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# Strengthening Accessibility and Inclusivity in Libraries: The Role of Adaptive Technology in Supporting Visually Impaired Users

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## ABSTRACT

**Background**. Libraries are essential in democratizing access to knowledge and information, but users with visual impairments still face significant barriers in accessing these resources.
**Purpose**. This research explores how adaptive technologies can improve accessibility and inclusivity in libraries for users with visual impairments.
**Method**. Using a qualitative methodology involving in-depth interviews and content analysis of library websites, this study assessed the effectiveness of current adaptive technologies and identified barriers to their use.
**Results**. The findings show that, although adaptive technologies such as screen readers and indoor navigation systems hold great potential to improve user experience, there remains a lack of implementation and insufficient awareness among library staff regarding the specific needs of visually impaired users.
**Conclusion**. The study emphasizes the importance of holistic integration of adaptive technologies in library service strategies to ensure equal access. Recommendations include better staff training, the development of solid and inclusive policies, and collaboration with disabled people's organizations to enhance library accessibility and inclusiveness, thereby supporting broader social participation of visually impaired users.

## KEYWORDS

Adaptive Technologies, Inclusivity, Library Accessibility, Screen Readers, Visual Impairments

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## INTRODUCTION

Libraries play an essential role in democratizing access to knowledge and information in society. As learning centers, libraries offer a wide array of resources that meet a variety of educational, research, professional development, and personal enrichment needs (Alabi & Mutula, 2020). Libraries stand as cornerstone institutions in making knowledge and information universally accessible. They house extensive resources, including books, periodicals, digital media, online databases, and the Internet. As pillars of literacy and lifelong learning, libraries offer everyone the chance to enhance their reading and information literacy skills regardless

of age or background. They enrich formal education by providing supplementary resources that extend beyond the classroom.

information and technological advancement. Ultimately, libraries embody the principle of democratizing knowledge and information within the community. They contribute significantly to education, research, professional growth, and personal development, fostering literacy, ongoing education, and equitable information access for everyone.

Nevertheless, libraries face challenges in fully serving every community member, particularly those with In today's digitized era, libraries are crucial in offering free access to computers, internet connectivity, and digital content, especially for those without home access. This is particularly vital for marginalized and underserved populations, for whom libraries are vital portals to the broader world of visual impairments. Obstacles like the lack of accessible format materials like Braille or audiobooks and difficulties navigating library spaces hamper access. These accessibility issues impede the use of available resources and limit personal autonomy, growth, and community involvement. Accessibility, in a broader sense, means ensuring that everyone, regardless of abilities or specific needs, can engage with, utilize, and gain from various resources, services, and settings. For libraries, this is crucial, given their mission to facilitate access to information and learning.

Visual disabilities encompass conditions ranging from slight vision impairment and color blindness to complete blindness, presenting significant challenges in accessing printed materials and navigating immediate surroundings. According to Golledge (1993), people with visual impairments encounter daily obstacles in public spaces, such as identifying signage and reading labels, highlighting the need for improved library accessibility to support these individuals fully.

Individuals with visual impairments face various barriers limiting their access to library information and services. These barriers include a need for print materials in alternative formats, limited screen reader software, challenging physical navigation within the library, and a need for more awareness or training among library staff regarding the specific needs of these users. Mobility limitations compound these challenges, reduced cognitive abilities, and fear of falling (Wong, 2018; Worth, 2013). Students with visual disabilities face additional difficulties reaching classrooms and other areas on and around campus.

The following is data on the number of people with visual disabilities in Malang City:

| District | 2019 | 2020 | 2021 |
|---|---|---|---|
| **Kedungkandang** | 11 | 59 | 61 |
| **Sukun** | 23 | 65 | 65 |
| **Klojen** | 6 | 33 | 35 |
| **Blimbing** | 6 | 44 | 45 |
| **Lowokwaru** | 18 | 61 | 63 |
| **Jumlah** | 64 | 262 | 269 |

**Table 1**. Number of people with visual disabilities in Malang city District
*Source*: Dinas Sosial Kota Malang (2024)

Individuals with disabilities, particularly those with visual impairments, are often isolated from active participation in community life. This situation runs counter to the principles espoused by the fourth goal of the U.N. Sustainable Development Agenda, which emphasizes the importance of creating an accessible environment for people with disabilities, allowing them free and unhindered access to educational buildings, recreational facilities, including libraries, cafeterias,

toilets, and play areas. Addressing these challenges is essential to ensure that individuals with visual impairments can utilize library resources and support inclusivity and equality. By providing equal access to information and knowledge, libraries can ensure that all members of society have equal opportunities to learn, grow, and contribute to their communities.

Adaptive technologies are essential tools designed to enhance usability and accessibility for individuals with disabilities, particularly within the library setting for those with visual impairments. These tools encompass a variety of systems, including software that vocalizes written text, technology that transforms printed documents to digital text for screen reading software, systems that assist in navigating the physical library space, and equipment that translates digital text into tactile Braille.

Such adaptive technologies are pivotal in making library resources available to those with visual impairments, offering aids like software that reads text aloud, optical character recognition (OCR) for converting printed text to digital formats, and standards for web accessibility that ensure users with visual impairments can efficiently utilize library materials across various devices (Wu & Adamic, 2014). Additionally, specific digital library setups designed for visually impaired users and criteria for assessing digital library usability are crucial for making information accessible to this demographic (Tu *et al.*, 2021; Xie *et al.*, 2022). Adherence to web accessibility guidelines, such as the WCAG, significantly enhances the accessibility of digital library content for users who are blind or have low vision (Fayyaz *et al.*, 2021). Designing library services from the outset to meet the diverse needs of all users is critical for fostering inclusivity. Research indicates that modifying board games with tactile indicators, Braille labels, and other innovative solutions can make recreational activities accessible to visually impaired individuals (Thévin *et al.*, 2021).

