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The Wireless Communication Technology and Its Application in Library Services: A Systematic Review

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The goal of this study is to assess the significant advancements made in the usage of wireless communication technology (WCT) in libraries over the last few decades. It analyses how wireless technology helps expand library services and user community integration in academic and social environments. Employing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, the researcher systematically analyzed scholarly articles sourced from databases such as EBSCO, J-gate+, and Google Scholar, focusing on publications in English directly related to libraries. Technical terms were defined using dictionaries and encyclopedia websites to ensure clarity. Findings revealed a growing adoption of WCT-based services in both academic institutions and public libraries, enhancing library services and fostering user community integration. However, challenges such as limited ICT skills, financial constraints, and resistance from library staff and patrons were identified as barriers to implementation. Despite these challenges, the benefits of wireless networking in supporting library services are evident, though concerns regarding security and network structure persist This study implies that libraries can leverage wireless technology to its fullest potential by implementing robust security measures, investing in infrastructure, and providing digital literacy programs to users.

Keywords: Wireless Technology, ICT, Library, Library Services, Systematic Review

Introduction

Growing developments in today's environment include wireless technology and artificial intelligence. In this scenario, computers are taking the place of human beings. These machines behave, think, and act like people do at work to increase productivity and reduce mistakes[1]. Many developments have brought a revolution in everyday human life in society. Wireless technology, which includes cordless telephones, walkie-talkies, Wi-Fi technology, and cellular phones, is undergoing intensive study and development. Radio technology's rapid advancement makes it simple to use for a variety of purposes[2]. Bluetooth, Wi-Fi, Zingbee, and NFS are the best examples of radio frequency activities that serve in the transition of information between two or more devices at a specific distance[3].

Wireless technology has become a vital part of modern libraries, improving user experience and allowing more flexible access to digital materials. The introduction of mobile devices and the widespread availability of Wi-Fi have transformed how users interact with library services, allowing content access on handheld gadgets via systems such as the LIB-INTRANET, which uses Wi-Fi technology to connect users to library content without the need for internet access. Although the evolution of wireless networks, such as Wi-Fi, has enabled users to share resources and access tremendous quantities of information, creating affordable and comprehensive wireless systems creates difficulties due to limits similar to those faced by prior communication networks[5]. Many libraries have implemented various radio frequency technologies in their service to accomplish the organization's educational goal and it supports personalized learning[6,7]. Here, each student gets an equivalent opportunity for professional development through e-resources and access to resources with well-

established network systems that help blended learning in institutions[8]. Optimizing teaching and learning are significant parameters in meeting learners' demands, and establishing connections between learners, faculties, and content plays a vital part in teaching, learning, and research development activities[9].

Definitions

Wireless technology is an emerging trend these days. According to Britannica[10], "Wireless communication is the system of using radio-frequency, infrared, microwave, or other types of electromagnetic or acoustic waves in place of wires, cables, or fibre optics to transmit signals or data". Wireless technology, although more expensive than its hard-wired competitors, offers significant benefits in retrofit applications as the level of disruption during the installation of wireless systems can be significantly less than the hard-wire alternatives.

