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Developing Web-Based Patient Reservation and Data Management System using Rapid Application Design

[1]A'ang Subiyakto*, [2]Satya Yudhanta, [3]Qurrotul Aini
[1]Department of Information Technology, UIN Syarif Hidayatullah
[2,3]Department of Information Systems, UIN Syarif Hidayatullah
[1,2,3]Jl. Juanda 95, South Tangerang, 15412, Indonesia
e-mail: [1]aang_subiyakto@uinjkt.ac.id, [2]satya.yudhanta@mhs.uinjkt.ac.id, [3]qurrotul.aini@uinjkt.ac.id

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Abstract

A private infant and toddler care clinic in the South Tangerang area, Omah Bayi, faces problems in managing reservations and patient data. During this time, reservations were recorded in a book and scheduling was done verbally. This causes inefficiency and increases the possibility of data recording errors. To solve this problem, a web-based reservation system was developed using the rapid application development (RAD) method. This method involves requirements analysis, design, implementation, and system testing, with the support of technologies such as PHP and MySQL. The designed system effectively shortens the turnaround time of the reservation process and patient data management. Test results show that reservation recording time is reduced from 10 minutes to two minutes (80% faster), and monthly report preparation time is reduced from two hours to 10 minutes (92% faster). This research aimed to create a digital solution that will not only improve the clinic's operational efficiency and prevent data duplication but will also make services more accessible to patients. It is expected that the implementation of this system will be the first step towards the clinic's digital transformation and will have a positive impact on the development of healthcare services in the future.

Keywords: design and development, online reservation system, patient data management.

1 Introduction

Technology integration into healthcare has become critical in meeting the growing need for efficient, accurate, and easily available services [1], [2]. As technology transforms healthcare operations worldwide, many clinics in Indonesia, especially tiny to medium-sized ones, continue to use manual methods for scheduling, patient data administration, and service coordination [3], [4]. This reliance on traditional ways frequently results in inefficiencies such as schedule conflicts, data duplication, and restricted access for patients seeking flexible options. These problems underscore the critical need for digital transformation to improve operational procedures and patient happiness [7], [8], [9] .

Healthcare facilities that use digital technology benefit from increased efficiency and organization. According to Darmansah, Daulay, and Zulna [10], technology allows a transition from traditional, manual processes to faster, more accurate systems, greatly decreasing administrative overhead. Implementing web-based systems improves data management and speeds up service delivery, ensuring operational precision and reliability. Furthermore, patients' increased expectations for smooth, accessible services, such as online reservations, are a significant driver of healthcare innovation. Despite these developments, many smaller clinics, including Omah Bayi, a infant and toddler care clinic in the South Tangerang area, still rely on manual systems. This reliance causes gaps in efficiency and patient experience, emphasizing the importance of focused technical solutions customized to the specific needs of such clinics. The clinic currently uses verbal and paper-based systems for scheduling and patient data administration, which frequently leads to fragmented workflows, data entry errors, and limited patient access. To address these difficulties, a system that integrates scheduling, patient management, and service coordination into a single platform will benefit the clinic and its patients.

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This study aimed to solve current gaps by creating and deploying a web-based reservation and management system that is specifically adapted to the clinic's operational requirements. The study focused on five major objectives for improving the facility's operations: (1) to create an online reservation system that would allow patients to easily plan appointments, examine available time slots, and track their booking status, (2) to create a complete patient data management system that ensures data correctness, removes redundancy, and allows easy access to patient information, (3) to create a service management module that will allow clinic staff to properly coordinate schedules, maintain service status updates, and optimize resource allocations, (4) to improve the clinic's overall operating efficiency by reducing human error, optimizing processes, and (5) to give more accessible service access to patients. Beyond solving the immediate operational concerns, this study adds considerably to the larger discussion about digital transformation in small-scale healthcare institutions. The project aims to show how personalized technological solutions can improve service delivery, operational efficiency, and patient satisfaction, potentially paving the path for more widespread use of digital solutions in similar healthcare settings. This complete approach aims to provide a practical paradigm for technological integration in specialized healthcare institutions.

This article is structured into the following sections: Literature Review, Research Method, Results and Analysis, and Conclusion.

2 Literature Review

The integration of information technology within the healthcare sector has become paramount to addressing the escalating demand for efficient, accurate, and readily accessible services [7], [10]. This digital transformation facilitates a crucial shift from traditional, manual processes to more rapid and precise systems, significantly alleviating administrative burdens [10]. Specifically, the implementation of web-based systems has demonstrably enhanced data management and accelerated service delivery, thereby ensuring operational precision and reliability [8], [9]. Furthermore, the increasing patient expectations for seamless and accessible services, such as online reservations, serve as a primary catalyst for innovation in healthcare provision [11].

