Jurnal Teknologi Informasi dan Komunikasi

Volume 16 Issue 2 Year 2025 | Page 162-173 | e-ISSN: 2477-3255 | ISSN: 2086-4884
*Received: 08-08-2025 | Revised: 30-10-2025 | Accepted: 14-11-2025*

# Implementing Offline Servers for Digital Library and Streaming Services in Areas with No Internet Access

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***Abstract***: *Access to digital libraries and streaming services is often limited in regions with no internet connectivity, commonly referred to as blank spot areas. This paper presents the design and implementation of an offline server system to provide digital library and multimedia streaming services in several villages on Bengkalis Island, Indonesia. The system was installed in three villages and utilised a local server equipped with over 1,200 digital learning resources, distributed to users through a wireless local area network (Wi-Fi) without the need for internet access. During the three-month pilot period, 94% of users (n = 127) reported successful access to e-books and educational videos via their personal devices, with average access speeds reaching 40–48 Mbps. Content updates were performed every four weeks via temporary internet connections. User satisfaction was high, with 91% of respondents stating that the system helped them access up-to-date learning materials and improved their learning motivation. These results demonstrate that the offline server solution effectively bridges the digital divide, enabling equitable access to information, educational resources, and multimedia content for underserved communities in remote areas.*

***Keywords***: *offline server, digital library, streaming services, blank spot areas, wireless LAN*

## 1. Introduction

The rapid advancement of information technology has fundamentally transformed the way individuals, communities, and institutions access knowledge and learning resources [1]. Digital libraries and streaming services are no longer mere conveniences; they have become essential platforms for education, self-development, and lifelong learning [2]. These technologies not only make information more accessible, but they also encourage collaboration, new ideas, and digital literacy in society as a whole [3].

Despite these significant benefits, digital equity remains a pressing challenge, especially in archipelagic countries like Indonesia [4]. While seamless digital access benefits urban populations and well-connected areas, it leaves many rural and remote communities behind. Bengkalis Island in Riau Province is a prime example. The island, surrounded by the Strait of Malacca and characterized by a mosaic of coastal and inland villages, faces substantial obstacles in

https://doi.org/10.31849/digitalzone.v16i2. 29045

telecommunications infrastructure [5]. Vast stretches of the island remain classified as blank spot areas zones where internet coverage is absent or extremely limited due to challenging terrain, geographical isolation, and high costs of infrastructure deployment.

This persistent digital divide has a direct and compounding impact on education and community advancement. In these underserved regions, students and teachers grapple with severe limitations in accessing up-to-date textbooks, reference materials, and multimedia learning content [6]. The reliance on outdated printed materials often hampers teaching effectiveness and student engagement. Beyond formal education, the general population also struggles to access current news, practical information, and opportunities for digital skill-building and economic empowerment. Previous initiatives by government and non-government stakeholders, such as distributing printed books, flash drives with static content, or portable media devices, have yielded limited results. These solutions often prove unsustainable and difficult to update and are rarely tailored to the evolving needs and interests of the local community.

Recognizing these challenges, this research is focused on developing and implementing an innovative offline server system in several strategically selected villages across Bengkalis Island. The chosen locations represent diverse local contexts, including both coastal and interior settlements, varying in population density, school infrastructure, and community digital readiness. Selection was based on a thorough assessment of digital access gaps, the specific educational needs of the residents, and their willingness to engage in technology adoption.

The core concept of this research is the deployment of an offline server as a centralized digital resource hub [7]. The server is equipped with a curated library of e-books, educational videos, and multimedia content, all accessible through a local Wi-Fi network [8], [9]. This allows residents, students, teachers, and the broader community to access and utilize rich educational resources using their personal devices, such as smartphones, tablets, or laptops, without requiring any internet connection [10].

An integral feature of the system is its capability for periodic content updates. Whenever a temporary internet connection is available, whether through mobile data, portable satellite devices, or scheduled visits by maintenance teams, the server can be updated to ensure that educational materials remain current and responsive to the community's needs. Furthermore, the project emphasizes robust community engagement, including user training, operator capacity-building, and participatory feedback mechanisms, to ensure that the system remains relevant, sustainable, and embraced by the local population. This study aims to provide a scalable, practical, and replicable model for digital content delivery in other regions facing similar connectivity barriers by rigorously documenting the design, deployment, and evaluation processes. Ultimately, the research aspires to contribute to narrowing the digital divide, enhancing local literacy and digital skills, and supporting equitable human resource development in regions that have long been marginalized from the digital revolution.