Introducing specialized technology into educational settings has significantly enriched the educational experience for students with visual impairments, enabling them to complete their studies as competent professionals (Ng'etich & Aiyobei, 2022). Integrating adaptive technologies within libraries facilitates better physical and digital access for visually impaired users and promotes their independence in accessing and utilizing library resources. With these technologies, users are empowered to independently locate, access, and engage with materials in various formats, affirming their right to access information and knowledge.

Furthermore, adaptive technology plays a crucial role in raising awareness among library staff about the unique needs of visually impaired users, encouraging the development of more inclusive practices and services. This not only enhances the quality of service provided to users with disabilities but also enriches the overall library environment, ensuring that libraries can more effectively serve the entire public.

However, integrating adaptive technology into library services poses several challenges, including the ongoing need for staff training, maintenance, and updates for hardware and software and the creation of user-friendly interfaces that accommodate users with varying levels of technical proficiency. Moreover, libraries must keep abreast of the latest technological advancements to ensure their services remain relevant and accessible to all users.

Adaptive assistive technologies enable individuals with disabilities to participate fully in community life, communicate effectively, and access and share information without barriers, thus avoiding exclusion in both the digital and social spheres (Lloyd *et al.*, 2016; Ragnedda, 2017). Unfortunately, many libraries have not adequately prioritized providing adaptive technology for visually impaired patrons. Consequently, these individuals often struggle to access information, face a scarcity of materials in accessible formats, and feel marginalized or overlooked by library service policies and website accessibility (Kaunda & Chizwina, 2019; Zaid & Zaid, 2017).

Despite the progress in adaptive technologies, challenges persist in achieving complete accessibility. Issues such as needing more dynamic cataloging systems, making web graphics accessible to visually impaired users, and developing voice-activated search engines exemplify ongoing efforts to overcome these accessibility barriers (Masood *et al.*, 2015; Tan *et al.*, 2007; Westlind, 2008). Furthermore, delivering effective library services to visually impaired patrons requires continuous collaboration among library staff, educational institutions, and associated organizations to align with legal standards and best practices (Harris & Oppenheim, 2003).

Moreover, the potential benefits of employing adaptive technology to enhance library accessibility for visually impaired users are vast. It facilitates greater access to educational and informational resources and strengthens the autonomy and social engagement of users with disabilities. Thus, investing in adaptive technology is a crucial step toward creating genuinely inclusive libraries that cater to the needs of all society members.

By leveraging adaptive technology, libraries can transcend their traditional role as mere repositories of books to become dynamic, inclusive centers of learning that ensure universal access to knowledge. This shift not only furthers the broader goal of social inclusion but also supports the development of a more informed, engaged, and interconnected society.

Viewed in a broader context, the role of adaptive technology in libraries underscores the significance of innovation and technology in surmounting social and physical barriers. It demonstrates that with the right tools, we can build a society that affords equal opportunities to everyone, regardless of their physical or sensory challenges. This not only opens new avenues for enhanced library accessibility but also promotes broader inclusion across various aspects of social and economic life.

Inclusion is a concept rooted in the recognition that specific segments of the population are often excluded from mainstream society due to factors such as economic hardship, disabilities, race, or cultural differences (Alam & Imran, 2015; Peters & Besley, 2014). The goal is to ensure everyone has equal opportunities to participate in community social, economic, and cultural activities (Lloyd *et al.*, 2016; Warschauer, 2004). With the advent of the information society and the increasing integration of technology into daily life, access to technology and the skills to use it have become crucial for full societal engagement, effective communication, understanding new environments, and expressing cultural identity (Andrade & Doolin, 2016). Consequently, technology has emerged as a critical component in advancing equality and social justice (Mendonça *et al.*, 2015; Thompson & Paul., 2016). Digital inclusion is now seen as a pivotal means of achieving social inclusion (Alam & Imran, 2015; Andrade & Doolin, 2016; Helsper, 2012; Ragnedda, 2017; Warschauer, 2002).

Digital inclusion is a policy initiative to bridge the digital divide and enhance digital literacy while reaching out to underserved and previously unengaged (Jaeger *et al.*, 2012). The concept of the digital divide itself is characterized by the disparity in technology access between the "technology-rich" and "technology-poor," which can be influenced by socioeconomic status, education levels, skills, language, and other factors (Real *et al.*, 2014).

Literature on library inclusion primarily focuses on the accessibility of information and communication technologies (ICT) and the development of digital literacy skills (Andrade & Doolin, 2016; Jaeger *et al.*, 2012; Kinney, 2010; Misuraca *et al.*, 2014; Morrone & Witt, 2013). For instance, Real *et al.* (2014) studies have discussed the barriers rural libraries face in fostering digital inclusion, pinpointing issues such as inadequate funding, staffing challenges, and staff training as critical obstacles to overcome. Other research highlights how public policy impacts digital inclusion initiatives in public libraries, showing that policymakers' interpretations of the digital divide, digital

literacy, and digital inclusion can significantly influence the support and funding libraries can garner from government entities (Jaeger *et al.*, 2012).

They suggest that librarians become more active advocates, voicing their need for more substantial support. Furthermore, Purnomo & Pratiwi (2023) explored the idea of libraries as new digital media hubs, emphasizing the need for more in-depth librarian training. Another study by Bertot & Jaeger (2015) surveyed the extent to which libraries provide Internet and Wi-Fi access, the training offered, and the number of staff available to organize such training as indicators of libraries' ability to support digital inclusion.

Libraries have a long tradition of providing information services that are open to all. This can be seen in their longstanding efforts to provide books in audio and braille formats for visually impaired users before laws against discrimination (Bertot & Jaeger, 2015). Later, there was also a proliferation of specialized libraries catering to the needs of people with disabilities. On the one hand, this move showed a commitment to specific services but also raised questions about the principle of inclusive services (Bonnici *et al.*, 2015). This has led to a discussion about whether it is better to maintain specialized libraries or make public libraries more accepting of everyone. However, with advances in digital technology, electronic format information, and new accessibility guidelines, there is a growing opportunity to realize fully inclusive information services (Beyene, 2016; Lazar *et al.*, 2014).

