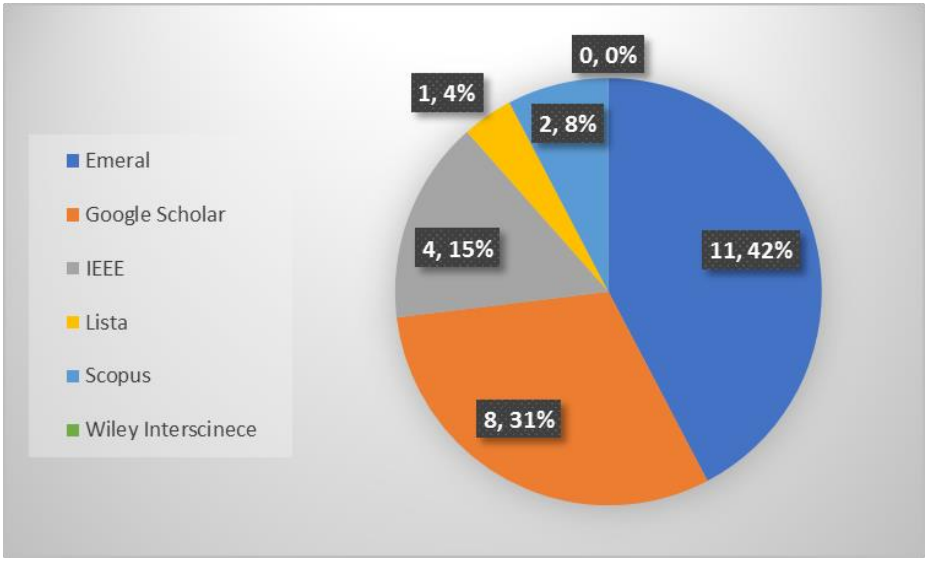

FIGURE 2. Adoption of augmented reality in libraries

A. ADOPTION OF AUGMENTED REALITY (AR) IN LIBRARIES

The findings determined the effects of AR on user engagement, advantages, challenges, and applications related to its adoption. Twenty-first-century libraries are progressively adopting technology across all facets of their operations. These libraries are called "smart libraries", a term introduced by Aittola [12]. The adoption of AR in libraries helps create innovative learning spaces.

B. USER ENGAGEMENT

AR provides a refined, user-friendly environment, unlike virtual reality, which is a digital experience; it enhances library patrons' interaction with informational resources to attract more users [13]. Additionally, in a real-world context, AR enhances the efficacy and effectiveness of education for users [11]. To engage users to showcase their materials, services, and resources, libraries can offer innovative methods [5]. It is easy to use and enjoyable to adopt AR technology, which directly influences users' attitudes and inclinations by engaging them in more creative ways [8]. In a library, it also helps users find books. It indicates the location of books on the shelves, provides e-book service, offers cohesive displays, such as audiovisual content, library, and city tours, as well as offers detailed information about book content through mobile device scanning [6]. Understanding and developing users in real-world contexts is another objective of AR. The purpose of AR is to provide virtual reality in the physical world, rather than

offering a direct glimpse of real-world environments [14].

C. AR APPLICATIONS

Numerous AR applications have been developed for educational and training purposes since the late 1960s; additionally, more practical applications are still being explored and implemented [15]. Other applications were being developed in the late 1990s, such as ARToolKit. Volkswagen created MARTA in 2013, Google unveiled Google Glass in 2014, and Microsoft released HoloLens in 2016. These applications provide immersive experiences, offer technical support, and enable users to explore their surroundings, also utilizing webcams and smartphones, to connect users in real-world settings [4]. By providing interactive interfaces for library services, including administrative operations, user services, educational activities, cultural programs, and promotional events [16]. For book stock recognition, navigation, and user identification, libraries use AR-based smartphone applications [17]. The University of Applied Sciences Potsdam developed myLibrARy, an AR app that provides library media evaluation and location information. ShelvAR, developed by Miami University, aids librarians in inventory and identifying books. LibrARi, an image-based AR program for mobile devices, helps users find their preferred books. The Bavarian State Library's smartphone app features a 3D e-book that allows users to view and interact with medieval manuscripts [18]. “SAAS” stands for “Software as a Service” and “Storage as a Service” is an application that uses an Android device's built-in camera to capture library books, which are then analyzed by a server to extract their spine [19].