Methodology

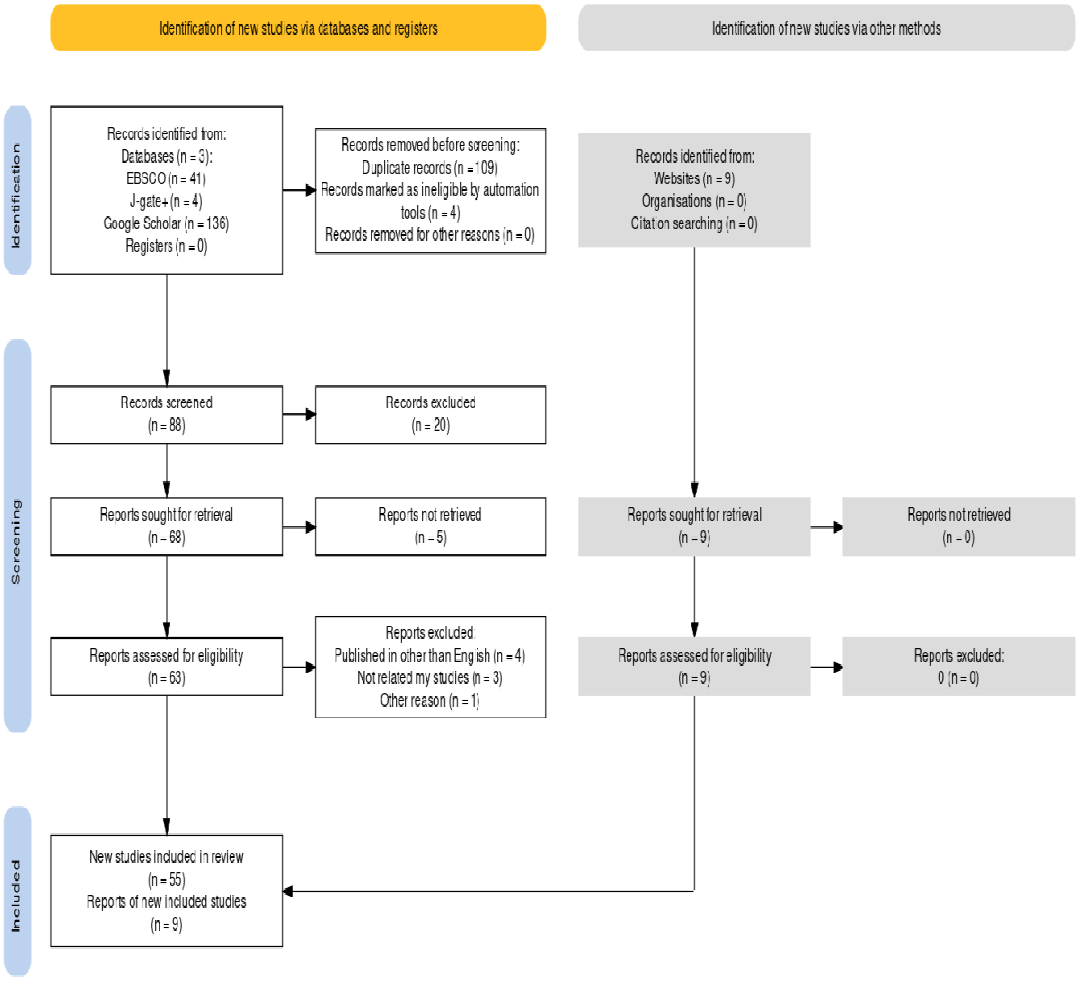
Design and Eligibility Criteria

The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" [11] (PRISMA) approach was used to carry out the research, where the researcher used three databases to locate scholarly articles on wireless technologies in libraries (EBSCO, J-gate+, and Google Scholar). He evaluated studies that have direct links to libraries and have been published in English. In addition, the researcher used dictionaries and encyclopaedia websites to define and clarify technical terms to strengthen the study.

Search strategy

The researcher used Boolean Logic (AND, OR, and NOT) to search for academic literature in databases. The search term is ((((Wireless technology)) AND (Libraries)) OR (Library Services)) and it was searched during March 2023 and November 2023.

Flow chart[11]



Result and Discussion:

According to the analysis and screening process, Google Scholar has an abundance of resources about wireless technology and its numerous uses in libraries. The highest number of the selected papers i.e. 22(56.41%) are accessed in Google Scholar, followed by 15(38.46%) in EBSCO. The lowest number of selected papers i.e. 2(5.13%) are accessed in J-GATE+.

