Web-Based E-Library Application with QR Code Using the RAD Method at SMA Negeri 4 Palembang

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Abstract

A library is a collection of written, printed, and graphic materials that are systematically arranged to support learning, research, and reading activities. At SMA Negeri 4 Palembang, library management is still carried out manually, which makes it difficult for students to obtain book information and for staff to store collection data effectively. This study aims to develop a web-based E-Library application equipped with a Quick Response (QR) Code feature to facilitate the storage of book data, the search for collection information, and the management of book borrowing and returning. The method used is Rapid Application Development (RAD), a software-development approach characterized by a relatively short timeframe achieved through iterative processes and repeated user feedback. Data were collected through interviews with library staff, direct observation of library activities, and a study of relevant literature. The resulting application displays book data in a structured manner, provides digital borrowing and returning services, records members and transactions, and identifies books through QR Code scanning. Functional testing of the borrowing, returning, and scanning modules indicates that the application operates as intended and improves the effectiveness of library management. The system is therefore feasible for implementation to support the enhancement of literacy services at SMA Negeri 4 Palembang.

Keywords: digital library; E-Library; Rapid Application Development; QR Code; web-based system

1. Introduction

A library functions as an information center that provides literature to support learning activities. A library collection comprises written, printed, and graphic materials—such as films, slides, sound recordings, and other media—that are arranged systematically. At SMA Negeri 4 Palembang, however, the library is not yet used optimally, because the management of its collection is still carried out manually.

Students often have difficulty searching for book information, locating the correct shelf, and determining whether an item is available. Some book labels are no longer clearly legible, which complicates identification. With a student population of 973 and a collection of more than 2,000 titles, the manual process makes library services less efficient.

A web-based E-Library system can serve as a solution to these obstacles. An information system organizes data so that they can be stored, processed, and retrieved in an integrated manner [1]. Such a system allows book data to be held in a centralized database that is easy to access and quick to update. Previous studies have developed library information systems and digital libraries in a range of settings, including library information systems for junior and senior high schools [2], [3], a digital library based on a document management system for a university faculty [4], a web-based library information system for a vocational school [5], a digital library application [6], and a web-based digital library for a district library [7].

The addition of a QR Code feature makes the retrieval of information easier through scanning, so that students and staff can obtain book data quickly and accurately. Code-based identification of this kind has previously been applied in learning media that use barcode encoding techniques [8]; the same principle allows a printed code attached to a book to be linked directly to its record in the database, without the need to type an identifier manually. The Rapid Application Development (RAD) method was chosen because it can accelerate application development through prototyping and direct feedback from users. The system produced can therefore be matched more closely to the needs of a school library. On this basis, the present study focuses on developing a web-based E-Library application with a QR Code feature at SMA Negeri 4 Palembang using the RAD method, with the aim of improving the storage of book data, the search for collection information, and the management of borrowing and returning.

The development of web-based library information systems has become an important approach to improving collection management and service delivery in educational institutions. A web-based system enables library

administrators to maintain book records, monitor collection availability, and manage circulation activities through an integrated platform. Research by Abigail and Nurkhamid [9] demonstrated the potential of a web-based school library information system to address conventional data-management problems, while also evaluating software quality in terms of functionality, performance efficiency, usability, and reliability. Similarly, Adhiwibowo and Mahmud [10] developed a web-based library system incorporating QR Code technology to support book circulation and reduce errors associated with manual processing. These studies support the relevance of developing an integrated library application for SMA Negeri 4 Palembang, where efficient management of a substantial collection is essential to meeting students' information needs.

The effectiveness of a library information system depends not only on digitizing existing records but also on how efficiently users can identify, retrieve, and interpret information. Ait-based or web-based interface should enable students to locate a book using relevant attributes, such as its title, author, category, or identifier, and then determine its availability and physical location. Research on web-based school library information systems has shown that software functionality and usability are important considerations in evaluating whether a system can support its intended operational tasks [9]. Iqbal et al. [11] further emphasized the importance of assessing usability in web-based library systems through criteria that address both general website characteristics and library-specific requirements. Consequently, the proposed E-Library application should be designed around practical user tasks, particularly searching for books, checking availability, identifying shelf locations, and accessing information with minimal effort.