Libraries have long been recognized as key players in digital and social inclusion, acting as a hub for public internet access, non-governmental organizations, and social workers in the fight for e-inclusion (Misuraca *et al.*, 2014). They are essential in providing people with access to computers, the Internet, digital content, and digital literacy education (Bertot & Jaeger, 2015). However, technology has also changed how librarians and patrons interact, with many now performing activities such as book borrowing, computer reservation, document printing, and accepting payment independently through machines (Morrone & Witt, 2013).

Studies have shown that the main focus of libraries is to expand physical access to digital technologies and improve digital literacy (Seale *et al.*, 2010; Selwyn & Facer, 2007). However, even though access and capabilities can be improved, individuals still need to be digitally isolated for specific reasons. For example, people with hearing impairments may be left out of video content without subtitles, and screen reader technology may be unable to access digital text for visually impaired users. These cases show that digital inclusion requires more than just access and skills to truly address issues of participation and use (Jaeger *et al.*, 2012).

Previous research on using adaptive technology in libraries has mainly explored how various tools and software can help reduce access barriers for users with visual impairments. Several studies have shown that technologies such as screen readers, OCR (Optical Character Recognition) readers, and Braille printers, as well as the use of web accessibility standards, such as WAI-ARIA and WCAG (Web Content Accessibility Guidelines), have brought significant changes in the way users with visual impairments access library information and resources. These technologies enable more straightforward navigation through digital resources, expand access to previously unavailable materials, and support a more inclusive and independent user experience.

However, despite their significant benefits, the literature also identifies some limitations of adaptive technologies. For example, challenges in compatibility between screen reader software and some digital library platforms or limitations in adaptive hardware updates and maintenance can hinder the user experience. In addition, training and awareness issues for users and library staff must be addressed to maximize the benefits of adaptive technology.

While there is a wealth of research on the use of adaptive technologies in libraries, there are significant gaps in the literature regarding how these technologies are integrated into library services. Many studies focus on specific tools or technologies without exploring how various adaptive technologies can work harmoniously to create a genuinely inclusive library environment.

Furthermore, there is a lack of research that comprehensively assesses how libraries can adopt a holistic approach to accessibility, which involves implementing adaptive technologies and considering aspects such as the design of the library's physical environment, staff training, and inclusion policies. In order to fully comprehend the possibilities and constraints of adaptive technologies within the larger framework of library services, as well as to determine the most effective techniques for their application, further study is required.

This research is necessary because it addresses critical issues in accessibility and inclusion in libraries, especially for users with visual impairments. Although technological advances have opened many doors to improve accessibility, the knowledge and application of adaptive technology in library settings still have many limitations. This study aims to offer fresh perspectives on how adaptive technology may be used more skillfully to address current accessibility issues, providing concrete solutions that can be implemented in libraries worldwide. Focusing on visually impaired users, this study seeks to answer important questions regarding the barriers faced and how technology can help overcome them.

It is anticipated that the results of this study will significantly alter library operations, especially in designing and providing more inclusive services for users with visual impairments. By understanding the most effective adaptive technologies and how they can be integrated into the library environment, libraries can make the necessary changes to ensure that their resources and services are accessible to all users, regardless of physical limitations. This will improve the user experience for individuals with visual impairments and demonstrate the library's commitment to inclusion and equal access.

Assessing the usefulness of adaptive technology in enhancing library accessibility for patrons with visual impairments is the primary goal of this study. This includes identifying adaptive technologies currently in use, assessing how well they meet user needs, and exploring ways to improve the implementation of technologies to make them more effective in facilitating access.

This paper aims to review how access to digital content relates to participation and usage, particularly from the perspective of print-disabled users who have digital skills. Print disability refers to individuals with difficulty reading printed text due to visual, cognitive, or motor impairments (Blansett, 2008). The interview data are analyzed using the International Classification of Functioning, Disability, and Health (ICF) Framework (Beyene, 2018). Therefore, this study aims to improve our understanding of digital inclusion and make suggestions for future research. As a result, this research poses numerous important queries: Which libraries regularly employ assistive technology to assist patrons who are blind or visually impaired? To what extent do these technologies enhance the availability of information and library resources? What obstacles prevent visually impaired patrons from effectively using adaptive technology in libraries? What plans of action and fixes can get beyond these obstacles and enhance how adaptive technologies are incorporated into library services?

In addition to filling a vacuum in the scholarly literature on the application of adaptive technology in libraries, this research should help libraries wanting to enhance the inclusivity and accessibility of their offerings by offering actionable advice. This will help ensure that all users, especially those with print disabilities, can fully utilize libraries' resources and services, supporting broader digital inclusion and active participation in the information society.

## RESEARCH METHODOLOGY

### Type of Research

This qualitative study aims to deeply understand how adaptive technology can improve accessibility and inclusiveness in libraries for users with visual impairments. This study explores the perceptions, experiences, and challenges users and library staff face using adaptive technology.

### Data Sources

To collect the necessary data, this study relied on in-depth interviews with users and library staff, participatory observation in a library setting to understand the use of adaptive technology first-hand, and document analysis that included library policies, accessibility guidelines, and promotional materials related to adaptive technology. Secondary data included academic literature and reports from government and non-government organizations on accessibility and inclusion standards in libraries.

### Research Resource

Finding the right participants is a significant challenge in research involving individuals with disabilities, as expressed by (Newell *et al.*, 2011). To overcome this problem, creative approaches such as theater techniques and persona development are recommended (Newell *et al.*, 2006, 2011). Recruitment of participants also encountered similar obstacles in this study, necessitating a qualitative exploratory research design.

This study explored the user experiences of individuals with print disabilities who access facilities at the Public Library of Malang City, including those who utilize the Braille Corner with equipment such as braille computers, braille digital aids, and talking book players. The Braille Corner also collaborates with the Technical Implementation Unit of Bina Sosial Bina Netra to organize periodic visits. Finally, this study managed to gather fifteen participants, consisting of six people with dyslexia and eight with visual impairment, the majority of whom were female and all from Malang City. Most participants were university students, with seven others being special school students, having educational backgrounds from early to late university level and aged between 17 and 25 years old.