Two types of AR applications have been designed and developed: 1) Android or IOS mobile app-based and 2) Web-based mobile programs. Mobile apps are utilized to build the platform of Unity app, Unreal Engine platform, or other platforms. AR.js, ARframe, and three.js are used to construct web-based mobile AR apps utilizing the E-C-S framework [12]. Classification of AR systems is frequently based on several characteristics, including tracking technology, techniques of human-system interaction, and data management strategies [20].

D. TECHNICAL FUNCTIONING OF AR

AR works technically through two ways: Marker-based System and Marker-less System.

1) MARKER-BASED SYSTEM

Marker-based AR systems use components from the real-world environment to overlay computer-generated images on them [1]. ARToolkit is an Android SDK that uses marker-based technology to create AR applications. The library's technology is based on marker-based image detection. It works as: i) Procurement of images, ii) Recognition of markers and calculation, and iii) Three-dimensional objects orientation and placement [19].

2) MARKER-LESS SYSTEM

The use of a marker-less system in library settings provides users with an easy access to digital information, such as book content or 3D models, without the need for an object marker. According to Parashar [1], it uses electrical sensors to track objects, such as GPS, accelerometers, a compass, and a gyroscope, to grab 3D visuals in the real-world environment, and to provide a smooth user experience.

To access the book’s contents, such as

original artifacts, providing books, and valuable assets, libraries use the Augmented Reality Rare Book and Manuscript (AR Rare-BM) tool or application and head-mounted display (HMD device). This tool/application is used to search and identify the books and show virtual contents of the books [18].

The key aspect of adopting AR in library administration is to ease the task of finding and locating books. For this purpose, two techniques have been provided:

• Marker-based tracking

• Book spine-based tracking

ARLib is among the early AR applications built to support operational tasks in the library. It helps users return a book to the shelf, and an indication on the shelf reveals the book's correct location after the user scans the marking on the book [18]. AR technology can enhance library services, with applications, such as Shelv AR that indicate misplaced books on shelves [17]. ARLib and ShelvAR are library systems that use marker-based tracking to identify books, using distinct spine marks and context-aware images. ShelvAR uses icon tags to automatically correct book arrangements [21]. The AR book is an Android application incorporating bookmarks on each page, linking to supplementary content. A smartphone camera scans a marker, producing 3D pictures and videos that may be rotated, scaled, and translated [4]. The use of AR applications reduces librarians' workload and enhances the user experience. Libraries utilize AR-mediated tours to introduce new users to various sections and inform them about available resources and services [22].

E. CHALLENGES/BARRIERS TO ADOPTING AR IN LIBRARIES

Implementing AR technology in libraries faces obstacles, such as staff training, hardware and software, a lack of IT expertise, infrastructure, cost-efficient devices, as well as information processing capabilities. However, it can attract users and improve library management [13]. AR technology requires extensive study and research to develop an appropriate concept aligned with user wants and expectations to avoid difficulties [11].

Moreover, implementing AR technologies maybe restricted due to financial barriers, including funding issues, unfamiliarity with technology, human resources concerns, ethical considerations, accessibility issues, production, and deployment [23]. Despite this, due to inadequate financial support and a lack of understanding of its urgency in such contexts, AR has not been widely accepted in the library environment [15].

Additionally, librarians face challenges in tackling AR applications, including the computer equipment and devices, which present numerous challenges. These include a lack of required technological expert staff to oversee AR applications, a lack of functionality issues in adding new content, and user-created features [7], [14].

Due to high costs and slow development, adopting AR technologies in libraries faces barriers, such as a lack of devices, limited content, security issues, and technical difficulties [24]. Further substantial challenges to the adoption of AR applications in libraries include technical constraints, such as hardware and software limitations, a lack of a native platform, and technological advancements [9]. The challenge is to provide patrons with an access to AR software [25].

AR maintenance applications typically follow a set of procedures. The issue concerns adopting an AR application to recognize and track real-world objects, as

well as their system reconfigurability [20]. Concerns may obstruct the mainstream adoption of AR in library services among users, including compatibility, connectivity, data privacy, accessibility, usability, complexity, cross-platform support, and dissemination [5]. To affect user experiences and dissemination, an application-based AR system requires more time and effort [26].

Challenges in implementing various introductions to AR include unclear availability of AR training, a lack of staff support, and limited programming skills in library services [25], [24]. Libraries face barriers in implementing AR due to integration issues, the high cost of design and maintenance, and scattered reluctance towards emerging technologies [15].