By documenting the process of designing, implementing, and evaluating the offline server solution in several villages in Bengkalis Island, this study aims to offer a practical and replicable model for other areas facing similar connectivity challenges. It is expected that this effort will help narrow the digital divide, enhance literacy, and support human resource development in regions that have long been marginalized from digital access.

Furthermore, this initiative directly supports Indonesia's national agenda for digital transformation and inclusive education. By facilitating equitable access to quality educational resources, the offline server system aligns with the Sustainable Development Goals (SDGs) [11], particularly Goal 4 (Quality Education) and Goal 10 (Reduced Inequalities) [12]. It also contributes to the Ministry of Education's digital literacy movement and the broader vision of "Merdeka Belajar," which emphasizes accessible, relevant, and innovative learning for all Indonesian students. the realization of a digitally literate and empowered society, especially in remote and underserved regions [13].

To operationalize this concept, the project developed an offline digital library and multimedia platform called SIPERPUS, which is built on top of the local server and Wi-Fi network infrastructure described above. SIPERPUS functions as the main user-facing application

layer, providing a structured catalogue of e-books, educational videos, and other learning resources that can be accessed through both a web-based interface and a dedicated Android application. The platform was specifically designed to match the needs and digital literacy levels of students, teachers, and community members in the selected villages, with simple navigation, clear content categories, and multilingual support where relevant. In the following sections, SIPERPUS refers to the combined offline digital library system that was set up and tested in the pilot areas.

## 2. Research Method

This research was conducted in several villages on Bengkalis Island, Riau Province, which were identified as having limited or no internet access. The research process consisted of several main stages: system design, implementation, and evaluation.

### 2.1 System Design and Architecture

The offline server system was designed to enable the delivery of digital library and multimedia streaming services without relying on permanent internet connectivity [14]. The architecture consists of an offline server, a local router/Wi-Fi access point, and user devices (laptops, smartphones, and tablets). The server is periodically updated via a temporary connection to the internet (ISP) to ensure content remains current. The detailed system topology is illustrated in Figure 1.

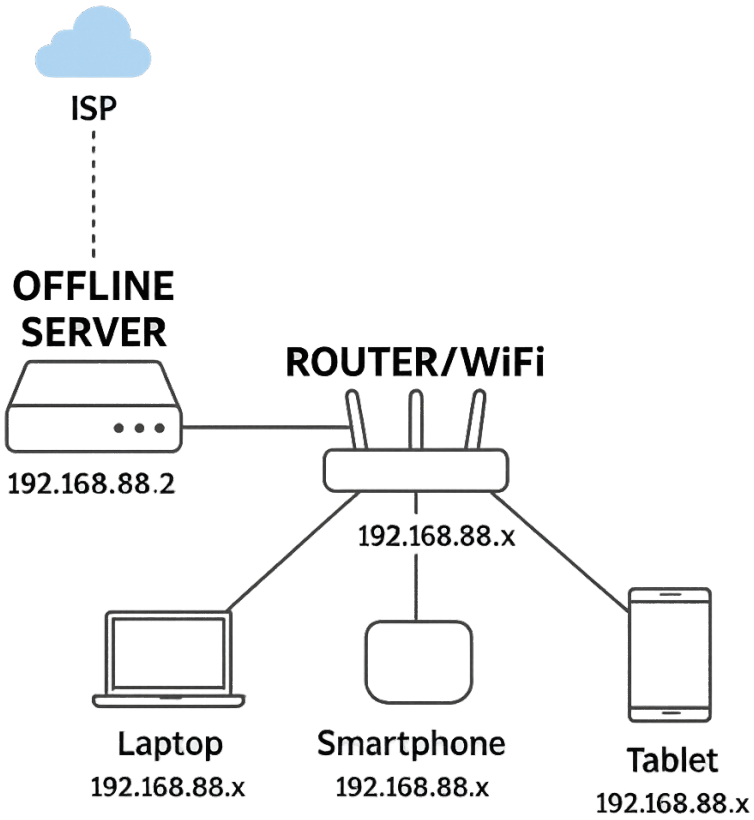


**Figure 1: Topology of the Offline Server System**

Figure 1: The topology of the Offline Server System illustrates the network architecture implemented to provide digital library and streaming services in areas with no internet access (blank spot). The offline server acts as the central repository for all digital content, which is distributed locally via a Wi-Fi router. Users utilizing laptops, smartphones, and tablets can