Iterviews with participants were conducted individually at the Public Library of Malang City. Collecting data from each participant was a challenge that was carried out from late January 2024 to March 2024. All participants have given their written consent to participate in this study.

### Data Collection Technique

The data collection technique involved semi-structured interviews to gather insight into the experiences, needs, and challenges of visually impaired users and library staff towards adaptive technology. Observations were conducted to review visually impaired users' interactions with library technology, including websites and adaptive devices. Document analysis aimed to gather information about library policies, guidelines, and promotions on adaptive technology.

### Data Analysis Method

This study used the International Classification of Functioning, Disability, and Health (ICF) Framework to analyze the interview data (Beyene, 2018). Beyene (2018); and Douglas *et al.* (2007) emphasized that the International Classification of Functioning, Disability, and Health (ICF) was created to support the social inclusion and participation agenda, providing a structure and terminology to evaluate disability-related physical limitations and identify factors that lead to social exclusion. Some of the essential concepts proposed by them (Douglas *et al.*, 2007; World Health Organization, 2002) include:

**Activity:** Actions or tasks performed by an individual.

**Participation:** Involvement in various life situations.

**Limitation of Participation:** Issues that individuals face in engaging in life activities.

**Impairment:** Constraints in body function and structure, including damage or loss.

**Environmental Factors:** The physical, social, and attitudinal aspects of the environment in which individuals interact and live their lives.

**Barriers:** Environmental factors that inhibit activity or participation.

**Facilitators:** Elements that overcome barriers and facilitate participation.

In the context of a study examining digital inclusion from the perspective of participation and usage, the ICF framework was considered the most suitable approach for this research.

In the data analysis, the first step was codification, where data was categorized into critical themes according to the research questions. Next, thematic analysis was conducted to identify and analyze emerging patterns or themes. Data triangulation was used to validate the findings, ensuring the reliability and validity of the study. Narrative analysis was developed to combine and present the findings in a coherent story, showing how adaptive technology plays a role in strengthening accessibility and inclusivity in the Public Library of Malang City.

## RESULT AND DISCUSSION

### Result

#### *Activity and Participation*

The research revealed that adaptive technology has enabled individuals with visual impairments to perform various previously tricky or impossible activities. With the help of screen readers and Braille printers, users can access book collections and library materials independently. This includes reading, researching, and accessing online information. These technologies facilitate increased independence in learning and accessing knowledge, significantly enriching users' experience in the library.

Furthermore, the findings highlight that adaptive technology has expanded opportunities for users with visual impairments to participate in library events and group activities, such as book discussions and workshops. This represents a significant increase in social engagement and inclusion within the library community. This active participation strengthens the sense of community among library users and promotes a rich exchange of ideas and experiences among all community members.

Some interviewees said that adaptive technology is beneficial in self-study. Others said that adaptive technology was beneficial in exploring information and knowledge and participating more actively in their community activities. As expressed by several users of Pojok Braille with visual impairments:

> "Before adaptive technology, I often depended on others to read or get information. Now, I can explore books and resources more independently. It has completely changed the way I learn and interact with the world".

Another interviewee said, "We are witnessing the transformation of adaptive technology, opening doors for us with visual impairments. Participating more actively and contributing to our community activities is inspiring".

> "Attending workshops and events held at the library is now something I look forward to. Adaptive technology has made it easier for me to get involved and share my experiences with others".

During an interview with the Braille Corner organizers, they said:

> "We strive to make all our events accessible to everyone. Hearing positive feedback from our users about how adaptive technology helps them participate more fully in library life motivates us to keep innovating".

These findings and interviews highlight the importance of adaptive technology in supporting the activities and participation of library users with visual impairments. These technologies enrich the individual experience of accessing knowledge and strengthen inclusivity and social cohesion within the library community.

***Participation Restrictions and Impairments***

The research found that individuals with visual impairments often experience significant barriers in participating in daily activities and library community events, which limit their opportunities for social interaction and self-enrichment. These barriers stem not only from physical limitations but also from a lack of accessible equipment or resources, such as books in Braille or audiobooks, and a lack of awareness or understanding from the community and library staff of their needs.

The study also identified impairments, or barriers in body function and structure, that significantly impact an individual's ability to access and use library resources independently and physically. This includes difficulties in navigation in library spaces, use of the online catalog, and access to print materials without the aid of adaptive technology. One of them said that:

> "I often feel isolated because many activities in the library are difficult for me to participate in. This makes me miss many opportunities to learn and meet new people".

During an interview with the manager of the Braille Corner, they said:

> "We realize that we still have a lot to do to overcome participation restrictions. Adaptive technology is one way, but we also need to raise our own and community awareness about the needs of users with disabilities".

One of the users who use the Braille Corner said:

> "One of the biggest challenges for me is accessing books and reference materials. Without adaptive technology, I am completely dependent on the help of others, which limits my independence".

In an interview with the manager of the Braille Corner, they said:

> "We have seen the immediate impact of the provision and use of adaptive technology on reducing disruption. However, we also know the importance of education and training for staff and the community to utilize these technologies' potential fully".

These findings and interviews highlight the challenges library users with visual impairments face in fully participating in library activities and community life. While adaptive technology offers solutions to overcome some of these barriers, improving accessibility and inclusivity requires broader efforts, including training and education, to ensure that all community members can actively participate and contribute.

***Access to Digital Content and Resources***

This research shows that access to digital content through adaptive technologies such as screen readers, text recognition apps, and text magnification software plays a vital role in unlocking information resources for users with visual impairments. While libraries have started to provide accessible digital content, there are still barriers to the availability and ease of use. Users expressed the need for more resources optimized for accessibility and training in using these technologies.