IV. DISCUSSION

The current study proposed a practical solution to effectively adopt AR in libraries. The study was based on a systematic review of the adoption of AR in libraries; the data spanned the period from 2010-2024.

AR provides unique learning opportunities for users and enhances their perceptions and engagement with the physical world, aligning with libraries' aim to create an innovative learning environment. AR tools are well-structured and facilitate efficient, interactive information literacy training and library tours. Via cutting-edge technology, it escalates the promotion of library services and resources and provides users with autonomous access to easily use them, engage in reading, and save time, reducing direct contact. It also demonstrated substantial potential to assist library staff, students, faculty, and researchers, as well as in technological devices, such as smartphones, smartboards, tablets, laptops, and computers. AR technology has become popular in library services by enhancing user-centered experiences and building interest and personalized experiences for patrons. Before effectively implementing AR technology in library services, it is important to comprehend the obstacles, interests, and awareness of librarians or library staff. These studies reported findings from Wójcik [2], Shahzad et al. [7], Vyas and Bhatt [10], Ajani et al. [6], Adewusi et al. [8], Dalili [9], Sumadio and Rambli [11], and Taha [5].

A. USER ENGAGEMENT

AR has provided a more engaging experience, boosted library patrons' interaction with informative resources and a user-focused environment, and improved the effectiveness of teaching and learning experiences for real-world users, unlike virtual reality, which is a digital experience. To showcase their assets and engage users, libraries have offered innovative methods, and AR technology has significantly affected users' attitudes and willingness, with a user-friendly, enjoyable nature. AR technology has made the library more fun by adding interactive displays, multimedia content, and extensive book information via mobile device scanning. This led to more visits to the city's historical library and more e-books. AR simplifies users experiences by providing virtual information and indirect views of real-world environments, such as live video streams, and enhances their understanding of real-world communication. These studies revealed the findings by Adeyemi et al. [13], Sumadio and Rambli [11], Taha et al. [5], Adewusi et al. [8], Ajani et al. [6], and Alkhamisi and Monowar [14].

The study findings demonstrated that as technological advancements increase, libraries are also up to date. Libraries are adopting AR technology and developing

more innovative methods to enhance the user learning environment for self-study and to engage users with real-world objectives within virtual contexts. It is also useful in libraries' daily operations, such as helping users read a book without touching or opening it, finding the correct location on the shelf, and providing an indirect view of the real-world environment, thereby developing users' understanding of the real and virtual worlds. Additionally, it improves the learning and teaching experiences compared to virtual reality. This is because AR has transformed pedagogical methods. To foster positive attitudes towards learning and make a user-friendly experience for self-directed education, users are more attracted and engaged with AR technology. Integrating multimedia content through AR technology in the library experience supports historical site tours, library tours, and library orientation.

B. AR APPLICATIONS

AR applications enhance library services by offering interactive displays of user services, educational initiatives, library resources, cultural programs, and promotional activities. AR smartphone applications are used in libraries for stock-taking of books, navigation, user identification, and locating books on the shelves, utilizing webcams to enhance interactive experiences. They do this by using webcams and smartphones to make the experience more interactive. SAAS, or Software as a Service, is an Android app that uses the device's camera to take pictures of library books. Platforms such as Unity, Unreal Engine, A-Frame, AR.js, and ECS are widely used to develop augmented reality (AR) applications for Android, iOS, and web-based platforms. Based on various factors, such as tracking technology, human-system interface approach, data management systems, and so on, AR systems are usually divided into these categories. These studies revealed the findings by Wójcik [16], Hussain [17], Mahadik et al. [19], Guha Roy and Kanjilal [12], and Lamberti et al. [20].

Findings demonstrated that AR provides enhanced interactive displays. In library settings, it increases user engagement, better integrates physical and digital collections of library materials, enhances accessibility, and improves resource access. This allows users to easily access digital collections and library services, including circulation, reference, digital services, and other services. It provides interactive exhibits that overlay multimedia content, such as 3D models, to deliver innovative displays in educational programs, including workshops and sessions on research skills and cultural promotional activities. Furthermore, it is also helpful in the collection development process, inventory assessment, stock-taking, and weeding out of library materials. Libraries use AR software or applications to enhance user engagement by allowing users to search for and organize books on shelves. AR systems in libraries utilize tracking technology and employ Android and iOS mobile applications. Additionally, these systems also utilize web-based programs and SAAS software, for tracking books, capturing images of library materials, and locating books on shelves by their spine labels, which are processed by a server to identify the books based on these labels.