Numerous studies have explored the development of information systems within healthcare environments. For instance, Ekadianti, Voutama, & Ridha [12] designed a web-based patient registration information system for Permata Hospital using the Waterfall method, aiming to improve registration efficiency. Similarly, Widiyana, Pratama, & Prasetyo [13] developed a web-based patient registration system for Dander Medical Center Clinic utilizing the SDLC methodology. These studies collectively demonstrate that digital systems can streamline patient registration and data input processes, reduce physical queues, and optimize staff time management [11]. Furthermore, Usia, Arfandy, & Munir [9] focused on a queue management and patient medical record data processing system for Puskesmas Pertiwi, underscoring the importance of integrated data management in healthcare facilities.

Beyond the healthcare sector, online reservation systems have been extensively implemented and evaluated across various industries. Fakhurokhman [14] developed a Laravel-based sports venue reservation application, enabling users to book facilities online. In a broader commercial context, Putra [15] implemented a web-based reservation information system for Cafe Sentani Garden Madiun, while Putri & Amaliyah [16] designed a web-based meeting room reservation system for the East Java Forestry Office to optimize room utilization and prevent scheduling conflicts. Kaunang [17] also developed a web-based room reservation system for Manadia Guest House, and Nirmala & Sari [18] designed a web-based reservation information system for hotels. These studies consistently highlight the benefits of enhanced accessibility, time efficiency, and reduction of manual errors offered by online reservation systems through process automation.

Despite the substantial evidence regarding the benefits of digitalization and online reservation systems across various sectors, including healthcare, the majority of previous research tends to focus on large-scale institutions such as hospitals or public health centers, or on more general reservation systems. A significant gap exists in the literature specifically addressing the development and implementation of tailored digital solutions for small-scale healthcare clinics, particularly infant and toddler care clinics, which frequently still rely heavily on manual methods for reservation and patient

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data management. This dependence on verbal and paper-based systems often leads to fragmented workflows, data entry errors, and limited patient access.

This study endeavors to bridge this research gap by designing and developing a web-based reservation and patient data management system specifically for Omah Bayi, a infant and toddler care clinic located in the South Tangerang area. The novelty of this study lies in its focus on adapting the Rapid Application Development (RAD) methodology to address the specific needs of a small clinic grappling with manual record-keeping and data duplication challenges. By quantitatively measuring the improvements in operational efficiency, this research not only contributes to the evidence base for digitalization in the healthcare sector but also provides a practical paradigm for digital transformation in small-scale healthcare facilities often overlooked in broader studies.

3 Research Method

This study employed a structured approach for data collection and system development. Data collection techniques included observation and interviews. Researchers conducted direct observations of the operational processes at Omah Bayi to identify existing challenges, specifically in patient registration, schedule management, and service delivery. Interviews were carried out with the clinic owner, midwives, and administrative staff to gather in-depth insights into system requirements and operational issues, including their subjective experiences with the current manual system and expectations for a digital solution. The web-based reservation system was developed using the Rapid Application Development (RAD) methodology, chosen for its efficiency in aligning development with user requirements [19].

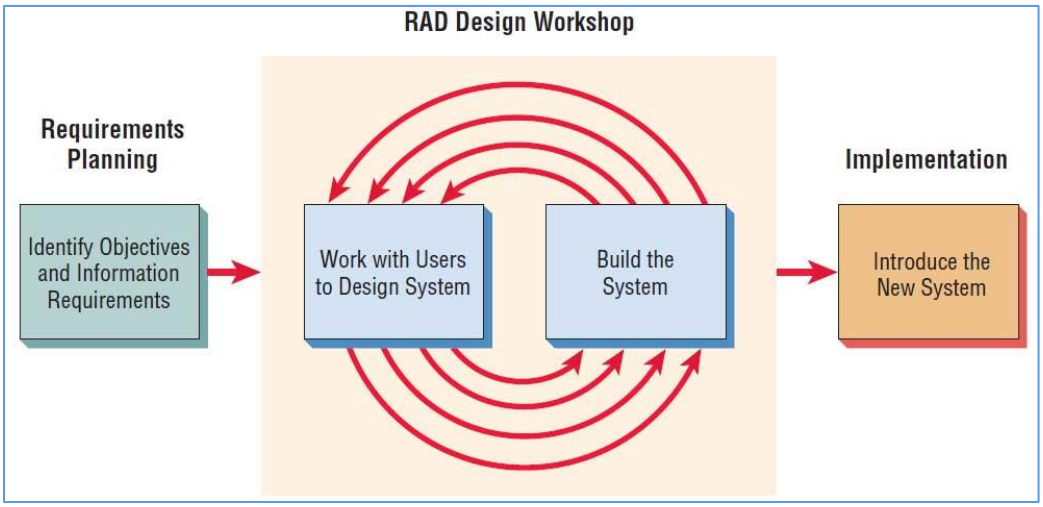

Figure 1 RAD workflow [16].

