



Development and Implementation of a Web-Based Digital Library System (SIPERPUS) at SMKN 1 Bengkalis

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ARTICLE INFO	ABSTRACT
Keywords: Community Service; Digital Library; Laravel; School Library; Vocational High School	Students at SMKN 1 Bengkalis, a vocational high school in Riau, Indonesia, had no online collection they could open from their own devices, and school staff reported limited access to books and difficulty managing the collection. This community service program adapted PustakaPlus, a digital library built in 2025 by a Politeknik Negeri Bengkalis team for a village in Bengkalis Regency, into SIPERPUS. An audit of PustakaPlus found twelve defects, including media files reachable without login, an insecure direct object reference, unlimited login attempts, and a layout unfit for phones. The program ran in five stages: a needs discussion with the school and a technical audit, design, development with Laravel 13, Inertia.js, Vue 3, and MySQL, testing and deployment to shared cPanel hosting, and a socialization session on 18 September 2026 attended by 16 participants: three library staff members, twelve teachers, and one student representative. All 191 automated tests passed after one outdated test expectation was corrected. On the production server, all 19 routes checked returned the expected pages, media were served through range requests, and requests without login were redirected; Lighthouse gave performance scores of 97 to 99 (largest contentful paint 1.7 to 2.1 s), compared with 64 for PustakaPlus. During hands-on practice, participants found the application flow easy to follow; the main obstacle was that library staff were not yet used to managing data on a computer. No usability or satisfaction instrument was administered, so the results show technical readiness and initial acceptance, not educational effectiveness.
Article History Received: September 28, 2026 Revised: October 05, 2026 Accepted: October 16, 2026	
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To cite this article : Tedyyana, A., & Ratnawati, F. (2026). Development and Implementation of a Web-Based Digital Library System (SIPERPUS) at SMKN 1 Bengkalis. <i>Vokatek: Journal of Research and Community Service</i> , 4(3), 36–47. https://doi.org/10.61255/vokatek.v4i3.2185	

INTRODUCTION

Indonesian 15-year-olds scored 359 in reading in PISA 2022, well below the OECD average of 476, down from 371 in 2018 (OECD, 2023). School libraries are one of the few places where students meet reading material outside textbooks, yet their reach is limited by opening hours, the number of printed copies, and the time students can spend on site. At senior secondary level, better library services have been associated with higher reading interest (Azmar et al., 2023). Digital literacy research also shows that students now expect to find and read learning material on their own devices (Peng & Yu, 2022).

Digital libraries respond to this expectation by moving part of the collection online. Studies in Indonesian schools report that students who used a digital library read more often and studied more independently (Mulyawati & Marini, 2022; Sumardi, 2023). Zatadini et al. (2025) built a digital library at MIN 7 Tulungagung with the Design Science Research Methodology and observed higher reading interest after its introduction. Halomoan et al. (2025) tested a web-based digital library in elementary schools and found it effective as a learning resource. These results come from primary and junior levels.

Studies in vocational high schools (SMK) describe a different set of problems. Saranga and Bustari (2025) evaluated the libraries of three state SMKs in Malinau and found too little technology, outdated collections, limited space, and too few staff. Johari et al. (2024) reported that the library of

SMK-PP Negeri Jambi still recorded loans by hand in an agenda book, which caused queues and lost records, and Maulana et al. (2023) described similar manual record keeping for school assets at SMK N 5 Telkom Banda Aceh. At SMKN 1 Lais, Nurhayati et al. (2023) linked students' reading interest to how library facilities and reading-habit programs were managed, while Mundir et al. (2026) recommended that SMKN 1 Pasuruan widen access to digital resources to support its literacy programs. In a systematic review, Puspasari (2025) concluded that research on the digital literacy of SMK students is still fragmented. These studies document the constraints of SMK libraries, but few of them report a system that gives students full-text access from their own devices.