C. TECHNICAL FUNCTIONING OF AR

There are two ways to achieve AR: Marker-based systems and Marker-less systems.

Marker-based AR devices use physical components to overlay computer-generated images. ARToolkit is an Android SDK for

AR applications that enables image acquisition, marker identification, and object positioning and orientation using marker-based technology. Marker-less AR systems employ electronic sensors, such as GPS, accelerometers, gyroscopes, and compasses to generate 3D graphics in the physical environment, thereby enhancing user experience. AR Rare-BM is a library tool that uses a head-mounted display (HMD device) to present a virtual book, allowing users to access its contents as if they were original artifacts. Mobile Augmented Reality (MAR) is being used in library administration to streamline book searching and determine its proximity, with two proposed methods, that is, marker-based tracking and book spine-based tracking. By using applications, such as ARLib and ShelvAR to search for books on shelves and display misplaced books, it uses marker-based tracking technology to locate books and automatically arrange them on shelves in an organized order. These findings were reported by Parashar [1], Mahadik et al. [19], Yusoff et al. [18], Hussain [17], Huang et al. [21], Zulfiqar [4], and De Sarkar [22].

Findings showed that, in libraries, marker-less systems for creating real-world 3D visuals use electronic sensors, such as GPS, accelerometers, gyroscopes, and compasses. The use of the AR Rare-BM tool in libraries to showcase virtual objects indicates book locations on the shelves. Moreover, it allows users to view book contents without touching the book, including original artifacts. To create computer-generated images to overlay real-world objects within the library using a marker-based reality system, and for image acquisition, marker recognition, and localization of books and objects in libraries, this Android-based application utilizes ARToolkit. Libraries use AR applications, that is, ARLib and ShelvAR, that use marker-based tracking to locate books on shelves and arrange them by call number. Additionally, these applications integrate digital information, such as book content or 3D models, into their real-world surroundings, incorporating activities, such as reading, navigation, tours, and promotional purposes.

D. CHALLENGES/BARRIERS TO ADOPTING AR IN LIBRARIES

Challenges faced in adopting AR in libraries include cost efficiency, lack of staff training, content, security issues, hardware and software, information processing capabilities, accessibility, and usability. These challenges also include dissemination issues, including complexity, cross-platform support, and additional time and effort. All these factors impact user experiences and dissemination. To establish a user-friendly environment, it is essential to have a comprehensive understanding of and expertise with AR technology devices, applications, and tools that align with user needs and expectations. Financial barriers, such as the high cost of devices, hardware and software, networks, infrastructure, design, maintenance, connectivity, native platforms, as well as physical surroundings make it difficult to integrate AR technology into libraries. Other issues after integration include technical problems, network and server connectivity issues, limited device availability, high hardware and software installation costs, and weak device development. Identifying and locating real-world objects with system configurations and maintaining AR applications and devices are the key barriers to integrating AR technology. These studies revealed the findings by Adeyemi et al. [13], Sumadio and Rambli [11], Subaveerapandiyan et al. [23], Lee [15], Noh and Shin [24], Greene

and Groenendyk [25], Dalili [9], Lamberti et al. [20], and Garzón [26].

For efficient and smooth operations, there is a need to ensure that AR applications, tools, devices, and hardware and software are compatible with system's configuration. Furthermore, it is a must to train library staff, provide training, and conduct workshops on AR technology. Moreover, libraries should train users, provide orientation on how to use AR technology, and explain its features and benefits, to generate concepts that match their expectations and preferences. Consequently, efficient functioning becomes challenging, necessitating the resolution of usability difficulties. Likewise, library patrons ought to be instructed in formulating concepts that align with their expectations and desires. Consequently, effective functioning becomes challenging, underscoring the need to address usability concerns.

E. CONCLUSION

This systematic review of AR in the library setting unveiled several pivotal findings. Moreover, it also helped in transforming library resources and services in more creative ways by promoting user engagement, revealing new teaching/learning practices, and enabling easy access to library resources and collections. It has been shown that AR can involve users in interactive ways, merging digital elements with the real world to stimulate curiosity and improve learning. Consequently, there are many barriers to integrating AR into libraries' budgets, including a lack of funding, staff resistance to adopting IT, and staff who are unqualified to use AR. Overcoming these challenges would require the entire community to develop a plan of action and invest in resources and training. AR apps transform the libraries into a smart space, enhancing the user experience through interactive exhibitions and customized services and resources. As a transformative technology, AR enables users to engage in dynamic, interactive learning communities within libraries, fostering stronger learning cultures. It engages students, enriches information delivery, and responds to individual tastes, signifying a substantial leap in modern education.