connect to the network and access educational and multimedia resources directly, without requiring internet connectivity [15]. The server is periodically updated through a temporary connection to the ISP to ensure content remains current. This architecture is implemented through the SIPERPUS platform, in which the offline server hosts the digital library and streaming content, while users interact with the system via a lightweight web interface and an optional Android application running on their personal devices. The architecture that is being used, demonstrates a practical solution for bridging the digital divide and improving access to information and learning resources in remote or underserved communities [16].

### 2.2 Data and Research Locations

Primary data for this research was collected through a combination of surveys, interviews, and direct field observations conducted in several selected villages on Bengkalis Island, Riau Province. The selection of research locations was based on several important criteria: the degree of internet connectivity in the area, the urgency of educational resource needs, and the willingness and readiness of the local community to adopt and support new technological solutions. The selected villages represented various contexts, including both coastal and inland settlements, each with unique challenges related to digital access. In these locations, surveys were distributed to students, teachers, and community members to gather information on their current access to educational materials, preferred learning formats, and familiarity with digital technology. Interviews with local leaders and school administrators were also conducted to better understand the infrastructure, the educational priorities, and the specific barriers faced by each community.

Direct field observations were essential to assess the physical infrastructure available, such as community centers, schools, and electricity supply, which would support the installation and operation of the offline server system. The research team also documented the existing routines for sharing information and educational content within each village, identifying both opportunities and limitations for the implementation of the system. The digital content provided through the offline server was carefully curated to match the needs and preferences of each village. This included a collection of e-books aligned with the national curriculum, educational videos on key subjects, and supplementary learning materials such as interactive exercises and reference guides. The selection process was done in collaboration with local teachers and community representatives to ensure relevance and engagement.

All data collection procedures adhered to standard ethical guidelines for educational research. Participation in surveys and interviews was entirely voluntary, and all respondents were informed about the purpose of the study, the types of data being collected, and their right to withdraw at any time without any negative consequences. No personally identifiable information was recorded in the datasets used for analysis; responses were anonymized and reported in aggregate form to protect the privacy and confidentiality of participants. Where required, permissions were obtained from school principals and relevant local authorities prior to conducting data collection activities in the selected villages.

### 2.3 Implementation Steps

The offline server was strategically installed in a central and easily accessible location within each village, such as a school, community center, or village hall. These sites were chosen for their physical accessibility and their role as community centers for education and socializing. The aim was to ensure that as many residents as possible, including students, teachers, and community members, could benefit from the system. Before installation, the server was pre-loaded with a comprehensive collection of digital content, including e-books, educational videos, interactive learning modules, and reference materials, tailored to the needs and preferences of the local population [17]. The content selection process involved consultation with local educators and community leaders to ensure that the resources would be relevant, age-appropriate, and aligned with the local curriculum and interests.

Once installed, the server was connected to a router or Wi-Fi access point, creating a local wireless network that covered the central area of the village. This network allowed users to connect to the server using their devices (laptops, smartphones, or tablets) without requiring any internet connection. The system provided both a web-based interface that could be accessed from

any Wi-Fi-enabled device via a standard browser, and, in addition, a dedicated Android application was made available for users of Android smartphones to offer an optimized mobile experience. This multi-channel access approach ensured compatibility with a wide range of devices commonly found in the community while still prioritizing ease of use for mobile users. To ensure that the system would be well utilized and sustainable, a series of user guides and training sessions were organized. These sessions targeted different groups of students, teachers, and general community members and focused on practical demonstrations of how to connect to the local Wi-Fi network, navigate the digital library or streaming services, and make the most of available educational content [18]. Printed step-by-step guides were also given out and put up in public places to help with the training. Additionally, selected local volunteers or community operators were trained in basic server maintenance, troubleshooting, and content update procedures. This approach fostered local ownership of the system and ensured that minor technical difficulties could be resolved quickly without relying on external support.