QR Code technology offers a practical mechanism for connecting physical library collections with their corresponding digital records. A QR Code can encode information or provide a link to a resource, allowing users to retrieve information through a compatible scanning device rather than manually entering a book identifier. Prathivi [12] examined the use of QR Codes for library book identification, including information such as book titles, authors, ISBNs, shelf numbers, and collection availability. Walsh [13] also discussed the potential of QR Codes to extend library services through mobile devices and links to online resources. These applications demonstrate how QR Codes can provide a convenient connection between physical objects and digital information. In the proposed system, each book can be associated with a unique identifier represented by a QR Code, allowing the corresponding database record to be retrieved during book identification and circulation activities.

The integration of QR Code technology into library operations has also been investigated in other educational settings. Aditia et al. [14] developed a web-based library information system using QR Codes at SMP Negeri 6 Kempas, addressing limitations associated with paper-based records and manual processing. Aprinaldo [15] similarly investigated a QR Code-based library information system at Patra Mandiri 2 Junior High School in Palembang, integrating book-data access with borrowing, returning, and reporting activities. These studies illustrate the applicability of QR Code-enabled systems to school libraries in Indonesia. However, the implementation of such technology must be supported by reliable database management and appropriate operational procedures. A QR Code facilitates identification, but the accuracy of information about a book's availability ultimately depends on the consistency of the underlying records and the correct recording of transactions.

Beyond book identification, an effective E-Library system must maintain consistent information across cataloging, inventory, and circulation processes. Book records should provide a reliable representation of the collection, while borrowing and returning transactions should update the relevant availability information. The use of a centralized database can help reduce duplicate entries, improve the consistency of stored records, and support the generation of administrative reports. Research by Adhiwibowo and Mahmud [10] provides an example of a web-based library system that combines QR Code technology with database-supported collection management. Similarly, Syah and Sukirman [16] examined a library borrowing system using QR Code identification to address the inefficiencies and potential recording errors associated with manual transactions. Such findings reinforce the importance of integrating book identification with circulation management rather than treating QR Code scanning as an isolated feature.

The choice of a software development methodology is another important consideration because the resulting application must reflect the actual requirements of librarians, students, and other relevant users. Rapid Application Development (RAD) emphasizes rapid prototyping, iterative development, and user feedback to support the progressive refinement of a system. Beynon-Davies et al. [17] examined RAD practices through empirical case studies, highlighting the relationship between the methodology and the organizational processes involved in developing information systems. Berger and Beynon-Davies [18] also investigated the applicability of RAD in a complex public-sector development project. Their work indicates that the suitability of RAD should be considered in relation to project characteristics and implementation requirements, rather than assuming that rapid development alone guarantees a successful outcome. For the present study, RAD provides a relevant framework for translating library requirements into a functional application and refining its features through repeated evaluation.

User involvement is particularly important when developing applications intended for routine use in an educational environment. Librarians understand the administrative requirements of cataloging, inventory control, and circulation, whereas students can provide feedback on the clarity and convenience of the search interface and QR

Code scanning process. Selamat et al. [19] discussed the role of end-user participation in software prototyping and its implications for system development. Their research supports the importance of organizing user involvement throughout the prototyping process rather than limiting it to the final evaluation stage. Accordingly, the development of the E-Library application should consider feedback from its intended users when refining the interface, arranging the information displayed on book records, and determining how scanning and circulation functions should operate. This approach is consistent with the iterative nature of RAD and can help align the implemented system with the practical needs of the school library.

System evaluation is equally important to determine whether the resulting application operates as intended and provides a usable service. A library application may implement all the required functions yet still create difficulties if its interface is confusing, its search results are unclear, or its transaction workflow requires unnecessary steps. Iqbal et al. [11] proposed a usability evaluation approach that considers general and library-specific characteristics of web-based systems. Abigail and Nurkhamid [9] also evaluated a school library system using software quality attributes that included functionality, efficiency, usability, and reliability. These studies suggest that evaluating the proposed application should extend beyond confirming that individual features work correctly. Relevant assessment criteria include whether users can retrieve book information successfully, whether QR Code identification functions as expected, whether borrowing and returning records are updated correctly, and whether the application can be used efficiently by its intended users.