Wireless communication technology

When we look back at the history of communication, we observe how wireless technology has revolutionized methods of communication[12]. These technologies include smoke signals, flashing reflections, flags, and other ornaments[13]. It became logical when radio transmission research began in 1895. Grahambel and Marconis' creation of the telephone demonstrated radio wireless communication, which created a miracle in communication principles and directed a new approach in society[14]. Then, in 1912, it switched to wireless telegraph, which required early coordination among countries for optimal use of the system[15]. Later, it involved two implementation faces, the first being a potential interface in radio transmission, and the second being a spectrum-based international transmission of signals for maritime and navigation, both of which were included in the service approach[16].

Rapid evaluation of wireless technology occurred throughout the twentieth century's 60th decade. Physical layer wireless communication theory innovation has brought new perspectives, particularly in cellular networks[17]. Mobile communication has reached all corners and nodes of the globe. It has become a basic human need, has practically reached everyone regardless of socioeconomic level, and is the hotspot of some of the most recent developments[18]. It has a large market nowadays, and a new wireless tech system contains the most modern features to efficiently perform multipath propagation[19]. Wireless technology applications appear in all domains in the present world, including high-tech industries, agriculture-based industries, and tertiary service sectors being the finest examples[20]. Comobaing and engaging with the ongoing development of library services through the latest wireless technologies gives an edge over the barriers of information dissemination[21]. The historical progression of wireless communication, from early methods to the contemporary ubiquity of mobile communication, emphasizes its impact on various industries and highlights its relevance in enhancing library services through the adoption of wireless technologies.

Advancement of Library Services through Wireless Communication

Libraries are the central attraction of learning and research institutions, which offer support in teaching, learning, and research development in the organization[22]. Every library aims to maximize its capacity to provide more optimized services to the users to ensure gradual development in an academic environment[23]. Foursquare, Gowalla, Brightkite, Glympse, Google Latitude, and Loopt are among the location-based services accessible in many libraries. Each service has its distinct characteristics, yet they all serve the same core purpose 24. These services employ Global Positioning System (GPS) and wireless network (Wi-Fi) mapping to identify a user's position, show nearby venues, and communicate the user's location with other users. It is simple to get started with location-based applications[25,26]. Totally Libraries have dealt with the "digital shift" in a variety of ways[27]. The multifaceted role of libraries in academic institutions, emphasizes the goal of optimizing services and briefly introduces the integration of location-based services as part of the evolving library landscape. Additionally, it hints at the broader influence of the digital shift on libraries, leaving room for further exploration of how libraries navigate the digital transformation.

Role of Wireless Tech in Security and Vigilance of the Library:

RFID (Radio Frequency Identification Device) technology is the most recent technology used in library theft detection systems. Compared to EM (Electro-Mechanical) and RF (Radio Frequency) systems, RFID-based infrastructure not only detects unauthorized removal of materials from libraries, but also speeds up staff charging and discharging, streamlines and speeds up patron charge and discharge, supports electronic inventorying and shelf searching, and interface with materials handling systems[28]. ***Institute of Electrical and Electronics Engineers***[29] ***(IEEE)*** is an organization that contributes significantly to the realm of technology[30]. It began in 1980 and classified wireless technology

into different classes based on its capabilities. It introduced the encryption keys notion for supplied authenticate connections to advance this technique. As a result, this type of technology enables libraries to identify users, send emails, and give increased security in information access[31].

In the RFID library application, smart labels with adhesive backing and adequate memory to hold the item identifier, which is typically equivalent to the barcode number, as well as other necessary information, such as the institutional identifier, are employed[32,33.] There are occasions when books are misplaced due to the enormous scale of book acquisition tactics and open self-access policies. RFID uses radio frequency signals to detect items from a great distance, and the combination of Biometric sensors plays a critical role[34]. It is permanently installed indoors and manages security, entrance, and exit monitoring, as well as providing long and convenient services[35]. RFID technology integration reflects advances in library systems and provides for the overall development of library services.