### 2.4 Evaluation Method

The effectiveness of the implemented offline server system was evaluated through several key criteria to ensure its suitability and impact in blank spot areas, building on established approaches to assessing digital libraries and Wi-Fi-based learning environments [2], [9], [10]. First, user accessibility was assessed by observing and documenting how users could connect to the local Wi-Fi network and access the digital library and streaming content provided by the offline server. This procedure involved monitoring the user connection process, login success rate, and the intuitiveness of the system interface [2], [9]. Second, the reliability of the system was measured by keeping track of how stable and up-to-date the server and the local network were. The research team monitored occurrences of system downtime, network interruptions, and any technical difficulties that could disrupt access to the digital resources. The objective was to ensure that the system could provide continuous and dependable service to users in the targeted villages [8], [14], [16]. Third, the content update mechanism was evaluated by examining the practicality and frequency of updating digital materials on the server. This included testing the procedures for content synchronization during periods of temporary internet access, as well as assessing the ease with which administrators could perform updates without requiring advanced technical skills [10], [14], [16], [17]. Lastly, user satisfaction was gauged by collecting feedback from users through surveys and interviews. Users were asked to share their experiences with the system's usefulness, usability, content relevance, and improvement suggestions. This feedback offered helpful observations about the real-world effectiveness of the solution and its acceptance within the community [3], [9], [18].

### 2.5 Structured Explanation of Methods

The primary method applied in this research was the deployment of a dedicated local wireless network centered on an offline server. This server acted as the central repository for all digital content, including e-books, educational videos, and multimedia learning materials. A Wi-Fi router was configured to create A Wi-Fi router was configured to create a high-coverage wireless local area network (WLAN) within the village or community center, allowing users to seamlessly connect their personal devices, such as smartphones, tablets, and laptops, to the server without any need for internet access. In this pilot implementation, the system was intentionally designed to provide open, low-barrier access: users could browse and consume content directly over the local network without creating accounts or logging into the system, and the server did not collect or store any personal user data. As a result, the study focuses on the feasibility, accessibility, and performance of offline content delivery rather than on advanced security mechanisms; detailed authentication, authorization, and fine-grained access control are therefore considered outside the scope of this work and are identified as directions for future development. All digital content was made available in real-time within the coverage area, enabling students, teachers, and community members to browse, download, and interact with educational resources

at any time. The user experience was designed to be intuitive and accessible, utilizing both web-based and mobile application interfaces tailored to various digital literacy levels.

Content update procedures were also structured for practicality and sustainability. Updates to the server's content library were scheduled and carried out periodically, typically during planned visits by administrators or local operators. During these sessions, a temporary internet connection, either via mobile data, portable satellite device, or other available means, was used to synchronize new materials and system updates. This ensured that the resources remained current, responsive to user needs, and aligned with the latest educational standards, without disrupting the offline nature of the primary service. In addition, the method incorporated basic training for local administrators and community operators, enabling them to independently manage routine maintenance, troubleshoot minor technical difficulties, and coordinate content update sessions. This approach not only supported the ongoing sustainability of the system but also encouraged a culture of ownership and technological empowerment.

## 3. Results and Discussion

The implementation of the SIPERPUS offline digital library system that is, the offline server-based platform introduced in the previous sections was carried out in several selected villages on Bengkalis Island that have limited internet access.

### 3.1 User Accessibility

The system proved to be easy to access for most users. Users simply connect their devices, such as laptops, smartphones, or tablets, to the local Wi-Fi network provided and then open the SIPERPUS application or web version via a browser. The application's simple interface and clear features were especially helpful for users who were less familiar with digital technology. During the trial period, the majority of users were able to access content smoothly without significant issues.