The implementation of QR Code-enabled library systems also requires attention to the relationship between technological convenience and operational reliability. QR Code labels must remain readable, each code must be associated with the correct book record, and transaction procedures must ensure that the database reflects the current status of the collection. Wang and Dong [20] investigated a book-retrieval approach combining QR Code identification with image-retrieval techniques, demonstrating the potential of integrating identification mechanisms with information-retrieval processes. Prathivi [12] likewise described the use of QR Codes to associate physical books with relevant bibliographic information. For a school library, these applications reinforce the importance of maintaining accurate identifiers and consistent metadata. The proposed application therefore needs to treat QR Code generation, book-record management, and database retrieval as interconnected functions that collectively support reliable library services.

Although previous research has addressed web-based school library systems, QR Code-based book identification, and the application of RAD in software development, the specific requirements of each institution remain important. Differences in collection size, user population, existing administrative procedures, and available technological resources can influence system design and implementation. Studies conducted in other school libraries provide useful design references, but their findings cannot automatically be assumed to represent the conditions at SMA Negeri 4 Palembang. The present study therefore addresses the local context of a school with 973 students and a collection exceeding 2,000 titles, where manual management creates difficulties in searching for books, identifying shelf locations, and determining availability.

Based on this context, the development of a web-based E-Library application with QR Code technology using the RAD method is intended to integrate collection-data management, book-information retrieval, and borrowing and returning activities within a single system. The contribution of this study lies in applying these complementary technologies and a rapid, iterative development approach to the specific operational needs of SMA Negeri 4 Palembang. The application is expected to facilitate access to book information, support more consistent collection records, and improve the efficiency of routine library services. Its practical value, however, should be established through system testing and evaluation against the requirements identified during development, rather than being inferred solely from the use of web technologies or QR Codes.

2. Method

Study Design

This study uses the Rapid Application Development (RAD) method, a software-development approach that emphasizes speed in design and implementation through an iterative process. Development proceeds in short cycles, so that each intermediate result can be reviewed together with users and refined in the following cycle. The analysis and design of the system follow the principles of information-systems analysis and design, in which data flows, user requirements, and the structure of the application are defined before implementation [21].

Data Collection

Data were collected through the following three techniques.

Interviews. Used to obtain information from library staff about system requirements and about the work processes for recording, borrowing, and returning books.

Observation. Carried out by directly observing library activities and students' patterns of book use.

Literature study. Carried out by examining books, journals, and scholarly references related to the development of digital libraries, QR Codes, and the RAD method.

System Development Procedure

The RAD phases carried out in this study comprise process modeling, application generation, and testing and turnover.

Process modeling. Defining the flow of information and the business processes required in the library system, including the addition, modification, deletion, and search of collection data. At this stage the data structure for books, members, and transactions is specified so that records can be stored consistently and retrieved efficiently [22].

Application generation. The system was built using fourth-generation programming tools and reusable components in order to accelerate development. Implementation used web technology so that the application can be accessed through a browser without installation on client devices [23].

Testing and turnover. Testing was carried out to confirm that the functionality of the system worked correctly, particularly in the book borrowing and returning modules and in the QR Code scanning feature.

3. Results

Implementation of the E-Library Application

The web-based E-Library application was successfully developed with a number of main features. Each feature is described below together with its interface display.

Homepage. The main page presents introductory information about the application and serves as the entry point for users.