Resource discovery is a significant challenge faced by users with visual impairments. Although adaptive technologies have helped in improving this situation, there are still difficulties in navigating the library catalog system and identifying relevant materials. Research shows the

importance of inclusive user interface design and intuitive search systems to make resource discovery easier for all users. They say that:

> "Access to e-books and online journals is critical to me. Adaptive technology allows me to 'read' these materials, but I wish more collections were available in easily accessible formats".

Interview with the manager of the Braille Corner, they said:

> "We are striving to improve our digital collection and ensure our interface is easy to use. Hearing from users about their challenges helps us improve and adapt our services to be more inclusive".

One of the interviewees said:

> "Often, I feel frustrated because I cannot find the book or article I need. A more intuitive search system and explanations on how to access different formats would be helpful".

Interview with the Library I.T. manager, they said:

> "We are developing tutorials and training sessions to help visually impaired users utilize our adaptive technology. We also collaborate with content providers to ensure new materials meet accessibility standards".

These findings and interviews emphasize the importance of libraries in strengthening access to digital content and easing resource discovery for users with visual impairments. Through increasing the availability of accessible content and developing user-friendly interfaces, libraries can play a crucial role in supporting the information and learning needs of users with disabilities.

***Environmental Factors***

Research shows that environmental factors, including the library's physical design and social atmosphere, significantly impact the accessibility and comfort of users with visual impairments. The availability of adaptive equipment and palpable navigation signals are essential elements that aid orientation and mobility within the library. It was found that variations in adaptive resources and alternative options, such as e-books, audiobooks, and access to screen reader technology, are necessary to meet the diverse needs of users with visual impairments. However, challenges still need to be solved in such resources' availability and ease of use.

Policies that support accessibility and inclusivity initiatives were identified as critical factors for progress. These include library policies that prioritize purchasing and developing accessible collections and staff training on the specific needs of users with disabilities. Adaptability and flexibility in the way content is delivered were found to be very important. Users with visual impairments require content that can be adapted according to their specific needs, including options for changing text size, color contrast, and provision of audio narration. Participants emphasized the right to access information and educational resources freely and independently as a fundamental principle that libraries should guarantee to support inclusivity and accessibility.

With the Braille Corner service at the Public Library of Malang City, people with visual disabilities can read books more easily. There are hundreds of braille books available for visual disabilities. In addition, there are also sound facilities that can be enjoyed by visual disabilities when using the Braille Corner service. The Braille Corner service also collaborates with UPT Bina Sosial Bina Netra for regular visits. The Braille Corner service has 364 copies of Braille books and 364 pieces of Talking Book Audio C.D.s.

**Figure 1**. Braille Corner Service at the Public Library of Malang City
Source: Public Library of Malang City

The needs of people with visual disabilities for directions are also facilitated by providing signs on the floor to make it easier to reach their destination. The hope that is built is an inclusive service that anyone can access easily, even people with visual disabilities. Innovations such as the M-Mobilib application and the Digital Reading Corner have also been developed to increase literacy.

Meanwhile, one of the people with visual disabilities, Yasmin, admitted that she was happy with the opening of the Braille Corner at the Malang City Public Library and Regional Archives. Apart from studying at her school in the Janti area, she can also learn more at the library. "Nowadays, it is essential for us to master much knowledge. The opening of this Braille Corner helps us learn," said Yasmin.

> "I appreciate that the library has palpable guidelines and equipment that make it easier for me to access books. However, I would like to see more initiatives that address our needs in digital access".
>
> "Having adaptive technology options gives me the freedom to choose how I access information. However, I often find that the resources I need are unavailable in a format I can use".

A visually impaired participant shared that she is susceptible to light, which allows her to read only in high-contrast settings with a black background. As such, she prefers to use electronic documents in PDF or HTML formats that are compatible with her screen reader software or that can be adjusted to a high-contrast setting. Commenting on the Braille Corner Library facilities, she said:

> "Informed library staff and policies that support accessibility make a big difference. I feel more welcome and supported when there is a real effort to make resources more accessible".
>
> "Flexibility in content presentation is essential to me. I appreciate when I can rearrange text or listen to books being read aloud. It makes learning and entertainment more accessible".

These findings and interviews highlight the importance of a holistic approach to improving accessibility and inclusivity in libraries, which includes attention to the physical and social environment, provision of diverse and accessible resources, supportive policies, and adaptive and flexible ways of delivering content. This shows that strengthening accessibility and inclusiveness in libraries involves improving the physical and social environment, supporting policies, providing rich and diverse resources, and respecting the access rights of visually impaired users. Through these initiatives, libraries can become more inclusive and serve all community members better.

***Barriers***

The research revealed some of the main challenges people with visual impairments face when they try to access and utilize library services. Some of these challenges relate to physical issues, such as the difficulty of getting around inside the library due to the complex design and lack of signage in Braille, as well as technical issues, such as the library's website and online book search system not being entirely usable with screen reading software for those who are blind. Not only that, but library staff's lack of expertise or awareness on how best to assist visually impaired patrons is also a common obstacle.

Some visually impaired patrons agreed with some of the barriers they face, ranging from limited materials and services, difficulty using technology, and several other barriers.

> "I often struggle to navigate in the library due to the lack of signage I can access. While there are technologies that can help, not all materials or services have been customized for my needs".
>
> "Library websites are often difficult for me to use. I use a screen reader, and not all parts of the site can be read or navigated easily, making finding information very time-consuming and sometimes frustrating".
>
> "One of my biggest challenges is when library staff do not understand how to help me. I understand they may not be trained, but a little more awareness about visual disabilities and how to use adaptive technology would be helpful".
>
> "I feel that the library could become more inclusive by providing more resources in formats I can access, such as electronic documents in high contrast mode or more books in Braille format. This would make my experience and that of others with visual impairments more valuable".

These findings and interviews highlight the importance of addressing environmental, technological, and social barriers to make libraries more accessible and inclusive for visually impaired users. Strengthening accessibility policies, improving technology compatibility, and enhancing staff training are essential to ensure that all users can maximize library resources and services.

