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DIGITAL ADVANCEMENTS IN RURAL PUBLIC LIBRARIES: OPPORTUNITIES AND BARRIERS TO SUSTAINABILITY

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Abstract:

This study explores user satisfaction with digital technology sustainability in rural public libraries, highlighting both opportunities and barriers to fostering long-term technological advancements in underserved communities. Leveraging data from 2,660 respondents, the research identifies critical challenges, including limited infrastructure, insufficient awareness, and gaps in service quality, which hinder effective integration and usage of digital technologies. Simultaneously, it underscores the potential of rural libraries to bridge digital divides by providing accessible, sustainability-oriented services that meet the evolving needs of users. Findings emphasize the need for targeted improvements in service quality, awareness campaigns, and infrastructure development to enhance user satisfaction and drive sustainable progress in rural digital initiatives.

Keywords:

Digital Advancements, Rural Libraries, Sustainability

Introduction

Rural public libraries have long been pillars of community development, providing access to knowledge, information, and essential services. In today's digital era, these libraries are increasingly recognized as critical facilitators of technological inclusion, particularly in

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underserved rural areas. By integrating digital technologies, rural libraries have the potential to empower communities with tools for education, communication, and economic growth. However, despite their transformative potential, rural libraries often face significant barriers to sustaining these advancements, including infrastructural limitations, inadequate funding, and low user awareness (Horrigan, 2023). The question of sustainability—both operational and environmental—remains central to the discourse on digital transformation in these spaces.
The opportunities for digital advancements in rural libraries are extensive, offering pathways to bridge the digital divide and enhance rural livelihoods. For example, studies by Rahman and Lim (2023) underscore the role of digital libraries in promoting educational equity by providing students and lifelong learners with access to online resources. Additionally, sustainable digital technologies, such as solar-powered devices and cloud-based systems, can reduce operational costs while promoting environmental responsibility (Hashim & Ismail, 2024). Rural libraries can serve as hubs for digital literacy programs, equipping users with essential skills for navigating an increasingly digital world. However, realizing these opportunities requires a tailored approach that accounts for the unique socioeconomic and cultural contexts of rural communities.

Rural public libraries are essential pillars of community development, providing access to information, educational resources, and digital services to populations that may otherwise face barriers to technological access. In the digital age, advancements in information and communication technologies (ICTs) have opened new opportunities for rural libraries to enhance their services. These advancements offer pathways for improved information literacy, educational outcomes, and social inclusion for rural populations (Pateman & Vincent, 2023). However, despite these opportunities, many rural libraries face significant barriers in achieving digital sustainability, including inadequate funding, limited internet infrastructure, and staff shortages (Smith et al., 2024).

The transition to sustainable digital services hinges on ensuring equitable access to reliable and relevant technologies, while also addressing digital literacy disparities (Johnson & White, 2023). Sustainable practices involve ongoing evaluation of user needs, investments in staff training, and leveraging partnerships to overcome financial and infrastructural constraints (Nguyen & Carter, 2024). Additionally, fostering a digital inclusion framework that prioritizes underserved populations ensures that no community segment is left behind in the digital revolution (World Digital Library Alliance, 2024).

Understanding and addressing the barriers to digital sustainability is critical for rural public libraries to realize their full potential as information hubs. This review will explore both the opportunities and barriers facing rural libraries as they navigate the complexities of digital advancement in pursuit of sustainability.

This study evaluates user satisfaction with digital technology sustainability in rural public libraries, focusing on the interplay between opportunities and barriers. Using data from 2,660 respondents, the research identifies critical areas for improvement, including enhancing service quality, fostering greater user awareness, and developing infrastructure tailored to rural needs. The findings highlight the dual necessity of advancing digital capabilities while embedding sustainability into operational practices. By prioritizing user satisfaction and integrating innovative, community-driven solutions, rural public libraries can strengthen their role as sustainable, digital resource hubs. This research contributes to the ongoing discourse on rural

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digital equity, offering actionable recommendations for policymakers, practitioners, and researchers committed to bridging the digital divide.