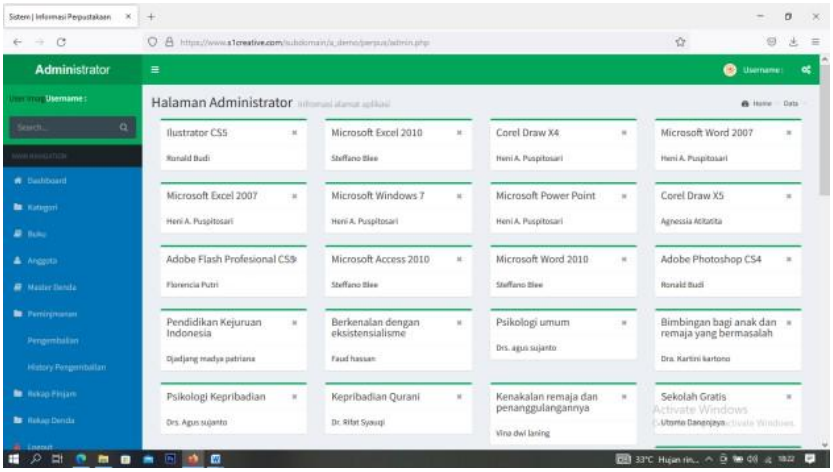


Figure 1. *Homepage display.*

Book category data. Displays the book categories managed by the administrator and accessible to students.

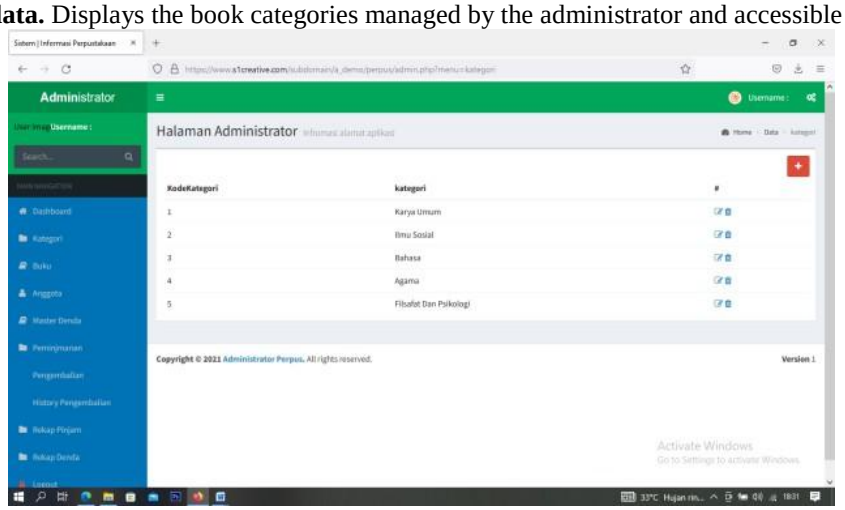


Figure 2. *Book category data display.*

Book data. Displays information on the book collection, including title, category, author, and availability.

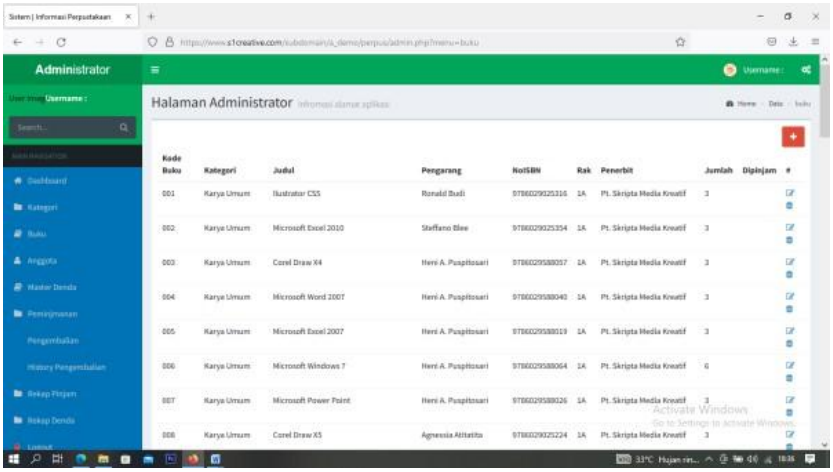


Figure 3. *Book data display.*

Member menu. Contains information on library members together with a facility for searching member data.