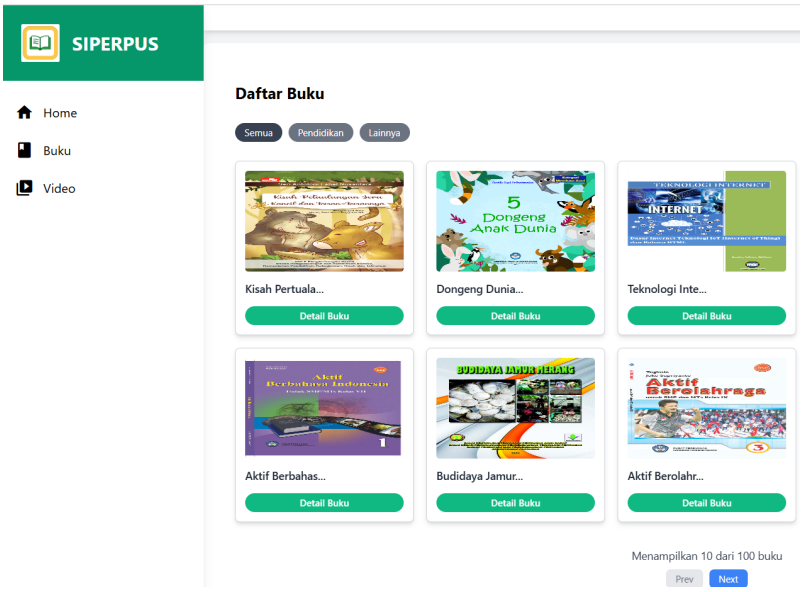


**Figure 2. SIPERPUS Book List Interface**

Figure 2 shows the book list interface in the SIPERPUS application, allowing users to choose from various book categories and access details or content directly through their personal devices.

### 3.2 System Reliability

Throughout the implementation and testing period, the offline server system and the local Wi-Fi network operated stably, with high uptime and minimal interruptions. Minor technical issues, such as brief power outages, could be resolved quickly by local administrators. The server and router hardware were selected to match rural conditions, ensuring reliable service in village environments.

### 3.3 System Access Speed

In addition to accessibility and reliability, access speed testing was conducted on various user devices. The results are summarised in Table 1.

**Table 1.** Average Access Speed by Device Type

| Device Type | Average Access Speed (Mbps) | Book Access Time (seconds) | Video Access Time (seconds) |
|---|---|---|---|
| **Laptop** | 48 | 1.6 | 3.2 |
| **Smartphone** | 42 | 1.9 | 3.6 |
| **Tablet** | 40 | 2.0 | 3.8 |

*Note: Measurements were taken on the local Wi-Fi network during peak usage hours.*

It is important to note that the performance evaluation in this study focused primarily on the user-facing experience, as reflected in the access speeds measured when opening e-books and streaming educational videos from the SIPERPUS server over the local Wi-Fi network. The measurements therefore capture end-to-end response times from the perspective of learners and educators using laptops, smartphones, and tablets, rather than low-level server metrics such as detailed network latency, long-term uptime statistics, or CPU and memory utilization. While these user-centered measurements are sufficient to assess whether SIPERPUS can provide a smooth and responsive access experience for the target communities, more fine-grained monitoring of server performance is beyond the scope of the current pilot implementation.

The access speed evaluation involved 127 users from the three pilot villages, including students, teachers, and community members who regularly used the SIPERPUS system during the implementation period. These users accessed the offline server using their own or shared devices available in schools and community centers, reflecting the typical device mix and usage patterns in the local context.

The tests were carried out over an approximately three-month evaluation period in mid-2025, covering regular school days and community usage hours to capture performance under realistic load conditions. During this period, 127 users accessed the SIPERPUS system using their laptops, smartphones, and tablets connected to the local Wi-Fi network, reflecting the typical mix of devices available in the participating villages. Although smartphones were observed to be the most commonly used devices, followed by laptops and a smaller number of tablets, the exact number of devices by type was not systematically recorded; accordingly, this study reports aggregate access speed measurements by device category rather than a detailed device-level breakdown. For each device category, multiple trials were conducted to open e-books and stream educational videos from the SIPERPUS server while connected to the local network to obtain representative average access times under normal usage conditions.

As shown in Table 1, the offline server provided consistently high access speeds across all device categories, with average throughput of 48 Mbps on laptops, 42 Mbps on smartphones, and 40 Mbps on tablets. In practical terms, this translated into average book access times of approximately 1.6–2.0 seconds and video access times of around 3–4 seconds, allowing pages to load almost instantaneously and videos to start with minimal buffering even during peak usage hours. Participants reported that this level of performance enabled a smooth and uninterrupted reading and viewing experience, which was particularly important for users who were previously unfamiliar with digital learning platforms and might be discouraged by slow or unreliable systems.

### 3.4 Content Update Mechanism

Content updates were carried out periodically whenever temporary internet connectivity was available, such as via mobile data or portable satellite devices. The synchronisation and data update processes on the server could be easily performed by trained village operators, ensuring that digital materials and the library collection remained relevant to user needs. This periodic

update mechanism was found to be effective and did not burden either the community or the system managers.