Literature Review

Rural public libraries play a pivotal role in addressing the digital divide by providing communities with access to essential technologies and digital resources. However, rural areas face unique challenges, such as limited infrastructure, low internet connectivity, and a lack of digital literacy, which hinders the effective use of these resources (Hassan & Ismail, 2023). These obstacles significantly impact the ability of rural libraries to implement and sustain digital technologies, creating a gap between the services they offer and the needs of their users. Recent research underscores the importance of overcoming these barriers through strategic investments in infrastructure, training programs, and community engagement (Aziz & Jalaludin, 2023). While the challenges are clear, there are also significant opportunities for rural libraries to foster digital sustainability by developing innovative programs, leveraging partnerships, and increasing awareness of available digital services (Rahman & Lim, 2024). This literature review examines the existing body of knowledge surrounding the role of rural libraries in digital transformation, focusing on the barriers they face and the opportunities for advancing sustainable digital practices in these essential community institutions.

The Role of Rural Public Libraries in Digital Transformation

Rural public libraries have long been recognized as vital community resources that provide access to information and foster learning. In the digital age, these libraries have expanded their roles by offering essential digital services such as internet access, computer use, and digital literacy programs. However, rural areas often face a technological gap compared to urban centres, which can limit the impact of these services. Despite these challenges, rural libraries have shown resilience by adopting digital technologies to meet the needs of their communities (Hassan & Ismail, 2023). As technology becomes increasingly integrated into everyday life, rural libraries are positioned as critical hubs for bridging the digital divide.

Recent studies emphasize that rural libraries are more than just providers of technology—they are facilitators of digital literacy and education. Research by Aziz & Jalaludin (2023) highlights how rural libraries can empower communities by offering programs that teach digital skills, from basic computer usage to more advanced technology training. These services not only help individuals gain technical skills but also enhance their ability to access essential information, such as healthcare, government services, and educational resources, thereby improving overall quality of life. However, the success of these programs relies heavily on the availability of adequate resources and infrastructure, which are often lacking in rural settings.

The growing importance of digital technology in rural public libraries calls for a closer look at how these libraries adapt and evolve in the face of challenges. While access to digital services is essential, it is also important to examine how effectively these services meet the needs of rural communities. Research by Rahman & Lim (2024) underscores that rural libraries must continuously innovate to stay relevant and offer sustainable digital solutions. For libraries to succeed in this digital transformation, there is a need for a broader strategy that includes technology integration, staff training, and community outreach efforts that promote long-term digital engagement.

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Barriers to Digital Technology Adoption in Rural Public Libraries

Despite the potential of rural public libraries to drive digital inclusion, several barriers impede the successful adoption of digital technologies. One of the most significant challenges is the limited infrastructure that exists in many rural communities. Poor internet connectivity, outdated hardware, and insufficient technological support create a significant gap in the quality of services that can be provided. According to Yusof & Rahman (2023), limited funding is a critical factor that prevents rural libraries from upgrading their technology, impacting their ability to meet the growing demands of users.

Another major barrier is the lack of digital literacy among rural populations. Many individuals in rural areas may not possess the necessary skills to effectively use digital tools, which leads to underutilization of available services. Research by Lim & Wahab (2023) reveals that even when technology is accessible, the absence of targeted training programs results in users feeling overwhelmed or disconnected from digital services. This issue is compounded by the fact that many rural libraries lack staff with the technical expertise to offer in-depth training, further limiting the impact of digital initiatives.

A third challenge is the low level of awareness about the availability of digital services in rural libraries. Many residents may not know that their local library offers digital resources or may not understand how to access them. As Davis & Bargozzi (2024) point out, effective communication and outreach strategies are essential to raising awareness and fostering engagement. Without these strategies, libraries risk failing to reach a significant portion of the community, leaving many without the benefits that digital services could provide. Overcoming these barriers requires coordinated efforts from library administrators, government bodies, and community leaders to ensure that digital technologies are accessible, understandable, and effectively utilized by rural populations.