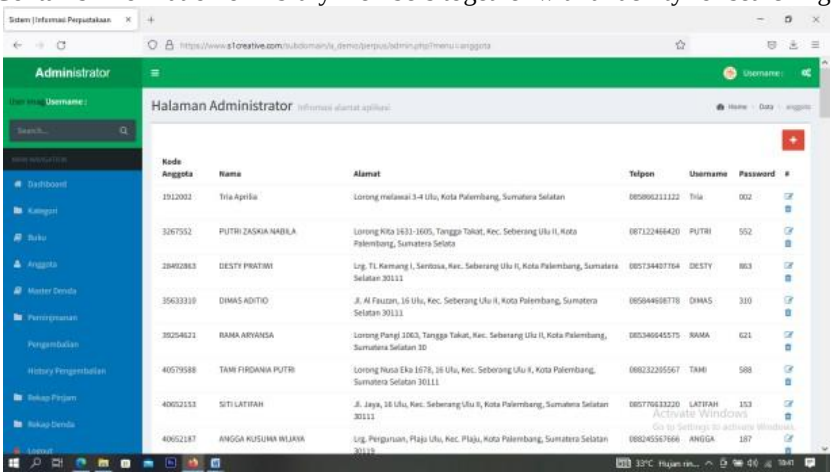


Figure 4. *Member menu display.*

Borrowing form. Used by students to submit a request to borrow a book.

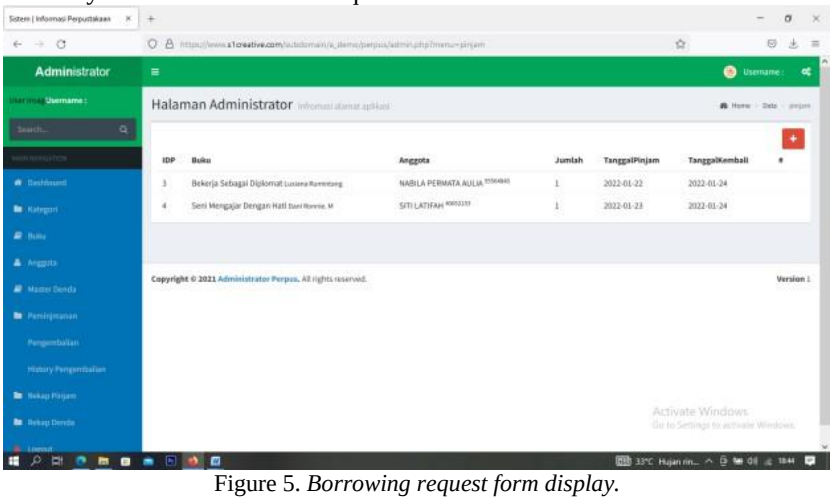


Figure 5. *Borrowing request form display.*

Book return data. Displays the return data processed by the administrator.

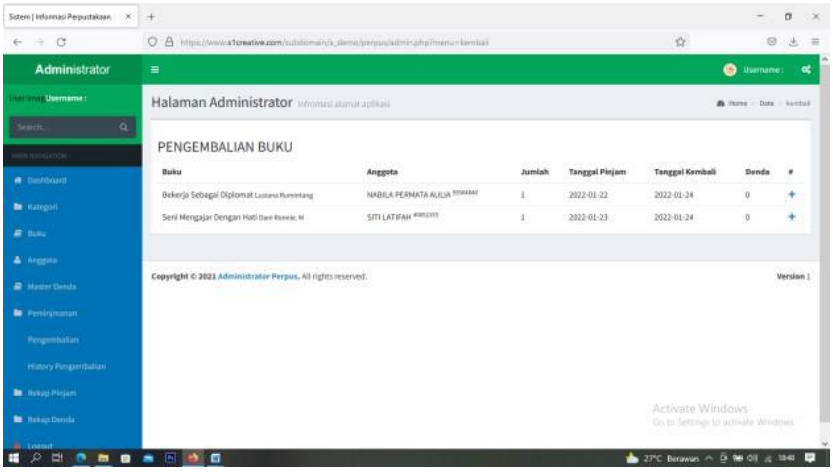


Figure 6. *Book return data display.*

Administrator login. The authentication page through which administrators access the management of library data.