The RAD process encompassed three main stages: (1) Requirement planning, where system needs were identified through observations and interviews, leading to the formulation of key features such as online reservations, patient data management, and schedule coordination. (2) Workshop design, involving the initial design of the system, including user interface creation and system modeling with Unified Modeling Language (UML), utilizing use case, activity, and class diagrams. (3) Implementation, where the system was built using technologies such as PHP for server-side programming, MySQL for database management, HTML and CSS for a responsive user interface, and XAMPP for development and testing support.

Efficiency in this study is operationally defined as the percentage reduction in time required to complete key operational tasks within the clinic. This includes: (1) the patient reservation recording process, (2) patient data retrieval, (3) reservation confirmation, and (4) monthly patient report compilation. Efficiency was calculated by comparing the average time taken to complete these tasks before system implementation with the average time after system implementation, using the following formula:

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$$Efficiency\ Percentage = \frac{(Time\ Before - Time\ After)}{Time\ After} \times 100 \quad (1)$$

System functionality was verified through black-box testing, focusing on ensuring that features such as reservations, schedule management, and patient data recording operated according to specifications without examining the underlying code implementation. A total of 14 test cases were designed and executed to comprehensively verify the system's functionalities. All identified use cases, as depicted in Figure 4, including user login/logout, viewing and managing patient and reservation lists, searching, filtering, updating reservation statuses, patient reservation form submission, and automatic dashboard statistics updates, were functionally tested and yielded successful results.

Beyond quantitative efficiency improvements, qualitative findings were gathered through interviews with the administrative staff and midwives after system implementation. These insights provided a more holistic view of the system's impact. Staff members reported that the system was "much easier and faster" compared to manual record-keeping, expressing relief from concerns about data entry errors and duplication. Midwives specifically noted that the new dashboard facilitated real-time viewing of patient schedules and reservation statuses, significantly aiding their daily tasks. While initial adaptation challenges were minimal, the overall feedback indicated that the system's intuitive interface and streamlined processes greatly improved their workflow and reduced administrative overhead.

4 Results and Analysis

First, the requirement planning phase revealed that the current reservation system at the sampled clinic relies on WhatsApp communication, where patients provide details such as baby name, age, phone number, treatment type, and preferred schedule. Admins manually record the information in a logbook, coordinate schedules with midwives, confirm appointments with patients, and ensure data is shared with midwives before treatments. To enhance efficiency and user experience, a web-based reservation and data management system is proposed. The new system includes online reservation functionality, where patients fill out forms with the required details, and the system validates inputs automatically. Admins can manage reservations through an organized dashboard, access integrated data storage for tracking patient histories and generating reports, and utilize automated statistics to monitor clinic operations. Midwives can update reservation statuses directly through their dashboard. This system aims to streamline clinic operations while improving service delivery for patients. Figure 2 and Figure 3 show the current and proposed flows of the reservation system respectively.