Opportunities for Digital Sustainability in Rural Libraries

While barriers to digital adoption in rural libraries are significant, there are also numerous opportunities for promoting sustainability in these services. One of the key opportunities is the potential for collaboration and partnership. Rural libraries can collaborate with governmental organizations, private sector companies, and non-profit groups to secure funding, share resources, and create innovative programs that address local digital needs (Hassan & Ismail, 2023). By leveraging external expertise and resources, libraries can reduce the burden of financial constraints and enhance their ability to provide sustainable digital services.

Another opportunity for rural libraries is the development of community-centred digital literacy programs. Research by Mammen & Arman (2024) suggests that community involvement in the creation and implementation of digital programs can enhance the relevance and effectiveness of these initiatives. Libraries can design programs that cater to the specific needs of the community, whether it's training for local businesses, job seekers, or students. By aligning digital literacy efforts with the broader goals of the community, libraries can increase engagement and create lasting digital benefits that extend beyond the library itself.

Additionally, rural libraries can capitalize on emerging technologies such as mobile internet and solar-powered solutions to overcome infrastructure limitations. According to Bransford (2024), mobile and renewable energy technologies have the potential to expand access to digital services in remote areas where traditional infrastructure is lacking. By adopting such

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technologies, rural libraries can not only provide more reliable digital services but also contribute to environmental sustainability by reducing dependence on non-renewable energy sources. These technological innovations offer a path toward long-term digital sustainability in rural communities.

Strategies for Enhancing User Satisfaction and Digital Service Quality

Ensuring high user satisfaction with digital services in rural libraries requires a multifaceted approach that addresses both the quality of services and the needs of the community. Research highlights that improving user experience involves not only providing access to technology but also ensuring that the technology is relevant, reliable, and supported by trained staff (Aziz & Jalaludin, 2023). Libraries must invest in regular training for staff to ensure they can assist users effectively and troubleshoot any technical issues that may arise. This will help create a more user-friendly environment, fostering greater engagement with digital services.

User satisfaction also hinges on the accessibility and inclusivity of digital services. Studies by Rahman & Lim (2024) emphasize that libraries must ensure their digital resources are accessible to all segments of the population, including the elderly, disabled, and economically disadvantaged. This can be achieved by providing adaptive technologies, offering different formats for digital content, and ensuring physical accessibility to library spaces. A comprehensive approach to accessibility not only improves user satisfaction but also enhances the overall impact of digital initiatives on community development.

Lastly, fostering a culture of continuous improvement is essential for maintaining high levels of user satisfaction over time. Libraries can gather feedback from users regularly to identify areas of improvement and implement changes accordingly. According to Yusof & Rahman (2023), libraries that engage in ongoing evaluations of their digital services are better equipped to adapt to changing technologies and user needs. By incorporating user feedback and responding to emerging trends, rural libraries can create sustainable and user-centered digital services that continue to meet the evolving needs of their communities.

Theoretical Frameworks on Past Studies

Several theoretical frameworks provide valuable insights into the challenges and opportunities of digital advancements in rural public libraries. Diffusion of Innovation Theory explores how new technologies are adopted by library staff and users, influenced by factors like awareness and perceived usefulness. The Technology Acceptance Model (TAM) emphasizes ease of use and perceived benefits as key to user adoption of digital resources. The Digital Divide Framework highlights disparities in access to digital technology, especially in rural areas, and how libraries can bridge these gaps. The Sustainable Development Framework, particularly the UN SDGs, focuses on how rural libraries can promote equitable and sustainable access to digital resources. The Resource-Based View (RBV) examines how libraries can leverage internal resources and partnerships to overcome barriers. Lastly, the Digital Literacy Framework underscores the importance of digital skills development to empower users and ensure effective use of technology. Together, these models provide a comprehensive lens for understanding and addressing the complexities of digital transformation in rural libraries.