***Facilitator or Enabler***

Adaptive technologies, including screen-reading software, Braille printers, and specialized navigation systems in the building, are crucial to helping people with visual impairments. These advanced tools allow them to explore and use the library's resources and participate in activities independently. With the help of this technology, they can access different types of content and experience the freedom of participating in the library community.

In addition, digital text formats that can be changed in font size and contrast are invaluable. For people with light sensitivities or who need other unique settings for reading, the ability to customize the appearance of digital text allows them to enjoy reading without hindrance. The ease of searching and finding digital resources is also essential. With a flexible digital search and catalog system that allows customization of search settings and provides full content descriptions, users can find what they need more easily and quickly.

In an interview, the interviewee said, "Adaptive technology is not just a tool; it is a bridge that connects me to the world of literacy. The ability to convert text to voice or utilize content in digital Braille format makes me feel more inclusive".

> "The digital text format allows me to 'read' in my way. The high contrast and text size adjustment features are beneficial, especially as I am susceptible to light".

"One of the aspects I appreciate the most is the flexibility in searching and accessing resources. A catalog system that is easy to navigate and accessible through screen reader software has changed how I use the library".

"Knowing that different formats of content are available makes me feel accommodated. I am not limited to one resource type; I can choose audiobooks, e-books, or even Braille materials according to the most convenient".

These findings and interviews highlight how adaptive technology and providing content in various alternative formats are significant facilitators in strengthening accessibility and inclusivity in libraries for users with visual impairments. Flexibility in resource discovery and access, along with the benefits of digital text formats, are vital elements that enable full participation and meet individual needs.

**Discussion**

This research offers insights into how libraries can become more inclusive and accessible for visually impaired users. The main focus of this discussion is to dig deeper into visual disability participation, barriers faced by users with visual impairments, the role of adaptive technology as a facilitator of access, and strategies to improve library services.

***Barriers Faced***

Visually impaired users often encounter barriers that prevent them from fully accessing library services (Farooq & Manzoor, 2021; Rayini, 2017; Singh, 2021). These challenges, which range from physical to technological constraints, underscore the importance of further efforts in creating truly accessible library environments for all (Kwafoa et al., 2020; Mutula & Majinge, 2016; Osman & Kwafoa, 2020).

Physical environmental barriers include a lack of Braille markings and difficult space navigation, often making it difficult for visually impaired users to orient themselves and find the needed resources (Seyama, 2004). The design of library spaces that do not consider the needs of users with visual impairments can increase their dependence on assistance from others, thus reducing their independence (Kwafoa et al., 2020; Singh, 2021). This highlights the need to apply universal design principles, which aim to create environments that are accessible and usable by everyone, regardless of their abilities (Farooq & Manzoor, 2021).

On the technology side, the mismatch between the library's website and catalog system and screen reader software is a significant barrier. Websites and online catalogs that are not designed to good web accessibility standards can make information difficult or even impossible to access for users with visual impairments (Mutula & Majinge, 2016; Rayini, 2017; Seyama, 2004). This emphasizes the importance of adhering to web accessibility guidelines, as formulated in the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C), to ensure that all users can obtain information and use library services independently and effectively.

To overcome the barriers visually impaired library users face, a multifaceted approach is required. Libraries must improve their physical and technological infrastructure while prioritizing staff training and awareness (Kwafoa et al., 2020; Newell et al., 2006; Osman & Kwafoa, 2020; Rayini, 2017; Singh, 2021). Trained library staff who have an in-depth understanding of accessibility requirements and the specific needs of visually impaired individuals play an essential role in improving the overall user experience of the library. Improving physical infrastructure involves ensuring that the library is designed and equipped to meet the needs of visually impaired users. This may include installing ramps, handrails, and paving to facilitate navigation for individuals with visual impairments. In addition, libraries should consider implementing features

such as Braille signage, tactile maps, and adjustable furniture to improve accessibility within the physical space (Farooq & Manzoor, 2021; Kwafoa et al., 2020; Seyama, 2004; Singh, 2021).

On the technology front, libraries can invest in assistive technologies such as screen readers, magnification software, and text-to-speech tools to enable visually impaired users to access digital resources and navigate online catalogs effectively. In addition, ensuring that library websites and online databases are designed with accessibility in mind (Purnomo et al., 2022), following guidelines such as the Web Content Accessibility Guidelines (WCAG), is crucial to providing an inclusive online experience for all users, including those with visual impairments. Along with infrastructure improvements, libraries should prioritize staff training to increase awareness and understanding of accessibility issues. Training programs should cover assistive technology, best practices for serving visually impaired users, and strategies for creating an inclusive library environment.

By equipping library staff with the knowledge and skills needed to support visually impaired individuals, libraries can significantly improve their service quality. In addition, fostering a culture of inclusivity and empathy within library staff is essential to creating a welcoming environment for all users, regardless of their abilities. Staff members should be encouraged to interact with visually impaired users respectfully, proactively offer assistance, and continuously seek feedback to improve services. In conclusion, overcoming the barriers faced by library users with visual impairments requires a comprehensive approach that includes improvements to physical and technological infrastructure and a commitment to staff training and awareness.

By investing in these areas, libraries can create a more inclusive and accessible environment that improves the overall user experience for visually impaired individuals. Improving accessibility and inclusivity in libraries is not just about implementing technology or physical design changes but also about developing a supportive culture where every user feels welcome and supported. Libraries need to be more than places to store books; they need to be inclusive community resource centers where everyone can learn, grow, and contribute regardless of their abilities.

To achieve this vision, libraries must continue to innovate and adapt, implementing creative solutions to overcome barriers faced by users with visual impairments and working with communities to identify and implement best practices in accessibility and inclusivity. In doing so, these joint efforts can ensure that libraries fulfill their role as centers of learning and participation for all community members.