Author Contribution

Muhmmad Rameez Sheikh: conceptualization, data curation, formal analysis, writing – original draft, visualization. **Naweed e Sehar:** supervision, conceptualization, methodology, validation, writing – review & editing, project administration. **Alishba Asif:** data curation, investigation, writing – review & editing, validation.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

Data supporting the findings of this study will be made available by the corresponding author upon request.

Funding Details

No funding has been received for this research.

Generative AI Disclosure Statement

The authors did not use any type of generative artificial intelligence software for this research.

REFERENCES

[1] V. Parashar, “Augmented reality: A new era in education,” *Int. J. Eng. Technol. Manag. Res.*, vol. 5, no. 2, pp. 19–29, Feb. 2018, https://doi.org/10.29121/ijetmr.v5.i2.2018.608.

[2] M. Wójcik, “Potential use of augmented reality in LIS education,”

Educ. Inf. Technol., vol. 21, no. 6, pp. 1555–1569, Nov. 2016, https://doi.org/10.1007/s10639-015-9399-z.

[3] S. Kannegiser, "Effects of an augmented reality library orientation on anxiety and self-efficacy: An exploratory study," *Coll. Res. Libr.*, vol. 82, no. 3, pp. 352–369, May 2021, https://doi.org/10.5860/crl.82.3.352.

[4] F. Zulfiqar, R. Raza, M. O. Khan, M. Arif, A. Alvi, and T. Alam, "Augmented reality and its applications in education: A systematic survey," *IEEE Access*, vol. 11, pp. 143250–143271, 2023, https://doi.org/10.1109/ACCESS.2023.3331218.

[5] S. Taha, A. Kaba, and M. A. Al-Qeed, "Exploring students' perceptions toward the use of augmented reality for digital library services," *Digit. Libr. Perspect.*, vol. 40, no. 1, pp. 53–66, 2024, https://doi.org/10.1108/DLP-06-2023-0053.

[6] Y. A. Ajani, B. D. Oladokun, R. T. Enakrire, E. S. Ibironke, L. Morodi, M. S. Enidiok, G. B. Sulaiman, and B. A. Moshood, "Metaverse adventures into libraries: What librarians and information users need to know," *Ref. Serv. Rev.*, vol. 52, no. 3, pp. 450–460, 2024, https://doi.org/10.1108/RSR-05-2024-0025.

[7] K. Shahzad, S. A. Khan, and A. Iqbal, "Impact of augmented reality on libraries: A systematic literature review," *J. Librariansh. Inf. Sci.*, vol. 57, no. 4, pp. 977–990, 2025, https://doi.org/10.1177/09610006241259492.

[8] M. A. Adewusi, S. Kazibwe, O. T. Odekeye, and S. E. Egbowon, "Augmented reality in library automation: Students' perception," *Educ. Perspect.*, vol. 12, no. 1, pp. 1–13, Jan. 2024.

[9] M. Dalili Saleh, M. Salami, F. Soheili, and S. Ziaei, "Augmented reality technology in the libraries of universities of medical sciences: Identifying the application, advantages, and challenges, and presenting a model," *Libr. Hi Tech*, vol. 40, no. 6, pp. 1782–1795, 2022, https://doi.org/10.1108/LHT-01-2021-0033.

[10] D. A. Vyas and D. N. Bhatt, "Augmented reality applications: A survey on current trends, challenges, and future scope," *Int. J. Adv. Res. Comput. Sci.*, vol. 8, no. 5, pp. 2724–2730, May–Jun. 2017, https://doi.org/10.26483/ijarcs.v8i5.4059.

[11] D. D. Sumadio and D. R. A. Rambli, "Preliminary evaluation on user acceptance of the augmented reality use for education," in *Proc. 2nd Int. Conf. Comput. Eng. Appl. (ICCEA)*, Bali, Indonesia, vol. 2, 2010, pp. 461–465, https://doi.org/10.1109/ICCEA.2010.239.

[12] S. G. Roy and U. Kanjilal, "Web-based augmented reality for information delivery services: A performance study," *DESIDOC J. Libr. Inf. Technol.*, vol. 41, no. 3, pp. 167–174, May 2021, https://doi.org/10.14429/djlit.41.03.16428.