The service need at SMKN 1 Bengkalis came from the school. In a discussion with the community service team before development, representatives of the students, teachers, and library staff described two problems: students had limited access to books, because the library served them only through printed copies that could be borrowed or read on site during school hours, and the library found the book collection difficult to manage. A starting point was available from an earlier program. In 2025, a community service team from Politeknik Negeri Bengkalis built PustakaPlus, a digital library for Senggoro Village in Bengkalis Regency that lets users read PDF books and watch learning videos online. When the team demonstrated PustakaPlus during the discussion, the school asked for a similar system with several adjustments, so this program adapted PustakaPlus rather than starting from nothing. An audit of its source code and live site found twelve problems, which are listed in Table 2. To display book covers, the catalogue page rendered the first page of each PDF in the visitor's browser, which forced the browser to download every PDF on the page in full. The PDF reader waited for the whole file before showing page one. Uploaded PDFs and videos were stored in a public folder and could be opened by anyone who knew the URL. The teacher profile page accepted a user ID in the URL, so one teacher could edit another teacher's profile, a flaw known as insecure direct object reference (IDOR). The login form had no limit on failed attempts, did not regenerate the session after login, and returned error messages that revealed whether a username existed. Videos without faststart metadata could not start playing until they were fully downloaded, and videos in formats such as MKV or AVI could not be played in the browser at all. Finally, book categories were hard-coded in four views, the footer showed fixed contact details that could not be changed without editing code, and the interface did not adapt to phone screens. Students would open the library mostly from phones, so the last problem alone would limit its use at the school.

Web-based school library systems are common in Indonesian literature. Hendriani and Indrawan (2021) built one with WordPress for a vocational high school. Samusu (2021), Hadi et al. (2022), Wakhidah et al. (2023), and Wulandari and Nugroho (2024) reported systems for senior high, madrasah, and elementary schools, and Putra and Nugraha (2026) used the Laravel framework for the same purpose. Community service programs have delivered similar systems together with training for librarians and teachers (Hamrul et al., 2023; Djawa et al., 2025; Ramdaniah et al., 2025; Franzhardi, 2026). At SMK N 1 Padang Cermin, Sulistiani et al. (2022) developed a digital library application and trained library staff, teachers, and students to manage book data, loans, returns, and periodic reports. Most of these systems manage the circulation of printed books. The literature gap addressed here is therefore twofold: few of the reported systems, and none of the SMK studies above, serve full-text PDF and video content to students' own devices, and few report how fast their pages load, how uploaded files are protected, or whether the interface meets accessibility guidelines. These properties matter once a library hosts copyrighted e-books and is opened by hundreds of students on mobile connections.

This community service program rebuilt PustakaPlus into a new system named SIPERPUS (Sistem Informasi Perpustakaan) for SMKN 1 Bengkalis. The work had three goals: to fix the security and performance problems found in the audit, to redesign the interface for phones first, and to add features that the old system lacked, namely favourites, reading and viewing history with automatic resume, and a statistics dashboard for the librarian. The system had to run on the school's shared cPanel hosting, which offers no ffmpeg, no background queue worker, and no Node.js runtime on the server. This article reports how the system was designed and built under that constraint, how its quality was measured against predefined targets, and how it was handed over to the school.

METHOD

The program ran in five stages (Figure 1): needs analysis and audit, design, development, testing and deployment, and user socialization. The first four stages took place in September 2026 and the socialization was held at SMKN 1 Bengkalis on Friday, 18 September 2026.