***The Role of Adaptive Technology***

Adaptive technology is essential in supporting visually impaired users in the library environment, offering new avenues towards inclusivity and accessibility. Tools such as screen readers, Braille printers, and indoor navigation systems facilitate access to library materials and resources and empower users, allowing them to actively and independently participate in library activities. Screen readers are software programs that convert text displayed on a screen into Braille speech or output, allowing visually impaired users to access digital content such as library catalogs, databases, and online resources. By providing auditory or tactile feedback, screen readers allow users to effectively navigate websites, read documents, and interact with electronic resources.

Braille printers are another important adaptive technology tool that supports visually impaired users in the library environment. These printers convert digital text into Braille, allowing visually impaired individuals to access printed materials such as books, handouts, and documents in a format they can access. By offering Braille printing services, libraries can ensure their resources are inclusive and accessible to all users. Indoor navigation systems represent cutting-edge technology that can enhance the library experience for visually impaired individuals. These systems use

Bluetooth beacons, RFID tags, and mobile apps to provide real-time navigation assistance within the library space. By guiding users through the library, providing information about their surroundings, and helping them locate specific resources or services, the indoor navigation system empowers visually impaired users to navigate the library independently and efficiently.

Adaptive technology tools such as screen readers, Braille printers, and indoor navigation systems are essential in supporting visually impaired users in the library environment. By utilizing these tools, libraries can increase inclusivity, accessibility, and independence for visually impaired individuals, allowing them to engage with library materials and resources fully. Investing in adaptive technology improves the user experience for individuals with visual impairments and underscores the library's commitment to diversity, equality, and inclusion.

**Adaptive Technology as an Accessibility Bridge**

Screen readers, for example, allow text on a computer screen or mobile device to be converted into sound, providing access to digital information for users who cannot see the screen. This is particularly meaningful in libraries where digital catalogs, research databases, and e-book collections are becoming increasingly important. With screen readers, users with visual impairments can explore these resources unhindered.

On the other hand, Braille printers convert digital text into a perceivable Braille format, opening up access to printed materials for those who need them. This eliminates one of the main barriers visually impaired users face in accessing printed information and allows them to learn and access knowledge the same way as other users.

Indoor navigation systems support user mobility and orientation within the library. This technology allows visually impaired users to move more freely and independently, locating books, reading rooms, or other facilities more efficiently.

**Flexibility and Adaptability in Content Delivery**

Advancements in adaptive technology offer unprecedented flexibility and adaptability in content delivery. These technologies can be customized to meet individual needs, from adjusting text size and contrast on e-readers to providing audiobooks for those who prefer listening to rather than reading text.

The importance of this adaptability lies in its ability to enhance the overall user experience, giving each individual more control over how they access and interact with materials (Purnomo, 2019). As such, adaptive technologies not only solve accessibility problems but also encourage greater independence and participation from users with visual impairments.

In various ways, adaptive technologies have allowed users with visual impairments to enjoy library resources more fully. They are essential tools supporting accessibility, independence, and inclusivity, making the library a more welcoming and accessible environment for all users, regardless of their visual abilities.

***Improving Library Services***

Improving library services to cater to visually impaired users is essential to ensuring inclusivity and accessibility in libraries. A comprehensive strategy to achieve this goal involves implementing adaptive technology, raising awareness, and training staff. Adaptive technology makes library services more accessible to visually impaired users. These technologies include screen readers, magnification software, braille displays, and text-to-speech tools.

Screen readers, for example, convert text on a computer screen into speech or braille output, allowing visually impaired users to access digital content. Magnification software allows users to enlarge text and images on the screen, making it easier for visually impaired individuals to read. Braille screens provide touchable digital content output, offering an alternative way to access

information for those proficient in Braille. Text-to-speech devices convert written text into spoken words, facilitating auditory access to written material. Visually impaired users can navigate library resources independently and effectively by incorporating these adaptive technologies into library services.

In addition to adaptive technology, staff awareness and training are essential components in creating an inclusive library environment for visually impaired users. Library staff should receive training on interacting with and assisting visually impaired patrons, including guiding them to resources, explaining the physical layout, and providing support using adaptive technology. Staff awareness programs can also help foster a culture of empathy and understanding towards visually impaired individuals, fostering a friendly and supportive atmosphere in the library. By equipping library staff with the knowledge and skills to assist visually impaired users, libraries can improve the overall quality of service delivery and ensure that all patrons receive equal access to library resources and facilities.

A comprehensive strategy to improve library services for visually impaired users should include implementing adaptive technology, raising awareness, and training staff. By embracing these initiatives, libraries can create a more inclusive and accessible environment that benefits visually impaired users while making the library more accessible.

**Adaptive Technology Development and Implementation**

Adaptive technologies such as screen reader software, Braille printers, and indoor navigation systems have been shown to improve accessibility and provide users with visual impairments the ability to access information and resources independently. However, implementing these technologies should not stagnate; libraries should continue to explore and adopt new technology solutions that can support users' diverse and changing needs. This includes ensuring that library websites and online catalogs adhere to international web accessibility standards, making navigation and access easier.

**Staff Training and Awareness**

Library staff play a crucial role in ensuring an inclusive and supportive environment. Regular training on the specific needs of visually impaired users and the use of adaptive technology can help staff provide more effective and sensitive assistance. This awareness enables staff to not only respond to user needs in a more empathetic way but also to identify and address accessibility barriers that may not be immediately apparent.

**Involve Users in the Planning Process**

Involving visually impaired users in the planning and evaluation of library services is critical to developing solutions that are genuinely effective and responsive to their needs. Through forums, surveys, and discussion groups, libraries can gather valuable feedback and ensure that users' voices are heard at every service development stage. This collaborative approach ensures that the library functions not only as a resource provider but also as a community space that supports and encourages the participation of all users.

Improving library services for visually impaired users requires a commitment to technological innovation, staff training, and user engagement. By focusing on these three areas, libraries can overcome accessibility barriers and promote a more inclusive environment. Through this concerted effort, libraries will improve the user experience for users with visual impairments and enrich the community.