[13] I. O. Adeyemi, K. A. Sulaiman, Z. M. Abdulsalam, and A. O. Issa, "Virtual and augmented reality as predictors of users' intention to use Lagos State Public Library, Lagos State, Nigeria," *Electron. Libr.*, vol. 41, no. 5, pp. 682–699, 2023, https://doi.org/10.1108/EL-03-2023-0075.

[14] A. O. Alkhamisi and M. M. Monowar, "Rise of augmented reality: Current and future application areas," *Int. J. Internet Distrib. Syst.*, vol. 1, no. 4, pp. 25–34, 2013, https://doi.org/10.4236/ijids.2013.14005.

[15] K. Lee, "Augmented reality in education and training," *TechTrends*, vol. 56, no. 2, pp. 13–21, Mar. 2012, https://doi.org/10.1007/s11528-012-0559-3.

[16] M. Wójcik, "Augmented intelligence technology: The ethical and practical problems of its implementation in libraries," *Libr. Hi Tech*, vol. 39, no. 2, pp. 435–447, 2021, https://doi.org/10.1108/LHT-02-2020-0043.

[17] A. Hussain, "Review of augmented reality in academic and research libraries," *Libr. Hi Tech News*, vol. 39, no. 9, pp. 23–25, 2022, https://doi.org/10.1108/LHTN-06-2022-0082.

[18] R. C. M. Yusoff, A. Osman, S. A. Shariff, N. H. Hassan, N. N. A. Sjarif, R. Ibrahim, and N. Maarop, "A systematic literature review of augmented reality applications in libraries," in *Recent Trends in Data Science and Soft Computing: Proc. 3rd Int. Conf. Reliable Information and Communication Technology (IRICT 2018)*, F. Saeed, N. Gazem, F. Mohammed, and A. Busalim, Eds. Cham, Switzerland: Springer, 2019, pp. 1037–1046, https://doi.org/10.1007/978-3-319-99007-1_96.

[19] A. Mahadik, Y. Katta, R. Naik, N. Naikwade, and N. F. Shaikh, "A review of augmented reality and its application in context-aware library system," in *Proc. Int. Conf. ICT Bus. Ind. Government (ICTBIG)*, Indore, India, 2016, pp. 1–6, https://doi.org/10.1109/ICTBIG.2016.7892686.

[20] F. Lamberti, F. Manuri, A. Sanna, G. Paravati, P. Pezzolla, and P. Montuschi, "Challenges, opportunities, and future trends of emerging techniques for augmented reality-based maintenance," *IEEE Trans. Emerg. Topics Comput.*, vol. 2, no. 4, pp. 411–421, Dec. 2014, https://doi.org/10.1109/TETC.2014.2368833.

[21] T.-C. Huang, Y. Shu, T.-C. Yeh, and P.-Y. Zeng, "Get lost in the library? An innovative application of augmented reality and indoor positioning technologies," *Electron. Libr.*, vol. 34, no. 1, pp. 99–115, 2016, https://doi.org/10.1108/EL-08-2014-0148.

[22] T. De Sarkar, "Augmented reality applications and the future library," *Libr. Hi Tech News*, vol. 40, no. 9, pp. 7–11, 2023, https://doi.org/10.1108/LHTN-07-2023-0129.

[23] A. Subaveerapandiyan, A. F. Alam, S. Butdisuwan, A. Taj, and S. Kataria, "Exploring emerging technologies: Librarians' awareness, challenges and ethical perspectives in Thai library contexts, with a focus on the metaverse," *Digit. Libr. Perspect.*, vol. 40, no. 3, pp. 377–393, 2024, https://doi.org/10.1108/DLP-12-2023-0111.

[24] Y. Noh and Y. Shin, "A study on the plan of activation of library by utilizing the virtual reality and augmented reality," *Int. J. Knowl. Content Dev. Technol.*, vol. 12, no. 1, pp. 85–104, 2022, https://doi.org/10.5865/IJKCT.2022.12.1.085.

[25] D. Greene and M. Groenendyk, "An environmental scan of virtual and augmented reality services in academic libraries," *Libr. Hi Tech*, vol. 39, no. 1, pp. 37–47, 2021, https://doi.org/10.1108/LHT-08-2019-0166.

[26] J. Garzón, "An overview of twenty-five years of augmented reality in education," *Multimodal Technol. Interact.*, vol. 5, no. 7, art. no. 37, Jul. 2021, https://doi.org/10.3390/mti5070037.