Wireless Communication Technology in Reference and Information Services:

Many libraries use wireless technology for data connectivity to improve staff mobility within the library. Plenty of libraries frequently alter their services to improve their effectiveness and provide responsive reference services that include library catalogues and subscribed database access services. Roving PDA ***(Personal Digital Assistance)*** and Roving Phone connection are examples of wireless services of libraries in action[36]. NFC, which is comparable to RFID technology, is the most recent breakthrough in library services. Both work on radio waves; NFC exchanges data within electrical devices in active mode, but evaluates data when both devices are close[37]. Which enables access control, the creation of a smart inventory, the tracking of transactions, borrowing, and return, and the authentication of individuals[38]. The best examples of wireless technology are fancy walkie-talkies; the usage of wireless communication devices in library services keeps people away from service counters[34]. The use of WCT extended to RFID tags for services that are based on location, while the study in outdoor environments has revealed boundaries, restricting the potential for commercial services in urban wireless networks[39]. Libraries, especially City Tech, are acknowledging the need to upgrade Wi-Fi infrastructure to fulfil the demands of mobile device users, using measures such as adding access points and optimizing network settings[40].

Many public libraries in Australia and other countries use walkie-talkies for reference services via the Vocera Communication System (VCS) https://www.vocera.com/[41]. The Roving references model of reference service is used here because instant-enabled communication delivers efficient reference services. These services were available at the Boston Public Library, the Jacksonville Public Library, the Minneapolis Public Library, the Senate Public Library, and other locations. This approach is only suitable for huge libraries and delivers security and support quickly[42]. Florida's public library system supports the wireless connection in their library service to encourage proactive participation of library personnel and patrons in the library environment.

Before the establishment of the internet-based reference service, a library's reference section was rushed and mismanaged[43]. To preserve consistency, the library authority provides training to library employees as well as patrons[44]. *Texas Tech University* [45] (TTU) Library has expanded its virtual reference services to include text message references. Reference librarians can receive and answer text messages from patrons via an online interface using Mosio's Text a Librarian service (formerly known as Mosio for Libraries). LU is a large public university in Lubbock, Texas, with an enrollment of roughly 33,000 students and a goal of increasing enrollment to 40,000 by 2020. During the week, subject specialists and general reference librarians are normally accessible for face-to-face instruction or consultation from 9 a.m. to 5 p.m., with chat reference services also available during those hours. The Libraries implemented text reference in May 2011 by utilizing Mosio's Text a Librarian service[46].

Mobile Technology and Library Services:

Because of the effectiveness of deployment and flexibility of wireless technologies such as 4G/5G, wireless networks have surpassed traditional connections, with Wi-Fi evolving as an intelligent and self-regulating network[47]. In the United Kingdom, public libraries provide Wi-Fi with authentication systems and monitoring software, controlling information access with the establishment of a safe public space[40]. Wi-Fi network security remains an important issue and requires adherence to regulations

and guidelines to prevent threats[48]. Wi-Fi is also used by IoT applications in home and office networks, and security measures such as WPA2 are required to prevent illegal access[49]. Cloud-based library systems have been proposed to take benefit of Wi-Fi hotspots to provide reliable and adaptable digital library services[50]. Finally, Wi-Fi is a vital part of an expanded wireless ecosystem that includes technologies such as WiMAX and 3G, each with a unique set of features and uses[51].

A mobile application provides numerous possibilities to improve library services and innovatively establish connectivity. This type of service encourages users to use it more effectively; engineering institutions allow librarians to have personal interactions with users and permit staff to obtain fast feedback from patrons and inputs cyclical design process[52]. Text-based reference delivery systems are being used in academic library services at numerous institutions. Wireless-based text reference solutions are simple to implement in centres that make use of email IDs as patron identifiers. Santa Barbora City College was the first to install it, and it involves sophisticated software that must be entered into the user's email ID address[53]. Today's library website functions as the library's virtual front door; a portal to high-quality and specialized resources; a crucial service point that provides support, guidance, and instruction; and a platform for user participation. Catalogues are becoming increasingly "webby" and integrated with other discovery and federated search technologies and clinical workflow settings. Because of the expanding use of mobile devices and tablet computing in research, patient care, and education, libraries are developing mobile-friendly websites, content, and support services to suit the demands of a growing mobile library community[27].