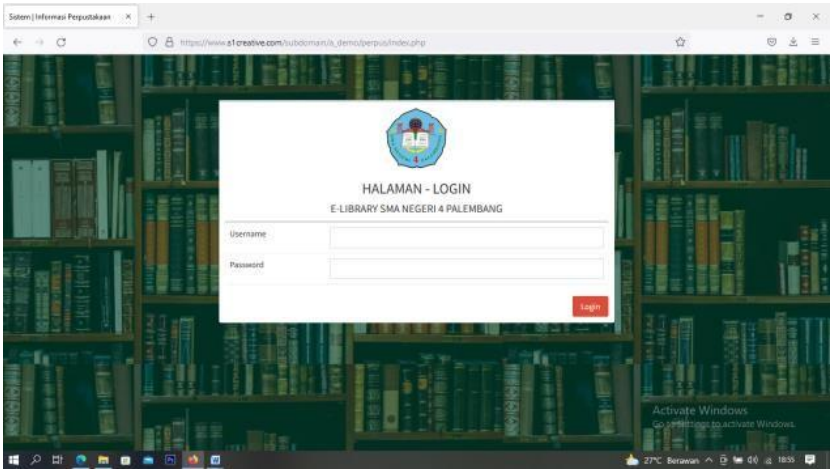


Figure 7. *Administrator login page display.*

Return history data. Displays the complete history of book returns.

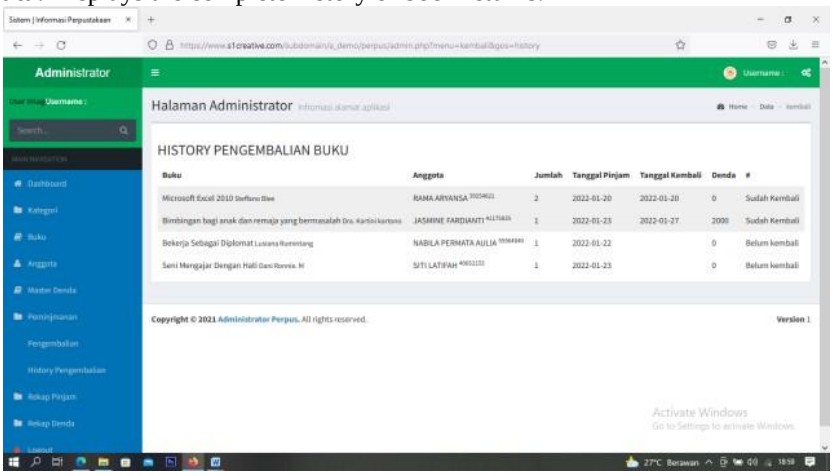


Figure 8. *Book return history display.*

Fine data. Displays the table of fines processed by the administrator.

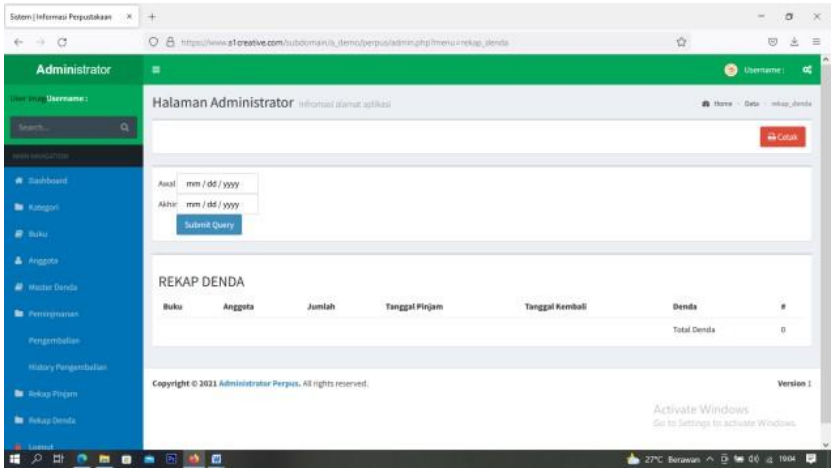


Figure 9. *Fine data table display.*

Book QR Code. The QR Code is used to simplify the identification of a book through scanning, so that its record can be retrieved without manual searching.