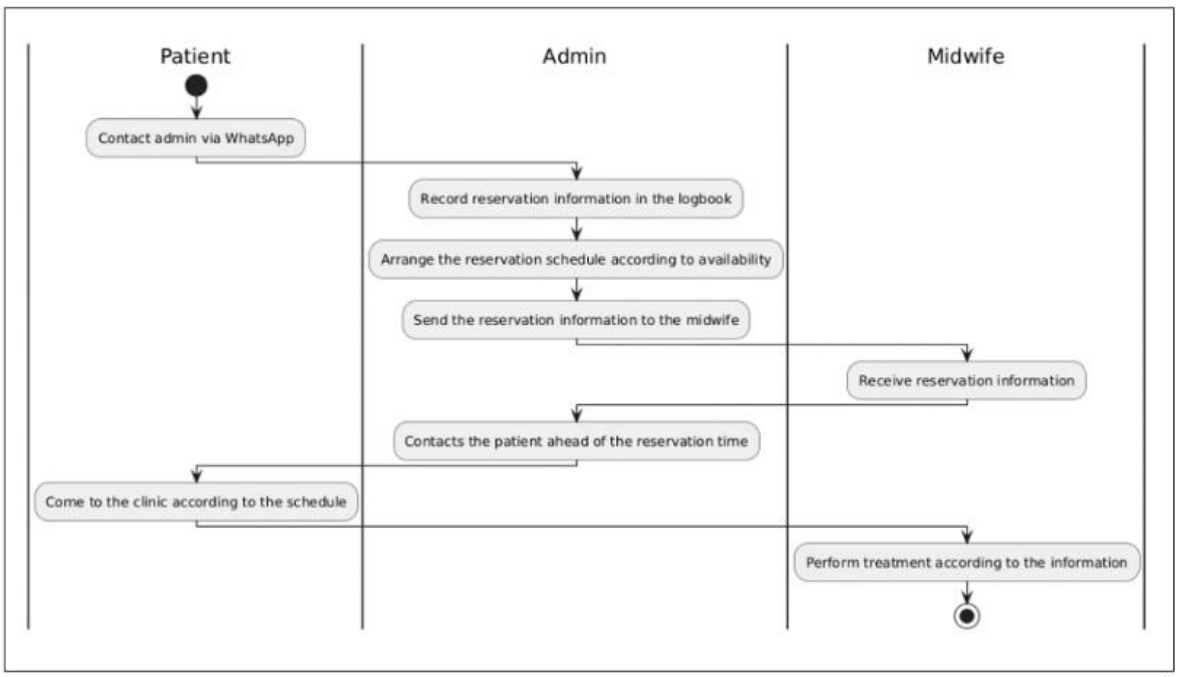

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Figure 2 Current reservation system flow

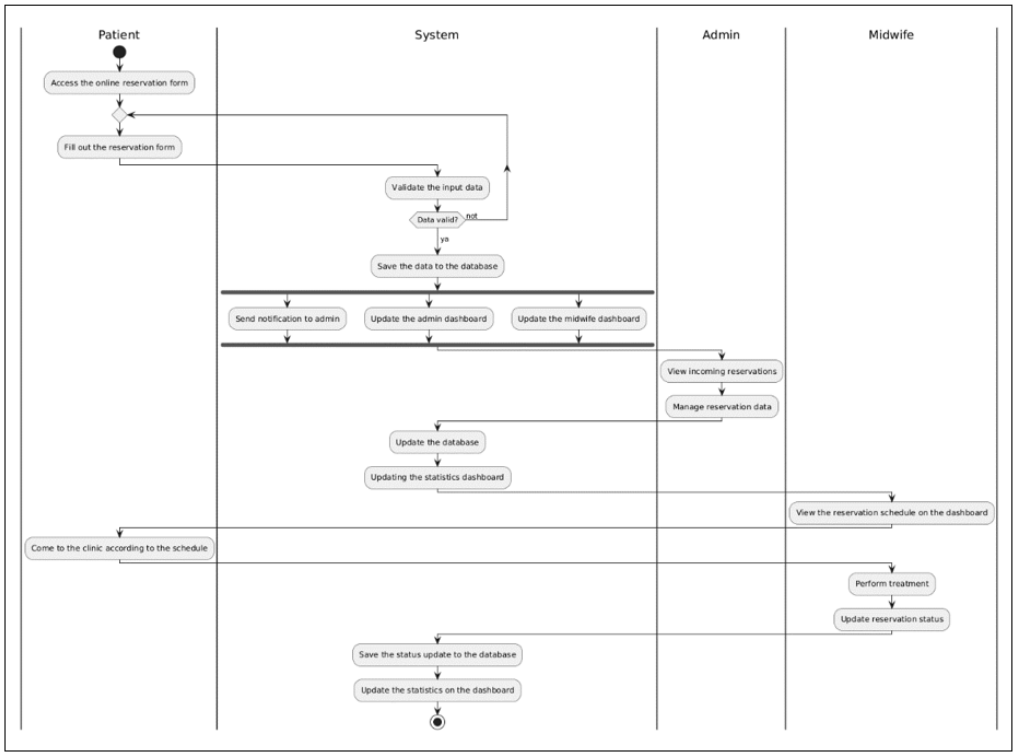

Figure 3 Proposed reservation system flow

Second, in the workshop design phase, the researchers identified the actors involved in the reservation and patient data management system, including admin, midwives, and patients, each with distinct roles and responsibilities. Admins manage reservations and patient data, midwives update reservation statuses, and patients input necessary details to make reservations. This actor analysis was followed by the identification of use cases that outline the interactions and activities within the system, such as logging in, viewing patient and reservation lists, updating reservation statuses, and conducting reservations. Figure 4 shows the use case diagram of the reservation and data management cases with three actors designed in the proposed system. Figure 5 demonstrates the sequence diagrams of the proposed system. This diagram was developed to detail interactions between objects for specific use cases, providing a clearer understanding of communication sequences. Figure 6 presents the class diagrams of the proposed system. This diagram depicted the structure of classes, including attributes, operations, and relationships, to establish the foundational system architecture. Figure 7 presents the activity diagrams modeled the step and processe of the proposed system which illustrate the reservation and data management workflows.