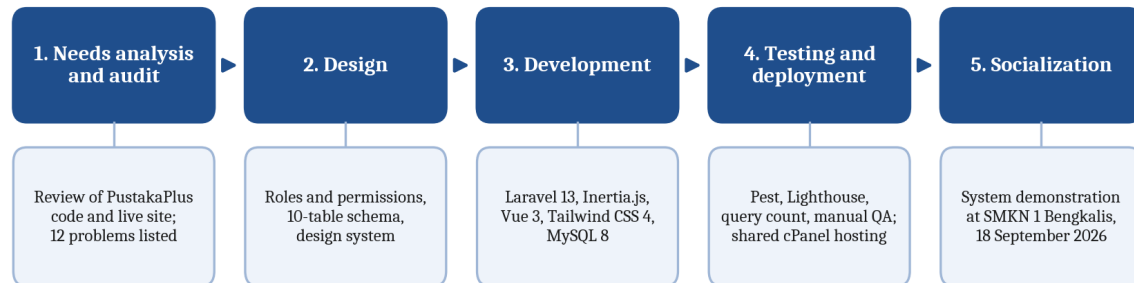


Figure 1. Stages of the community service program

Needs analysis and audit. The needs analysis had two parts. The first was a face-to-face discussion between the community service team and representatives of the students, teachers, and library staff of SMKN 1 Bengkalis before development. No questionnaire or interview guide was used, and the team did not take written notes, so the outcome is reported here as the needs agreed with the school rather than as coded interview data. The discussion centred on limited access to books and on managing the book collection. The team then demonstrated PustakaPlus, and the school asked for a similar system adjusted to its own context. These needs were translated into requirements: online reading of PDF books and videos from students' phones with an individual account for each member, an administration panel for books, videos, categories, and member accounts, site settings carrying the school's identity, and a dashboard showing how the collection is used. The second part was a technical audit. We read the PustakaPlus source code, used the live site as guest, member, and administrator, and listed each feature and each defect. Twelve features were kept, some with changes, and twelve problems were marked as issues that must not recur in the new system (Table 2). Two features were dropped, namely the Android and iOS installer downloads and the related /api endpoints, because the mobile application was no longer maintained.

Design. The design stage produced three outputs. The first was a role and permission matrix with four user types: guests, members (students, teachers, and staff), administrators (library staff), and super administrators. The second was a relational schema with ten tables covering users, categories, books, videos, favourites, reading progress, watch progress, access logs, activity logs, and site settings. The third was a design system that fixed the colour tokens, type scale, and reusable page blocks before any page was coded, so that every screen shares the same components.

Development. SIPERPUS was built on Laravel 13 (PHP 8.3) with the model-view-controller pattern (Rahmawati & Sumarsono, 2024; Bakhtiar et al., 2024). Pages are written in Vue 3 and connected to Laravel through Inertia.js, so the site behaves like a single-page application without a separate public API. Styling uses Tailwind CSS 4 and data are stored in MySQL 8. Three design decisions follow from the hosting constraint. Book covers and video posters are generated in the administrator's browser at upload time, using pdf.js and the HTML canvas, and then re-encoded on the server as WebP images, so visitors never download a PDF just to see its cover. Large files are uploaded in 5 MB chunks to stay below the upload limit of typical shared hosting. Work that would normally go to a queue, such as writing access logs, is deferred until after the response is sent.

Files are protected at several layers. PDFs and videos are stored on a private disk that has no public URL and are served by a controller only after an authorization policy allows the request. Every upload receives a new random file name and is checked by extension, MIME type, and file signature. Videos must be MP4 files with the metadata placed at the start of the file (faststart) so that playback can begin before the download finishes. The PDF reader uses HTTP range requests, which let pdf.js fetch only the parts of the file needed for the current page. Login is limited to five attempts per minute

for each username and IP address, profile routes never take a user ID, and every response carries security headers, including a Content Security Policy.