### 3.5 Discussion

The user flow diagram of the SIPERPUS offline digital library system (see Figure 3) offers an in-depth analysis of the practical workflow experienced by users and administrators in the implementation sites. The diagram visually outlines the step-by-step process, which begins with users connecting to the local Wi-Fi network and accessing the SIPERPUS platform through either a web browser on any Wi-Fi-enabled device or, for Android smartphone users, via the dedicated SIPERPUS mobile application. It continues with users selecting and consuming digital content, providing optional feedback, and concludes with the periodic content update process managed by the system administrator.

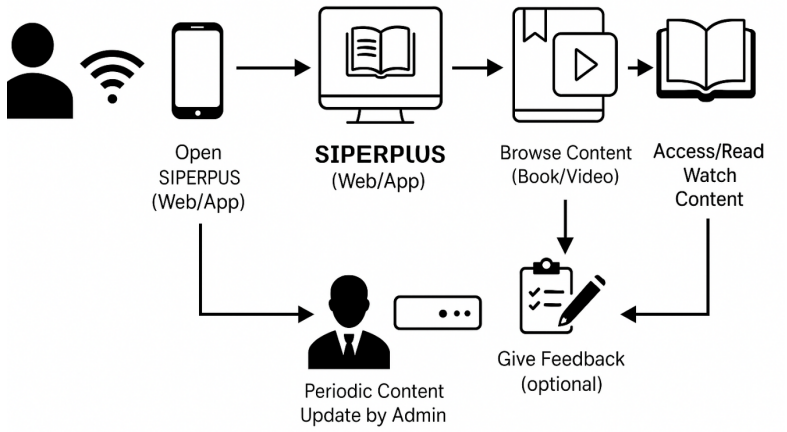


**Figure 3. User Flow Diagram of The SIPERPUS Offline Digital Library System**

This workflow embodies the core strengths and key differentiators of the SIPERPUS solution:

- Seamless User Experience and Accessibility. The process begins with a straightforward action connecting to the Wi-Fi network, which requires no technical expertise. Users can immediately access SIPERPUS through a web browser on their laptops, tablets, or smartphones, or, for those using Android smartphones, through the dedicated SIPERPUS mobile app, with both interfaces designed with simple navigation to accommodate varying levels of digital literacy. Users repeatedly cited the availability of digital resources at any time, without dependence on internet connectivity, as a major benefit, particularly for students and teachers who need consistent access to learning materials.
- Efficient Content Discovery and Utilization. Once connected, users can explore a wide selection of books, educational videos, and learning modules organized into clear categories. The diagram emphasizes the flexibility of the platform, allowing users to read, download, or watch content directly from their devices. This easy access to information makes it simpler for people to learn on their own, which is shown by how often users returned to the platform during the trial period.
- Feedback Mechanism for Continuous Improvement, The user flow incorporates a feedback loop, enabling users to share their experiences or report issues directly through the platform. This mechanism supports continuous service improvement and empowers the community by involving them in the system's development. Feedback collected during the implementation was instrumental in identifying content preferences and areas for further enhancement.
- Sustainable Content Update and System Maintenance, A unique feature of SIPERPUS, highlighted in the diagram, is the periodic content update process managed by local

administrators. By allowing updates during brief internet connections—via mobile data or portable satellite the system ensures that digital resources remain current without disrupting offline availability. Training local operators for server maintenance and content updates proved effective in building community ownership and system sustainability, as minimal technical difficulties were reported and swiftly resolved.