Methodology

This study aims to explore the opportunities and barriers to the sustainability of digital advancements in rural public libraries, focusing on the experiences and perceptions of library

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users. To achieve this, a quantitative research design was adopted, which allowed for the systematic collection and analysis of data on user satisfaction, digital technology awareness, and the challenges associated with digital adoption in rural settings. The methodology employed in this study is specifically designed to provide comprehensive insights into the factors influencing the successful implementation and sustainability of digital services in these libraries, addressing the key gaps identified in the literature and aligning with the research objectives outlined in the thesis.

Given the rural context of the study, a survey-based approach was chosen to ensure the inclusion of a wide range of participants from diverse demographic backgrounds. The data was collected using Google Forms, providing an efficient and accessible platform for respondents to participate. This method was selected to facilitate the collection of large-scale data and ensure inclusivity by accommodating respondents with varying levels of digital access. The methodology enables a thorough understanding of rural libraries' challenges in sustaining digital advancements and contributes to identifying potential solutions to enhance digital sustainability in these communities.

Research Design

The research design for this study is based on a quantitative approach, focusing on collecting numerical data to evaluate the effectiveness and sustainability of digital technology in rural public libraries. Using a survey-based methodology, the study aims to capture a broad range of user experiences, satisfaction levels, and perceived barriers to digital adoption. The quantitative design allows for measuring specific variables, including user awareness of digital resources, satisfaction with library services, and the challenges rural libraries face in implementing and sustaining these services. The structured questionnaire, designed to gather quantitative and qualitative data, was crucial in examining the relationship between these factors and their impact on digital sustainability.

A cross-sectional survey design was employed, where data was collected at a single point in time from a large sample of library users across multiple rural public libraries. This approach provided an efficient means of assessing current perceptions and experiences while also allowing for identifying patterns and trends related to the use of digital services. The survey design was particularly suitable for this research as it enabled the gathering of insights from diverse respondents, making it possible to analyze how demographic factors, such as age, education, and internet access, influence users' engagement with digital technologies in rural libraries. This methodology ensures that the study aligns with its objectives of identifying barriers, opportunities, and strategies for improving the sustainability of digital advancements in rural library settings.

Sampling and Participants

The participants in this study were selected from rural public libraries across Malaysia, with a total of 2,660 respondents. To ensure that the sample was representative of the diverse rural population, a stratified random sampling technique was employed. This method involved dividing the rural population into different strata based on key demographic characteristics such as age, gender, education level, and socioeconomic status. By using this approach, the study was able to capture a comprehensive range of perspectives, ensuring that the findings accurately reflect the experiences of various groups within rural communities.

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The inclusion criteria for participants required them to be regular users of library services, specifically those who had engaged with digital resources such as e-books, online databases, or internet access provided by the libraries. This criterion was essential to ensure that the respondents had sufficient experience with the digital services being evaluated. Participants were also required to be from rural areas to ensure the relevance of the data to the study's focus on rural public libraries. The sampling strategy aimed to collect data from a broad cross-section of the rural population to understand the factors affecting digital technology adoption and sustainability across different groups.

The sampling process was designed to address the research objectives by ensuring that a diverse range of participants contributed to the study. While the majority of the data was collected online through Google Forms to ensure broader accessibility, a smaller group of respondents who had limited internet access participated through paper-based surveys, which were later digitized for analysis. This mixed approach allowed the study to include participants from remote rural areas with limited digital literacy or access, ensuring that the findings reflect the full spectrum of user experiences with digital services in rural public libraries.