Testing and deployment. Quality was measured with four instruments. An automated test suite written with Pest covers authentication, authorization policies, file uploads, media streaming, search, statistics, and security headers. Google Lighthouse measured performance and accessibility on four public pages (home, book list, book detail, and video list) with mobile emulation and simulated 4G throttling. The number of database queries per page was recorded with Laravel's query listener and confirmed with Laravel Debugbar. Two rounds of manual testing in the browser, as guest, member, administrator, and super administrator, recorded usability defects together with the steps to reproduce them. Each measured value was compared with a target set during design, such as a Lighthouse accessibility score of at least 95 and no more than eight queries per public page. The approach follows studies that combine automated tools with manual checks for testing (Sunman et al., 2022), accessibility (Kumar et al., 2021), and security (Wen & Katt, 2023). After testing, the application was deployed to shared cPanel hosting and made publicly available at <https://siperpus.versio.my.id/>. On 13 October 2026, after deployment, the team repeated part of the measurement on the production server. Median time to first byte was measured from a browser over a 4G-class connection with ten uncached requests per public page, the cache and security headers of the responses were inspected, and a functional walkthrough with the super administrator account opened 19 routes covering the public, member, and administrator areas. Range requests for a PDF and a video were sent with and without a signed-in session. Lighthouse 13.5.0 was then run through PageSpeed Insights on the same four public pages in mobile mode with simulated slow 4G, and once on the member home page of PustakaPlus as a reference point.

Socialization and evaluation. On 18 September 2026 we presented SIPERPUS at SMKN 1 Bengkalis to 16 participants, namely three library staff members, twelve teachers, and one student representative. The session lasted about three hours and demonstrated how members search, read, and resume books and videos, and how administrators upload content, manage member accounts, and read the statistics dashboard. After the demonstration, participants took turns using a shared member account to search, read, and add favourites, while the library staff practised uploading a book and creating member accounts. The evaluation of this stage relied on direct observation: team members watched the practice, observed whether participants could carry out each demonstrated task, and observed where they needed help. The questions participants asked were also gathered. Because no written instrument was used, the observations were analysed qualitatively by grouping them into themes (Table 4), and no frequencies or scores are reported. The observations were not documented with a structured observation sheet or an audio or video recording, so they reflect the judgement of the team and cannot be audited independently; this limitation is acknowledged in the Discussion.

RESULTS AND DISCUSSION

Delivered system

SIPERPUS was deployed to shared cPanel hosting and is publicly available at <https://siperpus.versio.my.id/>. At the time of socialization it held 10 PDF books in five categories (Management, Non-fiction, Programming, Naval Engineering, and Civil Engineering) and 4 learning videos in the Programming category. Most of the books are government textbooks and teacher guides for SMK subjects such as naval construction, heavy equipment, office management, marketing, and game development. Table 1 lists the features available to each role.

Table 1. SIPERPUS features by user role

Role	Features
Guest	Home page with search, category chips, latest books and videos, and the most-read books of the last 30 days; book and video lists with search, category filter, sorting, and pagination; book and video detail pages
Member (student, teacher, staff)	All guest features; PDF reader with page navigation, zoom, swipe, keyboard shortcuts, and full screen; video streaming; automatic resume from the last page or second;

Role	Features
	favourites; reading and viewing history with progress; profile and password change; forced password change at first login
Administrator	Statistics dashboard; book and video management with draft status, download permission, trash, and restore; category management; member accounts with activation and password reset; access statistics by date range
Super administrator	All administrator features; administrator accounts; site settings (application name, school name, contact details, logo, welcome text); read-only activity log

Figure 2 shows the public home page on a phone screen, Figure 3 the PDF reader, and Figure 4 the administrator dashboard. At the time of writing, the dashboard recorded one active member account and 8 access events in the previous 30 days, five of them on the day of the socialization.