- Impact on Community and Educational Outcomes: The integrated workflow, as depicted in the diagram, resulted in high user satisfaction, increased digital literacy, and improved access to educational resources for previously underserved communities. The system's reliability and adaptability to local needs were consistently validated by positive user feedback, high system uptime, and strong engagement during training sessions.
- Comparison with Previous Studies, The findings of this study are broadly consistent with previous research on offline educational resource systems deployed in connectivity-constrained environments. Valarezo et al. reported that an offline educational resources access system implemented in the Galapagos Islands substantially improved access to curriculum-aligned materials and was positively received by teachers and students, despite severe limitations in internet connectivity, a pattern that parallels the high levels of user satisfaction and increased learning motivation observed among SIPERPUS users in the Bengkalis pilot villages [10]. Similarly, Purbo's work on internet-offline solutions in Indonesia demonstrated that locally hosted content and intranet-based access can significantly enhance perceived service quality and effective bandwidth utilization in remote settings, which aligns with the high local access speeds (40–48 Mbps) and smooth reading and streaming experiences documented in this study [14].
- Areas for Further Development. While the current workflow has proven successful, the diagram also reveals opportunities for further refinement. For instance, automating feedback analysis, streamlining the content update process, and expanding interactivity (such as collaborative learning features) could enhance both user engagement and learning outcomes. Additionally, broader partnerships with educational authorities could facilitate the scaling of SIPERPUS to more regions.

In summary, the user flow diagram not only clarifies the operational strengths of the SIPERPUS system but also serves as a strategic blueprint for its continued development and wider adoption. By centering the user journey and community involvement, the system addresses both technological and social dimensions of the digital divide, positioning SIPERPUS as a sustainable and replicable model for digital library implementation in remote areas.

### 3.6 Comparison with Existing Offline Education Platforms

The SIPERPUS implementation shares several characteristics with other well-known offline education platforms such as Kolibri, the eGranary Digital Library, and RACHEL. Similar to these initiatives, SIPERPUS relies on a local server combined with a wireless local area network to deliver curated educational resources to learners without the need for a stable internet connection, thereby addressing connectivity gaps that are common in remote and underserved regions. Kolibri, for example, provides an offline-first learning platform with a large multilingual content library and tools for teachers to create channels and track learner progress, while eGranary ("the Internet in a Box") offers an extensive offline repository of millions of web resources that can be accessed over institutional networks, and RACHEL supplies portable, battery-powered servers preloaded with open educational resources that can turn existing devices into offline learning hubs.

In contrast, SIPERPUS is intentionally designed as a lean and highly customizable offline system that can be adapted to the specific needs of the villages on Bengkalis Island and, more broadly, to other Indonesian rural contexts. Rather than providing a very large, generic global content bundle, SIPERPUS focuses on a community-driven collection that is tightly aligned with the national curriculum and locally relevant topics, with content selection and updates carried out in collaboration with teachers, school leaders, and community representatives. This customization extends beyond content to the configuration of the server and access workflows, allowing each deployment to be adjusted to local infrastructure constraints, device availability, and digital literacy levels so that the benefits of offline digital resources can be maximized for the specific target communities served by the system.

## 4. Conclusions

Several villages on Bengkalis Island have demonstrated significant effectiveness in addressing the digital divide in areas with limited or no internet connectivity. By establishing a local Wi-Fi network centered on an offline server, the system enables students, teachers, and community members to conveniently access a diverse range of educational and multimedia resources using their devices, without the need for an internet connection. The SIPERPUS platform, which supports both web-based and Android interfaces, proved to be highly user-friendly and accessible even for users with minimal digital literacy. Test results indicated that the system consistently delivered high access speeds and stable performance across various devices, including laptops, smartphones, and tablets. Periodic content updates, facilitated by local administrators through temporary internet connections, ensured that digital resources remained current and relevant. Furthermore, the training of local operators for system maintenance fostered a sense of community ownership and helped guarantee ongoing system sustainability. User feedback reflected high satisfaction, with most respondents highlighting the system's impact on improving access to up-to-date educational materials, enhancing learning motivation, and supporting independent study. The system was also valued for reducing reliance on outdated printed resources and offering a more flexible approach to information access, especially in remote and underserved areas.

In summary, the offline server solution not only bridges the digital access gap but also empowers rural communities by expanding opportunities for quality education, information dissemination, and digital literacy. The success of this approach underscores the importance of community engagement, ongoing content updates, and accessible technical support to ensure sustainability and scalability. For broader and more sustainable adoption, it is recommended that future development focus on:

- Further automating content synchronization and update mechanisms,
- Expanding the variety and interactivity of digital content, including more localized materials,
- Strengthening collaborations with educational authorities and stakeholders,
- Integrating additional features such as usage analytics, feedback loops, and remote management tools.

By continually evolving and adapting the system to local needs, the offline server model has the potential to serve as a replicable and impactful solution for bridging the digital divide in other remote and marginalized regions.

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