Data Collection and Analysis

Data for this study was collected through a structured questionnaire designed using Google Forms. The survey was distributed online through Google Forms to maximize accessibility and reach a wide range of respondents. Participants were invited to complete the questionnaire via social media platforms, email, and direct links shared by the libraries. This method allowed the study to collect responses from a broad cross-section of rural library users, especially those comfortable using digital platforms. The online format also ensured that data could be collected efficiently and managed quickly for analysis. To ensure that the study was inclusive, participants from rural areas with limited digital access were also allowed to complete paper-based versions of the questionnaire. These responses were later transcribed into the Google Form to ensure consistency in the data collection process.

To maintain the integrity and accuracy of the responses, participants were provided with clear instructions on completing the Google Form and informed of the study's purpose. The questionnaire was designed to take no more than 15-20 minutes to complete, ensuring that it was convenient for busy library users. Additionally, ethical considerations were taken into account, with participants being assured of confidentiality and anonymity and their informed consent obtained before they began the survey. This approach ensured that the study adhered to ethical guidelines, allowing for honest and accurate responses.

The data collected from the 2,660 respondents was analyzed using the Statistical Package for the Social Sciences (SPSS) to identify key trends and relationships between the variables of interest. Descriptive statistics, including frequencies, percentages, and means, were first used to summarize the demographic characteristics of the sample, as well as the respondents' answers to the survey questions. This provided an overview of users' awareness, satisfaction, and challenges related to the digital services available in rural libraries. Descriptive analysis also helped establish the general levels of awareness and satisfaction among library users. To assess the reliability of the survey instrument, Cronbach's Alpha was calculated using SPSS for the scales measuring awareness, satisfaction, and perceived barriers.

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Results and Discussions

The data collected from the respondents provided valuable insights into the use, satisfaction, and barriers related to digital services in rural public libraries. Demographically, the majority of respondents were between the ages of 18 and 45, with a nearly equal gender distribution. Educationally, a significant portion of the participants had completed at least secondary education, which is crucial since digital literacy often correlates with higher education levels. Many respondents reported being familiar with various digital tools, such as e-books, online databases, and internet services, suggesting a base level of digital competence. These factors likely influenced both the awareness and satisfaction levels reported by the respondents about the digital services available at their local rural libraries.

Regarding awareness and usage of digital services, 67% of respondents expressed awareness of the integrated digital technologies in rural libraries. Despite this high level of awareness, only 62% of respondents reported utilizing these services, indicating a gap between knowledge and actual use. This gap suggests that while rural library users are generally aware of the available digital services, they may face obstacles, such as limited access to devices or unreliable internet connections, that prevent them from fully engaging with these resources. When analyzing satisfaction with digital services, the results were mixed. While 62% of respondents were satisfied, with an average satisfaction score of 3.85 on a 5-point Likert scale, 19% of participants expressed dissatisfaction. The primary reasons cited for dissatisfaction included slow internet speeds, the lack of sufficient devices, and technical difficulties, suggesting that the infrastructure and accessibility of these services need significant improvements.

The analysis also identified several key barriers to the effective use of digital services in rural libraries. The most frequently reported barriers included poor internet connectivity (45%), limited access to digital devices (37%), and insufficient digital literacy programs (28%). Moreover, 41% of respondents highlighted the lack of technical support and equipment maintenance as a significant hindrance to their ability to utilize digital resources fully. These barriers clearly impacted user satisfaction, with a statistically significant negative correlation ($r = -0.45$, $p < 0.01$) between perceived barriers and overall satisfaction. This underscores the importance of addressing technical and infrastructural challenges to enhance user experience and improve the sustainability of digital library services in rural areas.

To ensure the reliability of the survey results, Cronbach's Alpha was calculated for the survey scales measuring satisfaction, awareness, and barriers. The satisfaction scale showed high internal consistency with an Alpha value of 0.87, while the awareness and barriers scales also demonstrated acceptable reliability, with values above 0.80. These results confirm the survey instrument's robustness and the data's validity. The findings, presented through various tables and charts, clearly illustrate that while rural library users are generally aware of and somewhat satisfied with digital services, significant barriers related to infrastructure and accessibility remain. Addressing these challenges is crucial to enhancing user engagement and ensuring the sustainability of digital services in rural public libraries.