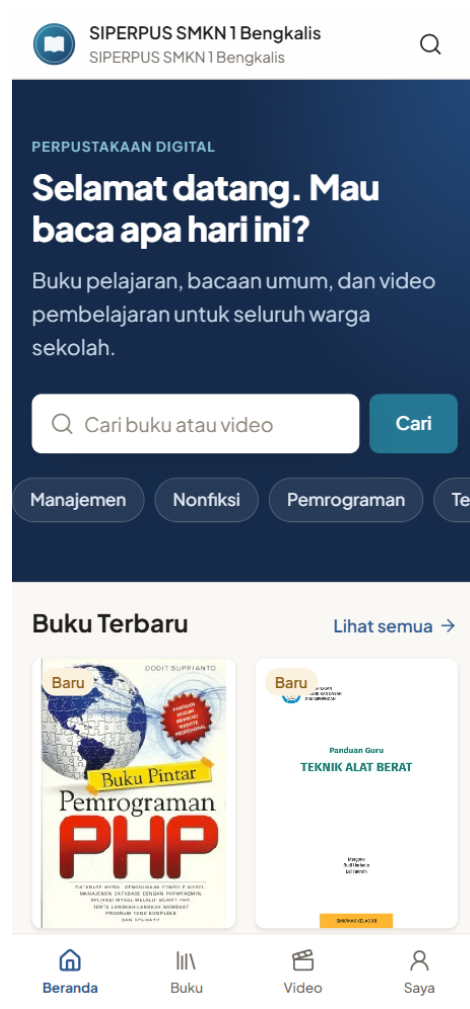


Figure 2. Public home page of SIPERPUS on a phone screen

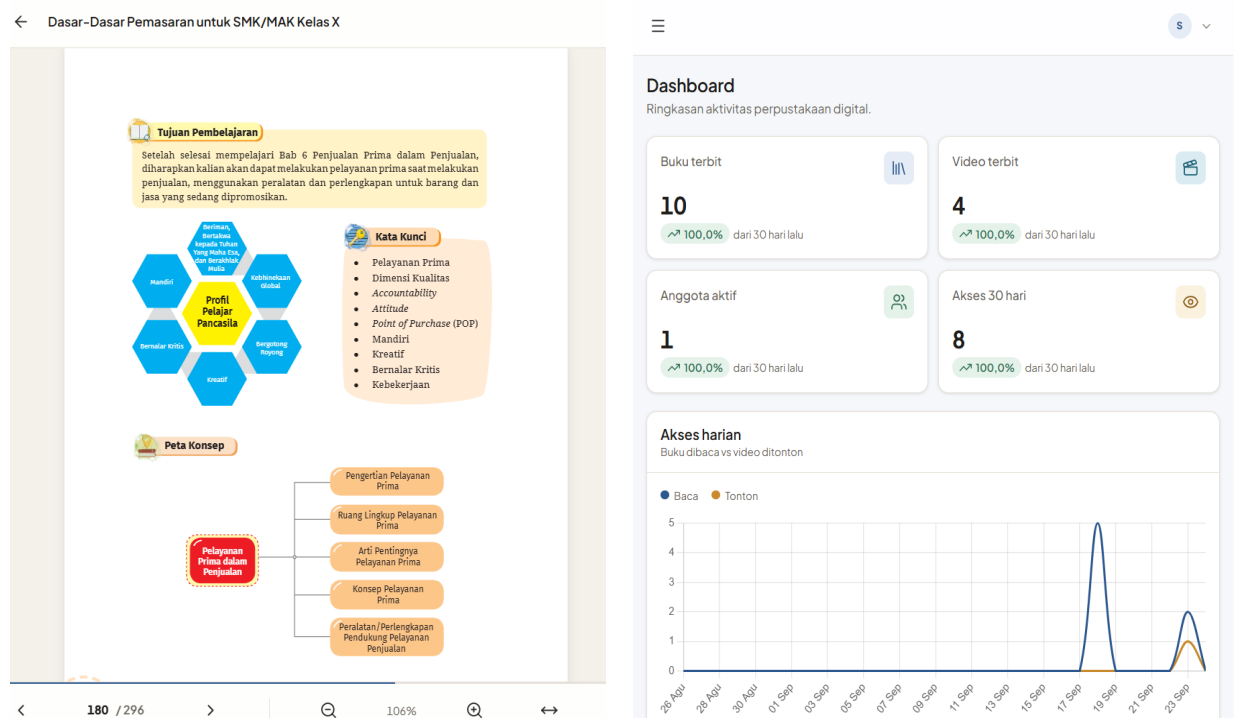


Figure 3. PDF reader opening a textbook and Administrator dashboard

Problems of the previous system and their solutions

Table 2 pairs each of the twelve problems found in the audit with the change made in SIPERPUS.