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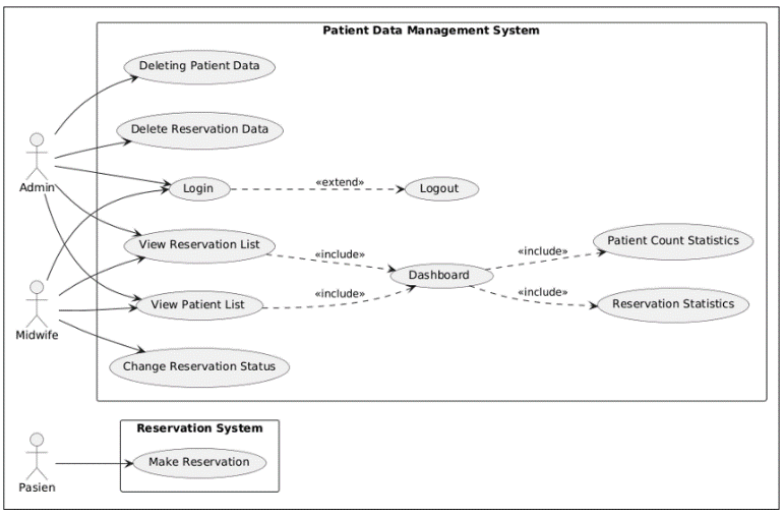