Figure 10. *QR Code display.*

4. Discussion

Contribution of the System to Library Services

The system developed offers several benefits for library management. First, it improves the effectiveness of library services, because a digital system makes searching for and identifying a collection easier than a manual process. Second, it simplifies borrowing and returning, since recording no longer relies on manual forms. Third, it optimizes the recording of the collection: data on books, members, borrowing, and returning are stored in a structured way within a single database. Fourth, the use of the QR Code accelerates the retrieval of book data and reduces recording errors, because identification no longer depends on labels that must be read and typed manually.

Taken together, these features address the problems identified at the outset of the study. The difficulty students faced in locating items and checking availability is met by the book-data and category features, while the burden of manual recording borne by staff is reduced by the digital borrowing, returning, fine, and history modules.

Reflection on the RAD Approach

The RAD method allowed development to proceed quickly and adaptively, in keeping with the needs of a school library. Because each iteration produced a prototype that staff could review directly, requirements that had not emerged in the initial interviews could be accommodated in the following cycle. This characteristic is relevant to a school environment, where development time is limited and users are not always able to express their requirements in technical terms at the outset. Even so, the speed of RAD depends on the continuing availability of users to provide feedback; where that involvement is limited, the advantage of the method is reduced.

Limitations and Suggestions

This study has several limitations. The application was developed and tested within the context of a single school, so the results cannot be generalized directly to libraries with different collection sizes, work procedures, or

infrastructure. Testing was directed at the functionality of the system's modules; a formal evaluation of usability, user acceptance, and the effect of the system on the speed of service has not been reported. In addition, the QR Code feature assumes the availability of devices capable of scanning, which needs to be taken into account when planning its use by students.

Further development can therefore be directed at a formal evaluation of usability and user acceptance, measurement of service performance before and after implementation, the addition of borrowing-report and collection-analysis features, and integration with the school's academic information system.

5. Conclusion

The web-based E-Library application provides more effective and better-structured library services for SMA Negeri 4 Palembang. The application assists students in borrowing and returning books digitally, and it simplifies the recording of the collection, of members, and of library transactions. The addition of the QR Code feature accelerates the identification of books, while the RAD method enabled the application to be developed within a relatively short time and adjusted to the needs of library staff through repeated feedback. On this basis, the system is feasible for implementation to support the improvement of literacy services at the school, with a further evaluation of usability and service performance recommended as the next step.

Declarations

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Conflict of Interest. The authors declare that they have no conflict of interest regarding the publication of this article.

Data Availability. The application source code and supporting data generated or analyzed during this study are available from the corresponding author upon reasonable request, subject to applicable institutional policies and data confidentiality requirements.

6. References

[1] J. Hutahaean, *Konsep Sistem Informasi*, vol. 1. Yogyakarta, Indonesia: Deepublish, 2014.

[2] A. Aryantio and T. Irianto, "Pembuatan sistem informasi perpustakaan SMP Muhammadiyah 7 Surakarta," *Jurnal Speed – Sentra Penelitian Engineering dan Edukasi*, vol. 5, no. 1, pp. 15–20, 2013.

[3] R. Irviani and R. Oktaviana, "Aplikasi perpustakaan pada SMA N1 Kelumbayan Barat menggunakan Visual Basic," *Jurnal TAM (Technology Acceptance Model)*, vol. 8, no. 1, p. 64, 2017.

[4] Y. Gustiana, J. Haerul Jaman, and N. Heryana, "Rancang bangun perpustakaan digital berbasis document management system pada Fakultas Ilmu Komputer UNSIKA," *Jurnal Informatika: Jurnal Pengembangan IT*, vol. 3, no. 2, pp. 225–232, 2018.

[5] D. D. Hutagalung and F. Arif, "Rancang bangun sistem informasi perpustakaan berbasis web pada SMK Citra Negara Depok," 2018.

[6] S. Adrianto and K. Wahyuni, "Perancangan aplikasi perpustakaan digital," *Lentera Dumai*, vol. 10, pp. 1–8, 2019.

[7] S. Batubara, S. Wahyuni, and M. Iqbal, "Sistem informasi perpustakaan digital berbasis web (studi kasus: Perpustakaan Kecamatan Medan Belawan)," in *Seminar Nasional Matematika dan Terapan*, vol. 1, 2019, pp. 145–148.