Table 2. The twelve problems in PustakaPlus and the solutions implemented in SIPERPUS

Problem in PustakaPlus	Solution in SIPERPUS
The catalogue rendered page one of every PDF in the visitor's browser to show covers, downloading each file in full.	WebP covers (300 and 600 px) are generated once when the administrator uploads a book.
The PDF reader waited until the whole file was downloaded.	pdf.js reads the file through HTTP range requests in 1 MB chunks and pre-renders the next page.
Videos without faststart metadata could not start playing until they were fully downloaded.	Only faststart MP4 is accepted; the server checks the file structure and answers range requests with 206 Partial Content.
Videos in formats such as MKV or AVI could not be played in the browser.	Uploads are limited to MP4 files and checked by extension, MIME type, and file signature.
PDFs and videos were stored in a public folder and reachable by URL.	Files are kept on a private disk and served by a controller after an authorization policy check.
Profile routes took a user ID, letting one teacher edit another's profile (IDOR).	Profile routes carry no ID and always use the signed-in account.
The login form had no limit on failed attempts.	Five attempts per minute per username and IP address.
The session was not regenerated after login.	The session is regenerated after every successful login.
Login error messages revealed whether a username existed.	One generic error message for every failed login.
Categories were hard-coded in four views.	Categories are stored in a database table and managed by administrators.
Contact details were fixed in the page template	A settings table editable by the super administrator
The layout did not adapt to phone screens.	Mobile-first layout built from a shared design system, with a bottom navigation bar on phones.

Testing results

Table 3 compares each measured value with the target set at the design stage.

Table 3. Testing results against the design targets

Aspect	Target	Result
Automated tests (Pest)	All pass	191 tests, 957 assertions; all passed after one outdated expectation was corrected
Lighthouse accessibility, mobile (development / production)	≥ 95	100 / 100 on all four pages
Lighthouse performance, mobile (development / production)	≥ 90	88 to 89 / 97 to 99
Largest Contentful Paint, simulated 4G (development / production)	< 2.5 s	3.2 s / 1.7 to 2.1 s
Initial JavaScript, gzip	< 150 KB	91.3 to 92.2 KB
Database queries per public page	≤ 8, no N+1	3 to 7
Time to first byte (development / production)	< 300 ms	330 to 350 ms / median 149 to 247 ms
PDF range request	206 Partial Content	206 returned for a 30 MB PDF
Static asset caching (production)	Long-term cache header	max-age one year, immutable; Brotli compression
Functional walkthrough (production)	All routes reachable	19 of 19 routes returned the expected page
Media access without login (production)	Redirect to login	Redirected for PDF and video
Manual testing, two rounds	No open defects	12 defects found (8 and 4), all fixed

In the first run of the suite, one test failed. It checked that a user can open the administrator page after changing a password, but the user factory had since been changed to create members by default, so the test received the correct 403 response for a member and failed on its old expectation. The behaviour of the application was correct, so the test was updated to create an administrator explicitly, and on rerunning the suite all 191 tests passed. Two kinds of result should be kept apart. The functional checks show that the system was implemented as designed: on the production server all 19 routes returned the expected page, the PDF and video endpoints answered range requests with 206 Partial Content, and requests without a session were redirected to the login page. The performance targets missed on the development server (Lighthouse 88 to 89, largest contentful paint 3.2 s, time to first byte 330 to 350 ms) were met on production, where the static assets carry a one-year immutable cache header and are compressed with Brotli. Lighthouse gave performance scores of 97 to 99, accessibility scores of 100, and a largest contentful paint of 1.7 to 2.1 s on the four public pages, and median time to first byte was 149 to 247 ms. For reference, the member home page of PustakaPlus scored 64 for performance and 80 for accessibility, with a largest contentful paint of 6.2 s, under the same Lighthouse settings. These are single laboratory runs; field data from real visitors are not yet available because traffic is still low. Downloading a 1 MB range of a PDF took 5.3 to 13.6 s over the client connection used for the walkthrough, so on slow networks the first page of a book can take several seconds to appear. Video start-up time was not measured.