***Strategies for the Future***

Addressing the challenges of accessibility and inclusivity in libraries, especially for visually impaired users, requires a multifaceted strategy that involves collaboration between libraries, accessibility experts, disability organizations, and users. By working together, these stakeholders can create an environment that effectively supports all members of society, regardless of their abilities (Permadi et al., 2022). This collaborative approach underscores the importance of inclusive policies, improved collections in accessible formats, and continued advances in adaptive technologies.

Inclusive policies are fundamental in ensuring libraries welcome and accommodate individuals with visual impairments. This policy should outline guidelines for providing equal access to library resources and services, as well as procedures for addressing accessibility issues promptly. By establishing a clear and comprehensive policy, libraries can demonstrate their commitment to inclusivity and set the standard for accessibility in the community.

Increasing collections in accessible formats is another crucial aspect of improving library services for visually impaired users. Libraries should prioritize acquiring materials in formats such as Braille, large print, and audiobooks to meet diverse reading preferences and needs. Collaborating with publishers, accessibility experts, and disability organizations can help libraries expand their collections in accessible formats and ensure that blind users have equitable access to information and literature.

Continuous innovation in adaptive technology is essential to keep pace with the evolving needs of visually impaired users. Libraries should invest in the latest assistive technologies, such as screen readers, magnification software, and tactile interfaces, to improve the accessibility of digital resources and services. By staying abreast of technological advances and collaborating with experts in the field of assistive technology, libraries can provide visually impaired users with cutting-edge tools to effectively navigate library resources.

Addressing the challenges of accessibility and inclusivity in libraries for visually impaired users requires a comprehensive and collaborative approach. By fostering partnerships with accessibility experts, disability organizations, and users, libraries can develop inclusive policies, enhance collections in accessible formats, and innovate adaptive technologies to create environments that truly support all individuals' diverse needs. Let us elaborate more on each element of this strategy.

**Inclusive Policies**

Adopting an inclusive policy is the foundation for creating an accessible library environment. This policy should include clear guidelines on providing accessible services and resources, staff training on accessibility, and a commitment to continuous improvement. The policy should recognize the diverse needs of users and provide a framework for responding effectively to those needs.

**Improving Accessible Collections**

The library should actively increase its collection of materials in accessible formats, such as digital books, e-books compatible with screen readers, audiobooks, and documents in Braille format. These efforts allow users with different visual impairments to find the materials they need in the best format. Expanding accessible collections meets individual needs and demonstrates the library's commitment to inclusivity.

**Innovations in Adaptive Technology**

Adaptive technology has been instrumental in expanding access for users with visual impairments. Libraries should continue to innovate and adopt new emerging technology

solutions to improve user experience. This could be the development of more inclusive mobile apps, updated indoor navigation systems, or more advanced screen readers. Innovating in adaptive technology ensures that libraries can continue to meet the changing needs of users over time.

**Collaboration as Key**

This strategy requires close collaboration between the library and accessibility experts, disability organizations, and users. This collaboration allows libraries to understand users' specific needs better and develop more targeted solutions. Collaboration also opens opportunities to share resources, knowledge, and best practices, strengthening the accessibility ecosystem.

Facing the challenges of accessibility and inclusivity requires a comprehensive approach involving inclusive policies, improved collections of accessible materials, adaptive technological innovations, and strong collaboration. With these strategies, libraries will not only become more accessible for users with visual impairments but also become more inclusive and supportive environments for all community members.

## CONCLUSION

This research explores how adaptive technologies improve accessibility and inclusivity in libraries for users with visual impairments, identifies the challenges faced by these users, and offers recommendations for more effective integration of adaptive technologies in library services. Through in-depth interviews and content analysis, this study underscores the importance of adaptive technologies such as screen readers, Braille printers, and indoor navigation systems. It reveals gaps in implementation and staff awareness of the needs of visually impaired users.

Libraries use various adaptive technologies to support visually impaired users, including screen readers, Braille printers, and indoor navigation systems. These technologies enable visually impaired users to independently access the library's collection of books and materials, read, conduct research, and access information online. Adaptive technologies have proven highly effective in improving visually impaired users' access to information and library resources, facilitating increased independence in learning and accessing knowledge. This reflects the critical role of technology in supporting inclusivity and social cohesion within the library community. Visually impaired users face various challenges in using adaptive technology in libraries, including lack of access to materials in accessible formats, challenging physical navigation, and lack of awareness or training of library staff. Difficulties navigating the library catalog system and identifying relevant materials are also significant challenges.

To address these challenges and improve the integration of adaptive technologies, this study recommends better staff training, developing solid and inclusive policies, and collaborating with disabled people's organizations. Increasing the availability of accessible content, developing user-friendly interfaces, and investing in new adaptive technologies are critical to ensuring equal access for all library users. Adaptive technology is essential in supporting the access and participation of library users with visual impairments. However, maximizing its potential requires concerted efforts to address environmental, technological, and social barriers and improved staff training and inclusive policies. By doing so, libraries can become more inclusive and better serve all members of society, supporting broader digital inclusion and active participation in the information society.

In this study, several suggestions were made to improve the accessibility and inclusiveness of library services for users with visual impairments, focusing on using adaptive technologies. First, the research emphasizes the need for libraries to continuously expand and update their collections of

materials in accessible formats, such as Braille books and audiobooks, to meet the needs of diverse users. Secondly, there are suggestions to improve the training and awareness of library staff on accessibility issues and adaptive technologies so that they can provide more effective support to users with visual impairments. In addition, this study suggests that libraries work more closely with disabled people's organizations and visually impaired users in service planning and evaluation, ensuring that the services developed genuinely meet users' needs. Lastly, it is proposed that libraries continue innovating adaptive technologies and seeking creative solutions to overcome accessibility challenges, ensuring that libraries remain inclusive and supportive spaces for all members of society.

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**AUTHORS' CONTRIBUTION**

Author 1: Conceptualization; Formal analysis; Methodology; Writing - review and editing.
Author 2: Project administration; Investigation.
Author 3: Data curation; Resources.

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