QR codes are free, simple to install and use, and are becoming increasingly popular. Libraries have nothing to lose by incorporating smartphone use into library services, publicity, and marketing initiatives, especially with smartphone use on the rise or the library's website to give users a more engaging learning experience[54]. Recent advancements in the Quick Response (QR) code have transformed several sectors through its specific capabilities, and its application in Mobile page services in the library, particularly in hand-free access to the library[55]. The Mobile LibGuide provided many of the same mobile resources that were referenced on the mobile website. It has four pages in Mobile LibGuide: Websites and Apps, Calculators, Utilities, Wireless Access, and Device Tips are all available. Mobile drop-in sessions were used to help users connect to the mobile wireless network, raise awareness of, and guide on using mobile library resources[56,57].

The Mobile Committee envisioned users using the LibGuide mostly through their desktop or laptop computers[58]. Several libraries have created information literacy lectures that can help students immediately master how to use databases or assess the accuracy of a digital resource. Teachers might provide these as homework or incorporate them into information literacy classes[59]. LibGuide improves resource availability and makes campus-wide operations easier and more efficient[60]. Security and user management are critical in library wireless networks since these organizations constantly deal with a diverse user base and must also adhere to a variety of internal and governmental requirements regarding content[57].

Factors Hindering the Implementation of Wireless Communication Technology in Libraries

Wireless technology in libraries offers numerous advantages, such as enhanced access to digital content and the facilitation of mobile connectivity. However, there are some barriers to the effective implementation and use of wireless technology in library settings. The challenge is the digital divide, which refers to unequal access to ICT facilities[61]. A significant barrier is security concerns. Wireless networks, by their nature, are more susceptible to unauthorized access and information leakage than wired networks[49]. Libraries must ensure that their Wi-Fi networks are secure to protect users' privacy and prevent data breaches. This often requires continuous updates and maintenance to keep up with evolving security threats. Another challenge is the digital divide, which refers to unequal access to ICT facilities[61]. While wireless technology can help bridge this divide by providing access in areas with limited infrastructure, the lack of basic ICT infrastructure and electricity in some regions, such as the high mountainous topography of District Chitral, can severely limit the deployment and use of wireless networks in libraries.

Furthermore, the issue of digital exclusion, which encompasses inequalities in access to, use of, and skills needed for digital technologies, is a barrier that

libraries must address[62]. Libraries play a central part in reducing the digital divide by offering training and consultancy, but they face challenges in redefining their social value and securing the necessary funds, skills, and infrastructure for digital inclusion programs. Additionally, the physical limitations of Wi-Fi technology, such as the range of connectivity and signal strength indoors versus outdoors, can affect the user experience within library spaces[63]. Libraries must design their wireless networks to provide adequate coverage and performance for users.

Conclusion

Libraries can incorporate Wireless Technology into their services using a variety of methods. Overall, Wireless Technology actively engages with the requirements of students and readers[23]. The findings indicate that libraries are moving towards the implementation of mobile technologies to improve library services, enhance user engagement, and adapt to shifting library patron needs. The growing demand for wireless connectivity can lead to network congestion, especially when multiple users attempt to access a single Wi-Fi router simultaneously, resulting in decreased signal strength and slower data access[64]. Libraries must plan for scalable network solutions to accommodate growing numbers of users and devices. Libraries can leverage wireless technology to its fullest potential by implementing robust security measures, investing in infrastructure, and providing digital literacy programs to users.

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