[8] S. Arfida and R. E. Harahap, "Implementasi media pembelajaran teknik pengkodean barcode berbasis multimedia," in *Prosiding Seminar Bisnis & Teknologi IIB Darmajaya*, 2014, pp. 407–420.

[9] A. S. Abigail and Nurkhamid, "Development and analysis of web-based school library information system," *E-JPTI (Jurnal Elektronik Pendidikan Teknik Informatika)*, vol. 7, no. 3, 2018. Available: https://doi.org/10.21831/e-jpti.v7i3.14180

[10] W. Adhiwibowo and G. Mahmud, "Sistem perpustakaan menggunakan QR Code berbasis web dengan framework CodeIgniter," *Information Science and Library*, vol. 2, no. 1, pp. 55–62, 2021. Available: https://doi.org/10.26623/jisl.v2i1.3424

[11] S. Iqbal, N. Ikram, S. Imtiaz, et al., "Maximizing coverage, reducing time: A usability evaluation method for web-based library systems," *Scientific Reports*, vol. 12, Art. no. 7285, 2022. Available: https://doi.org/10.1038/s41598-022-11215-7
[12] R. Prathivi, "Analisa sistem QR Code untuk identifikasi buku perpustakaan," *Jurnal Pengembangan Rekayasa dan Teknologi*, vol. 2, no. 2, pp. 37–40, 2018. Available: https://doi.org/10.26623/jprt.v14i2.1225
[13] A. Walsh, "Quick response codes and libraries," *Library Hi Tech News*, vol. 26, nos. 5–6, pp. 7–9, 2009. Available: https://doi.org/10.1108/07419050910985255
[14] F. Aditia, F. Yunita, I. Ilyas, and M. S. Rozi, "Sistem informasi perpustakaan menggunakan QR Code pada SMP Negeri 6 Kempas berbasis web," *Jurnal Informatika dan Teknik Elektro Terapan*, vol. 12, no. 3S1, 2024. Available: https://doi.org/10.23960/jitet.v12i3S1.5273
[15] R. Aprinaldo, "Library information system using QR Code technology at Patra Mandiri 2 Junior High School, Palembang," *Jurnal Ilmu Komputer dan Sistem Informasi (JIKSI)*, vol. 6, no. 2, pp. 64–70, 2025. Available: https://doi.org/10.61346/jiksi.v6i2.201
[16] K. F. Syah and Sukirman, "Sistem peminjaman buku perpustakaan dengan identifikasi kode Quick Response (QR)," *Edumatic: Jurnal Pendidikan Informatika*, vol. 7, no. 1, pp. 79–87, 2023. Available: https://doi.org/10.29408/edumatic.v7i1.13372
[17] P. Beynon-Davies, C. Carne, H. Mackay, and D. Tudhope, "Rapid application development (RAD): An empirical review," *European Journal of Information Systems*, vol. 8, no. 3, pp. 211–223, 1999. Available: https://doi.org/10.1057/palgrave.ejis.3000325
[18] H. Berger and P. Beynon-Davies, "The utility of rapid application development in large-scale, complex projects," *Information Systems Journal*, 2009. Available: https://doi.org/10.1111/j.1365-2575.2009.00329.x
[19] M. H. Selamat, M. M. Rahim, and A. T. Othman, "End-user involvement in software prototyping," *Jurnal Teknologi*, vol. 23, no. 1, pp. 7–14, 1994. Available: https://doi.org/10.11113/jt.v23.1077
[20] Q. Wang and H. Dong, "Book retrieval method based on QR Code and CBIR technology," *Journal on Artificial Intelligence*, vol. 1, no. 2, pp. 101–110, 2019. Available: https://doi.org/10.32604/jai.2019.08170
[21] H. Al-Fatta, *Analisis dan Perancangan Sistem Informasi untuk Keunggulan Bersaing Perusahaan dan Organisasi Modern*. Yogyakarta, Indonesia: Andi, 2007.
[22] Indrajani, *Database Systems: Case Study All in One*. Jakarta, Indonesia: PT Elex Media Komputindo, 2014.
[23] P. Hidayatullah and J. K. Kawistara, *Pemrograman Web*, rev. ed. Bandung, Indonesia: Informatika, 2017.

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