Figure 4 Use case diagram

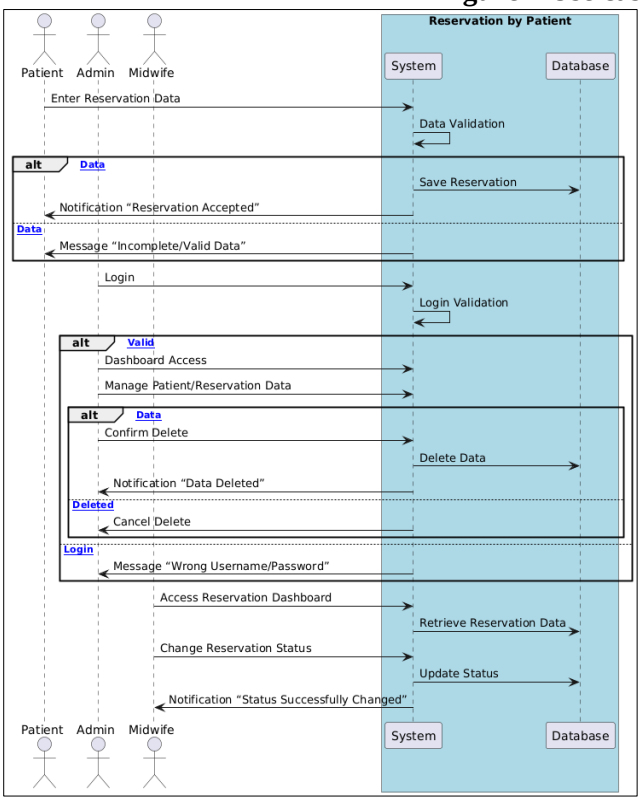

Figure 5 Sequence diagram

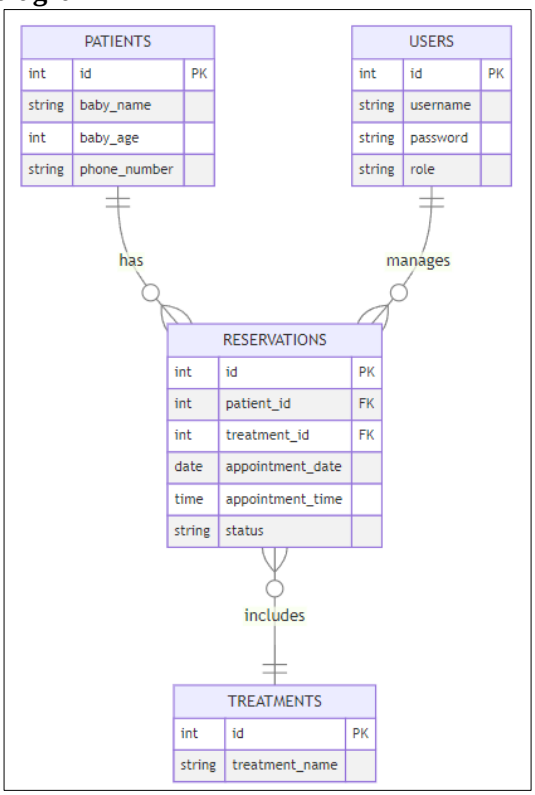

Figure 6 Class diagram

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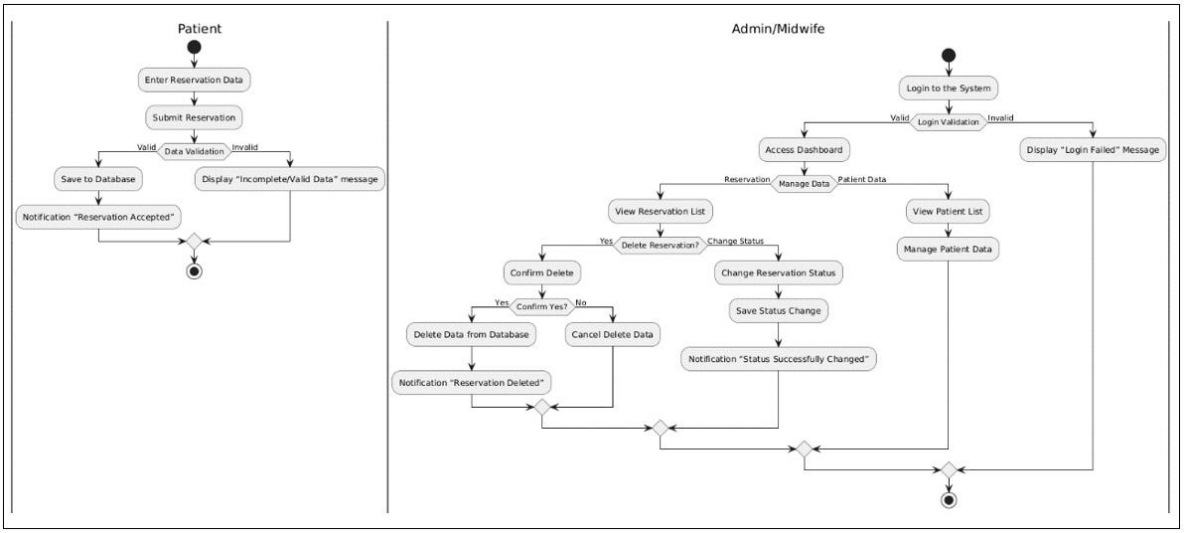

Figure 7 Activity diagram

Third, the authors focused on usability and user experience, featuring a consistent color scheme, intuitive layout, and clear navigation in the interface design. The designed pages in this stage were the login, dashboard, patient, reservation, and confirmation pages. The login page provides authentication for admins and midwives. Successful logins redirect to the dashboard, while errors trigger warnings (Figure 8). The dashboard page displays reservation and patient lists, logout options, and live statistics on patients and daily reservations (Figure 9).