By exploring these findings about existing research, the discussion is organized around four key subthemes: (1) the gap between awareness and usage of digital services, (2) the impact of technological barriers on user satisfaction, (3) the role of digital literacy in enhancing user engagement, and (4) opportunities for improving the sustainability of digital services. Each

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subtheme will be explored in detail, offering potential solutions to enhance the sustainability of digital technologies in rural library settings. The visual representations of the quantitative results indicated below:

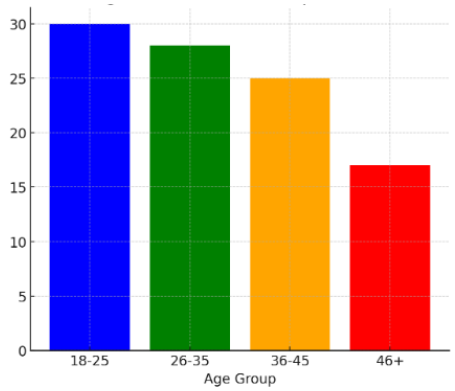

Figure 1: Age Distribution of Respondents

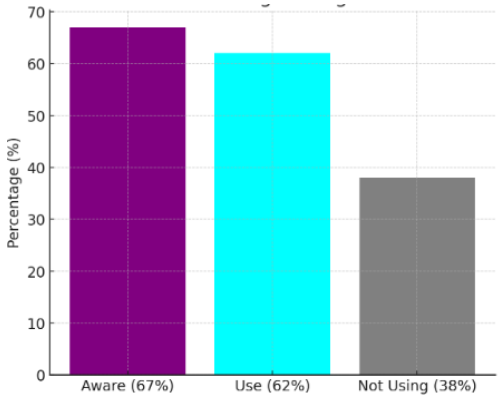

Figure 2: Awareness vs. Usage of Digital Services

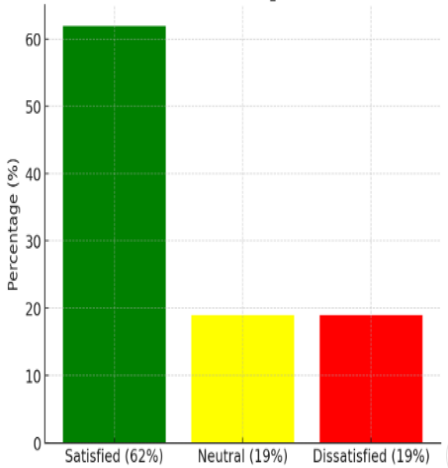

Figure 3: Satisfaction with Digital Services

Gap Between Awareness and Usage of Digital Services

One of the most prominent findings of this study is the gap between the awareness and actual use of digital services in rural public libraries. Although 67% of respondents reported being aware of digital technologies in their libraries, only 62% used them, highlighting a significant

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disconnect. This disparity can be attributed to multiple factors, particularly infrastructural challenges like limited internet access and insufficient devices, which hinder the full utilization of digital services. In rural areas, even when users are aware of available digital services, they often lack the necessary resources to engage with them effectively. This gap is not unique to this study but is consistent with prior research, which has also pointed out that awareness does not always translate into usage due to external barriers such as technical issues, lack of equipment, or financial constraints (Horrigan, 2022). Therefore, to address this issue, rural libraries must focus on raising awareness and improving access to the technology and services they offer. Solutions like community-based technology lending programs or partnerships with local internet providers could bridge this gap and promote more significant usage.