The manual tests found eight defects in the first round, including validation messages without Indonesian field labels and a PDF reader that did not fit wide landscape pages. The second round found four more. Two were rated high: the profile page lost the site header and navigation, and the most-read table on the statistics page was empty on screens narrower than 768 px. The other two were error messages in the video player and PDF reader that either blamed the internet connection for a missing file or showed raw technical details. All twelve were fixed before deployment. These twelve defects were found in SIPERPUS during development and are distinct from the twelve problems of PustakaPlus listed in Table 2.

Socialization

The socialization on 18 September 2026 was attended by 16 participants: three library staff members, twelve teachers from several vocational programs, and one student representative. Table 4 groups the team's observations and the participants' questions into four themes. Individual responses were not recorded, so the table shows which issues arose, not how often.

Table 4. Themes from observation and questions during the socialization

Theme	Observation or question
Ease of use	Participants, including the student representative, found the flow for searching, reading, resuming, and adding favourites easy to follow; no serious problem was observed
Staff computer skills	Library staff had some difficulty with the administration tasks because they were not yet used to managing library data on a computer
Operational questions	How students would receive their accounts, the largest file size allowed for scanned books, and whether books could be read offline
Follow-up agreed	Library staff will create student accounts class by class and add textbooks for each vocational program in the following semester

Discussion

The largest gains came from changing where work is done. In PustakaPlus every visitor's browser rendered covers from full PDFs, so the cost of opening the catalogue grew with the size of the collection. SIPERPUS moves that work to a single moment, the upload, and to a single machine, the administrator's browser. The public pages now load 91 to 92 KB of JavaScript no matter how many books the library holds, and pdf.js (129 KB gzip) is loaded only when a member opens the reader. Gupta and Singh (2026) found that library catalogue websites often fail Core Web Vitals thresholds, and Król and Sroka (2023) showed that slow pages are felt most by users on weaker rural connections, a condition shared by many students in Bengkalis. On the development server the largest contentful paint was 3.2 s, above the 2.5 s target; on production, with the caching headers in place, it fell to 1.7 to 2.1 s. The slow transfer of PDF ranges over a weak connection suggests that a range size smaller than 1 MB may suit students on such networks. Wehner et al. (2023) also caution that Core Web Vitals do not always match the quality users actually experience, which is one more reason to collect feedback from users.

Accessibility reached a Lighthouse score of 100 on the four pages tested. Automated checkers detect only part of the WCAG success criteria, and Kumar et al. (2021) found that ten tools gave different results for the same websites. Suryasih et al. (2026) reported frequent WCAG failures on Indonesian university websites. The score shows that SIPERPUS passes the automated checks. It says nothing yet about use with a screen reader or keyboard alone, which needs manual testing with users.

Security was handled in the design rather than added after release. The IDOR and public-file problems in PustakaPlus fall under broken access control, the first category in the OWASP Top 10, which Imtias et al. (2025) and Wen and Katt (2023) use as the basis for evaluating web applications. In SIPERPUS each rule is backed by an automated test: requests without a CSRF token receive 419, private storage cannot be reached by URL, responses never contain internal file paths or password hashes, and administrator routes refuse members. Sunman et al. (2022) point out that automated tests catch regressions when an application is changed later. This matters here because the school will add content and may ask for new features after the handover. No external penetration test has been done, so these results show that the stated rules are enforced, not that the system is free of vulnerabilities.

Compared with most school library systems in the literature, which record the circulation of printed books (Hendriani & Indrawan, 2021; Wakhidah et al., 2023; Wulandari & Nugroho, 2024), SIPERPUS serves the full text of books and videos and records how far each member has read or watched. The outcomes that the available evidence supports are immediate ones. Technical readiness is shown by the automated tests and the production walkthrough. Initial usability is suggested by the observation that participants found the application flow easy to follow, although this was not measured with an instrument. Adoption readiness is still low: by 13 October 2026 the

system held one active member account and the activity log contained 49 entries, because student accounts had not yet been created. The capability of the library staff is the main constraint, since they were not yet used to managing data on a computer, which matches the staffing and technology problems Saranga and Bustari (2025) found in other SMK libraries. Claims about reading interest or learning outcomes, of the kind made by Mulyawati and Marini (2022) and Sumardi (2023), would need usage and longitudinal data that this program does not yet have.