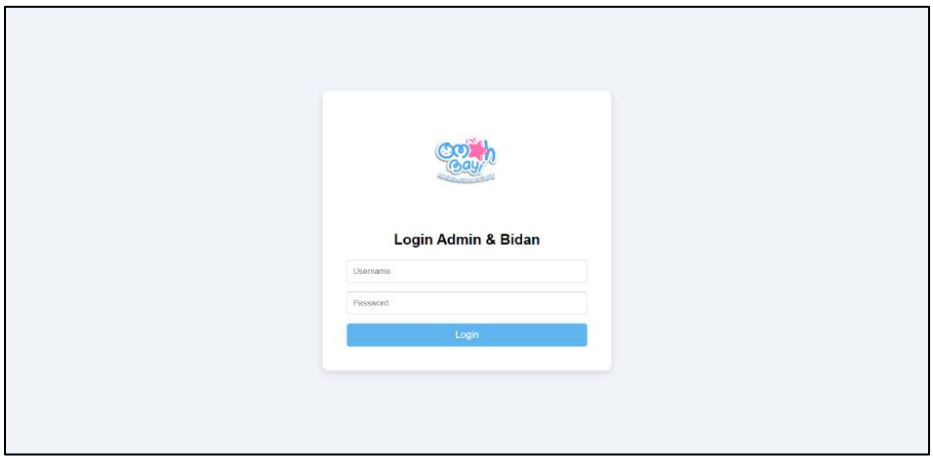

Figure 8 Login page interface

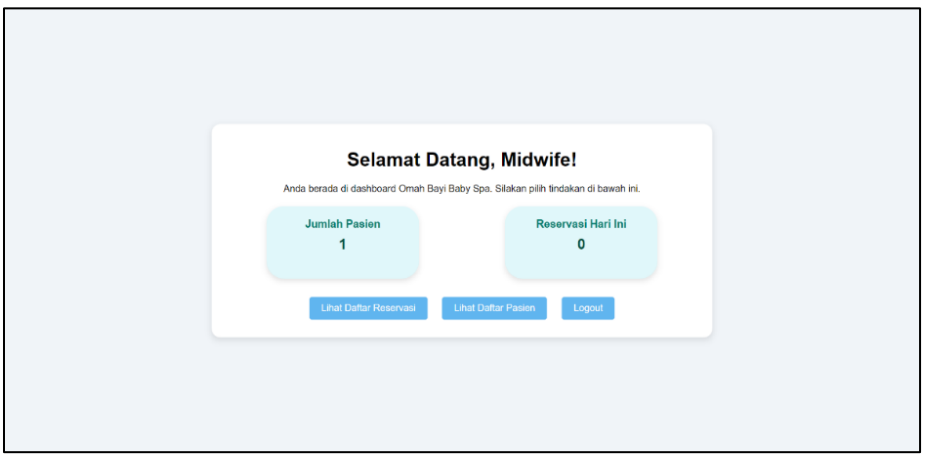

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Figure 9 Dashboard interface

The patient page lists detailed patient data with search functionality and easy dashboard navigation (Figure 10). The reservation page elucidates reservation data with filtering options and direct dashboard access (Figure 11). The reservation list page allows patients to input required details, with validation for completeness before processing (Figure 12). The confirmation page notifies patients of successful reservations with an option to return to the form (Figure 13). In short, these designs provide a comprehensive foundation for system development, ensuring efficiency, usability, and enhanced clinic operations.

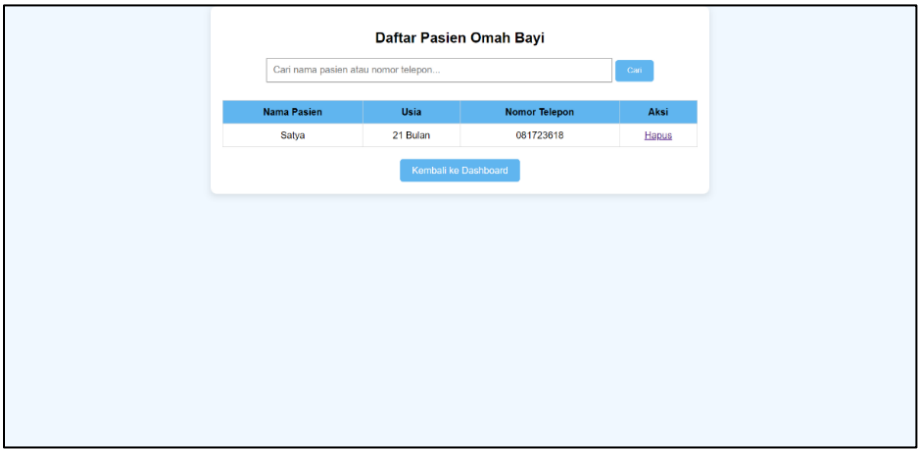

Figure 10 Patient list page interface

Figure 11 Reservation list page interface

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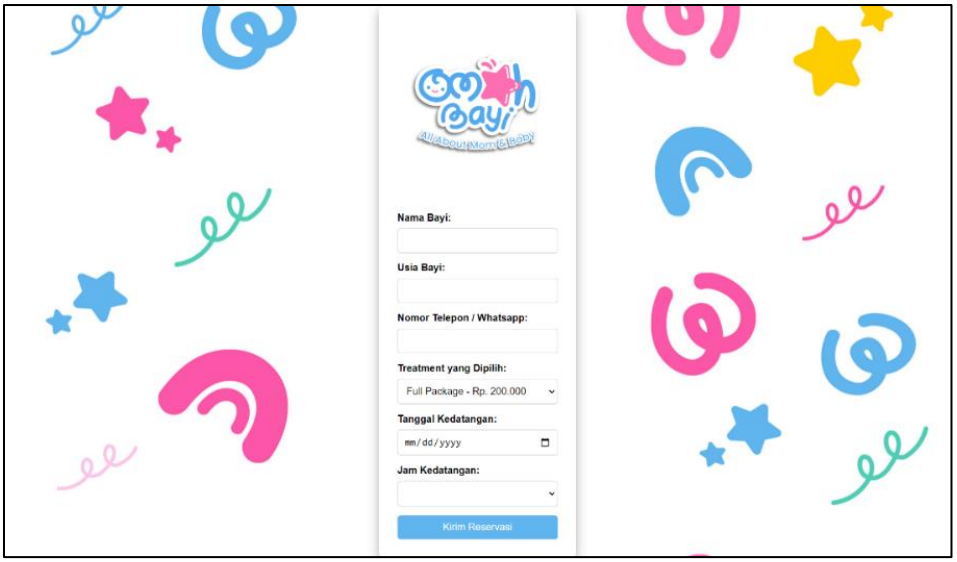