Impact of Technological Barriers on User Satisfaction

The analysis revealed that while most respondents (62%) expressed satisfaction with digital library services, a substantial portion (19%) was dissatisfied, primarily due to barriers like poor internet connectivity and limited access to devices. These findings emphasize that the quality of technology infrastructure directly influences user satisfaction. As highlighted by Ventaksh (2023), reliable access to high-speed internet and digital devices is crucial for users to fully use online resources and services. In rural areas, where such infrastructure is often lacking, users experience frustration, leading to decreased satisfaction with library services. The data from this study show that respondents who reported experiencing poor connectivity or a lack of devices were more likely to express dissatisfaction, supporting the notion that technological barriers significantly impact the overall user experience. To address these challenges, rural libraries should invest in upgrading internet infrastructure and ensure the availability of modern, functioning devices that can support a wide range of digital services. Collaborations with technology companies or governmental agencies to subsidize the cost of technology could further improve access for underserved communities.

The Role of Digital Literacy in Enhancing User Engagement

Another critical barrier identified in this study is the lack of digital literacy programs. With 28% of respondents highlighting insufficient digital skills as a challenge, it's clear that the digital divide is about access to technology and the ability to use it effectively. Low digital literacy levels hinder users from fully engaging with online resources, which diminishes the overall value of digital services. As Rahman & Lim (2021) have noted, even in rural areas with access to digital tools, users often struggle to use these resources effectively due to insufficient skills and confidence. The study suggests that offering targeted digital literacy programs would empower rural library users to navigate digital services more effectively, increasing satisfaction and usage rates. These programs could be designed in collaboration with local schools, community centers, or adult education programs to ensure they are accessible to various age groups and skill levels. Libraries could also develop online tutorials or in-person workshops focusing on practical skills, such as using e-books, accessing online databases, or engaging with library websites. Such initiatives would enhance user engagement and foster digital inclusivity in rural communities.

Opportunities for Improving the Sustainability of Digital Services

While this study highlights several barriers to the effective use of digital services in rural public libraries, it also uncovers valuable opportunities for improving their sustainability. The correlation between awareness and satisfaction suggests that increasing the visibility of digital services could drive greater user engagement. Rural libraries should consider implementing

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more proactive outreach strategies, such as promoting digital services through community events, social media, or collaborations with local institutions. Additionally, as this study demonstrates, improving the technological infrastructure of rural libraries is essential for increasing satisfaction and long-term usage. Investment in better internet connectivity, modern devices, and regular maintenance of existing equipment could result in significant improvements in user experience. Policymakers and library administrators should advocate for the expansion of broadband access in rural areas, which would not only enhance digital library services but also benefit other aspects of rural life, such as education and healthcare. Furthermore, incorporating sustainability practices, such as energy-efficient technologies and community-based support networks for technical assistance, could help ensure the long-term viability of digital services. The findings suggest that with targeted investments in infrastructure and digital literacy, rural libraries can become hubs of digital inclusion and innovation, ultimately improving their role in supporting rural communities' educational and informational needs.

Conclusion

This study has explored the challenges and opportunities surrounding the sustainability of digital services in rural public libraries, focusing on the factors influencing their adoption and effectiveness. The findings indicate that while rural libraries offer significant potential for improving access to digital resources, several barriers, such as limited technological infrastructure and digital literacy, still hinder their full utilization. Despite these challenges, there are clear opportunities for enhancing digital service sustainability, including improving technological infrastructure, increasing digital literacy initiatives, and fostering community partnerships. It is proven that this study has achieved all of the objectives.

The study has also highlighted the importance of understanding digital services' broader social and economic impact on rural communities. As libraries evolve and adapt to technological advancements, further research is essential to explore long-term solutions and innovative models for sustaining digital services in rural settings. By addressing these challenges and exploring new opportunities, rural libraries can better serve their communities, ensuring they remain hubs of education, information, and connection in an increasingly digital world.

In conclusion, while there are significant hurdles to overcome, the future of digital services in rural public libraries holds excellent promise. With targeted interventions and further research into infrastructure, literacy, and community engagement, the sustainability of digital services in these libraries can be greatly enhanced, benefiting rural residents and contributing to more inclusive digital societies.

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