The program also has practical implications for the school and for similar community service programs. For SMKN 1 Bengkalis, SIPERPUS reduces the dependence on printed copies and library opening hours: once student accounts are created, many students can open the same textbook from their phones at the same time, which matters for vocational subjects in which the school holds only a few printed copies. Library staff gain one place to manage books, videos, categories, and member accounts, and the statistics dashboard shows which titles are read, which can guide decisions on which textbooks to add for each vocational program. Because the system runs on ordinary shared hosting with PHP and MySQL only, and the school identity and contact details can be changed from the settings page, the school can operate it at low cost without editing code or relying on the team for routine tasks. For community service practice, the program shows that auditing and adapting a system from an earlier program, rather than building a new one, can deliver a working result within a short period, and that setting measurable targets before development makes the outcome easier to verify. These implications are expected benefits rather than measured outcomes. Whether they are realised depends on the school creating student accounts, adding content, and strengthening the computer skills of its library staff, which the team plans to support through follow-up training.

The program has five limitations. First, the evaluation of users is observational only: no usability or satisfaction instrument was given to students, teachers, or library staff, and neither the needs discussion nor the observations during socialization were documented with structured records, so they cannot be verified independently. Second, the production performance figures come from single Lighthouse laboratory runs and from one client connection; no field data from real visitors are available yet. Third, the collection is still small, with 10 books and 4 videos, and only one member account is active, so the results do not show how the system performs with hundreds of titles and concurrent readers. Fourth, no external penetration test has been carried out. Fifth, the program period was too short to assess long-term usability, sustained use, or effects on reading interest and learning outcomes; these remain questions for a follow-up evaluation rather than findings of this program.

CONCLUSIONS

This program rebuilt the PustakaPlus digital library into SIPERPUS for SMKN 1 Bengkalis in response to the school's need for wider access to books and easier management of its collection, and handed the system over through a socialization session on 18 September 2026. The problems found in the audit were addressed: covers no longer require downloading whole PDFs, media files sit behind login and authorization, the IDOR and unlimited-login flaws are closed, and the interface fits phone screens. The system passed all 191 automated tests and worked as designed on the production server, where Lighthouse gave performance scores of 97 to 99 and accessibility scores of 100. Participants found the application flow easy to follow, and the main obstacle observed was the limited computer experience of the library staff. These results establish technical readiness and initial acceptance. Usability, performance for real visitors, scalability, and use by many students at once have not yet been validated, so the approach is at most technically transferable to schools with similar shared hosting. The next steps are to create member accounts for students and teachers, to train library staff in managing data on a computer, to run a System Usability Scale survey, and to collect usage statistics and field performance data over at least one semester while the collection grows beyond its current 10 books and 4 videos.

ACKNOWLEDGMENT

This community service program was funded by the Center for Research and Community Service (P3M) of Politeknik Negeri Bengkalis. The authors thank the students, teachers, and library staff of SMKN 1 Bengkalis for their cooperation, and the library staff for providing the initial book collection.

AUTHOR CONTRIBUTION STATEMENT

AT and FR jointly prepared the book collection, led the socialization session, carried out the other preparations for the program, and edited the manuscript before submission. AT also designed the system, developed, tested, and deployed the application, and drafted the manuscript. Students and the community service unit of Politeknik Negeri Bengkalis assisted during the activity.

AI DISCLOSURE STATEMENT

The authors used Claude (Anthropic) during the preparation of this work to assist with parts of the software development and to help draft and edit the manuscript. After using the tool, the authors thoroughly reviewed and edited the content as needed and take full responsibility for the content of the publication.

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