Figure 12 Reservation page interface

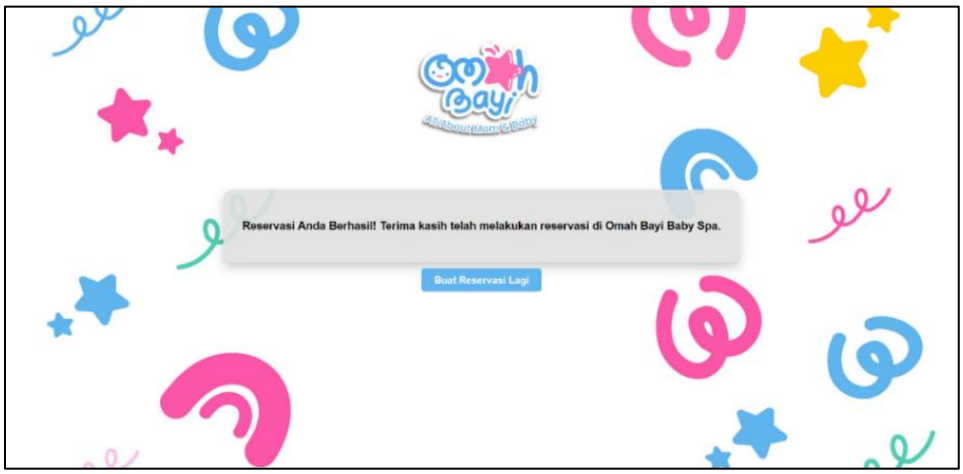

Figure 13 Confirmation page interface

Fourth, in the implementation phase, the proposed patient reservation and data management system of the sampled clinic was evaluated using black-box testing to assess its functional aspects. Each test case ensured that the system performed as expected. Results confirmed that all core functionalities, such as user login/logout, patient and reservation management, filtering, status updates, form validations, and automated dashboard statistics, operated successfully as designed.

For a discussion, the efficiency improvements were quantified by comparing the average completion times for key processes before and after system implementation. The results demonstrated significant time savings, e.g., (1) The development reduced from 10 minutes to two minutes per reservation (80% faster) in the reservation recording function. (2) The proposed system reduced from 5-10 minutes to one minute (up to 90% faster) in the patient data retrieval function. (3) The new system reduced from five minutes to one minute (80% faster) in the reservation confirmation function. (4) The developed system reduced from 1-2 hours to 10 minutes (up to 92% faster) in the monthly report compilation function. These enhancements not only streamlined administrative tasks but also improved patient experience by minimizing communication delays and eliminating manual errors. The findings validated the system's ability to achieve its research objectives of increased operational efficiency. The system's success highlights its potential applicability to other clinics seeking to enhance service quality and operational workflows.

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5 Conclusion

Based on the research findings, the implementation of a web-based reservation and patient data management system at Omah Bayi signifies a substantial technological advancement from their previous manual system, which relied on traditional books and WhatsApp communication. The former manual process presented various operational challenges, including data duplication, scheduling inaccuracies, and significant time inefficiencies. The newly developed web-based system, built using PHP and MySQL through the Rapid Application Development (RAD) methodology, successfully integrates patient data management, reservation handling, and service scheduling into a comprehensive digital solution. Testing results unequivocally demonstrate remarkable improvements in operational efficiency. For instance, the time required for the reservation recording process has been reduced from an average of 10 minutes to just two minutes, representing an 80% improvement in processing speed. Similarly, the preparation of monthly patient reports, which previously consumed up to two hours, now requires only 10 minutes, indicating a 92% reduction in time. These quantifiable improvements clearly underscore the system's significant potential to transform the clinic's daily operations and enhance the overall patient experience by minimizing communication delays and eliminating manual errors. Despite the significant efficiencies achieved, this research acknowledges several limitations. The developed system is currently confined to handling specific infant care services defined by the clinic, and its scope does not extend to services outside this specialized area. Furthermore, advanced features such as online payment integration, automated notifications, or integration with third-party systems were not included within the scope of this development. The user base for this system is also limited to defined roles: patients, midwives, and administrators. These limitations highlight specific areas for future enhancements and further research. For future development, several recommendations are proposed to further optimize the system's performance and adaptability to evolving needs. Implementing online payment features and automated notification systems could significantly enhance patient convenience. Comprehensive training for all clinic staff, including administrators and midwives, is crucial to ensure maximum utilization of the new system's functionalities. Regular system maintenance and periodic evaluations are recommended to ensure optimal performance and to adapt to changing operational requirements. Given that the system handles sensitive patient data, continuous prioritization of robust security measures, such as data encryption and enhanced user authentication, is imperative to protect patient privacy. Finally, gathering continuous feedback from both patients and staff post-implementation will be invaluable for ongoing system improvement and service quality enhancement.

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