Development Web-Based Patient Registration and Queue Management System Using RAD Method with QR Code Verification

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Abstract—The smoothness of healthcare services, particularly in the registration and queuing processes, is a key factor influencing patient satisfaction. The Bunda Meifa Foundation Clinic, located in Tondano, faces challenges in patient management due to its manual registration process and dynamic doctor schedules. This research aims to design and build a web-based information system that not only provides a user-friendly self-registration interface for patients but also integrates QR Code verification to expedite the check-in process, reduce waiting times, and ease the workload for staff. The system development method used is Rapid Application Development (RAD), which emphasizes a rapid and adaptive development cycle. The developed system offers modern features such as self-service online registration according to available doctor schedules, the creation of a Digital Card with a unique QR Code as proof of appointment, and an innovative "scan-to-queue" system where queue numbers are assigned upon QR Code scanning at the clinic. For administrators, the system includes a protected dashboard to flexibly manage practice schedules, monitor the queue in real-time, and print queue receipts via a thermal printer. System testing was performed using the Black Box Testing method, and the results indicate that all developed features function as designed. With this system, the registration and queuing processes at the Bunda Meifa Foundation Clinic are expected to become more organized, fair, and structured, ultimately enhancing the overall quality of service.

Keywords: Registration; Queue; QR Code; Rapid Application Development (RAD); Clinic

1. INTRODUCTION

A clinic is a healthcare facility that provides individual health services, including basic and/or specialized medical care, delivered by multiple healthcare professionals and led by a licensed medical practitioner. As a frontline healthcare provider, a clinic plays a crucial role in ensuring accessible, efficient, and high-quality medical services for the community. However, one of the persistent challenges in healthcare service delivery is the prolonged patient waiting time, which often fails to meet the standard set by the Indonesian Ministry of Health Regulation [1], requiring a maximum waiting time of less than 60 minutes [2].

Patient registration is a fundamental administrative process that involves recording essential information such as identity, address, and other relevant data into a structured system. An effective registration system is essential to ensure accurate data management and smooth service flow. In the era of rapid technological advancement, information technology has significantly transformed organizational operations by providing speed, accuracy, and efficiency in data processing compared to conventional manual methods. Manual processes are increasingly being replaced by automated systems, enabling better data management and minimizing human errors [3], [4].

The rapid development of digital technology across various sectors, including healthcare, has led to innovative solutions aimed at improving service quality and operational efficiency. One such innovation is the implementation of Quick Response (QR) Code technology. QR Codes are capable of storing and delivering information quickly and accurately, making them highly suitable for applications in healthcare services, particularly in patient registration and queue management systems. The integration of QR Code technology enables faster verification of patient arrivals, reduces administrative workload, and enhances overall service efficiency [5], [6]. The effectiveness of patient registration and queue management systems is a critical indicator of service quality in healthcare institutions. A well-organized workflow not only improves patient satisfaction but also supports healthcare staff in delivering services more efficiently. However, this remains a challenge for the Bunda Meifa Foundation Clinic, a healthcare facility located in Tondano that specializes in drug rehabilitation services.

The existing manual system presents several significant limitations that hinder the overall efficiency and quality of healthcare service delivery. The reliance on handwritten data recording not only consumes considerable time but also frequently results in delays in service processes, particularly during peak hours when patient volume is high. In addition, manual data entry increases the likelihood of human errors, such as incorrect patient information, duplication of records, or misplaced documentation, which can negatively impact the accuracy and reliability of medical records [7]. Furthermore, the absence of a structured and transparent queue management mechanism often creates confusion among patients regarding their queue positions, leading to dissatisfaction, perceived unfairness, and potential conflicts within the waiting area. These challenges collectively reduce the effectiveness of administrative workflows and place additional burdens on healthcare staff, who must manage both service delivery and manual documentation simultaneously [8]. Therefore, these inefficiencies clearly highlight the urgent need for the implementation of a more structured, reliable, and technology-driven system that can streamline processes, enhance data accuracy, and improve the overall patient experience.To address these challenges, this study proposes the development of a web-based patient registration and queue management system integrated with QR Code verification. The system is designed to streamline

the registration process, replacing time-consuming manual procedures with a more efficient digital platform. Through this system, patients can register independently from any location, allowing healthcare staff to focus more on delivering quality care.

The novelty of this system lies in the integration of QR Code technology as both a digital proof of registration and an efficient patient arrival verification tool within a unified platform. After completing the online registration process, patients are provided with a digital identification card embedded with a unique QR Code that securely stores their registration data. This digital approach not only minimizes the need for physical documentation but also enhances data accessibility and security. Upon arrival at the clinic, healthcare staff can simply scan the QR Code using a connected device to instantly verify the patient's identity and registration status, eliminating the need for repetitive manual data entry or searching through physical records. Furthermore, the system is designed to automatically assign and update the patient's position in the queue in real time based on the verification process, thereby ensuring a more systematic and transparent queue management mechanism. This approach significantly reduces administrative workload, minimizes human error, and shortens patient waiting times. In addition, it promotes fairness and orderliness in service delivery by ensuring that queue positions are determined objectively based on actual arrival time rather than manual estimation or intervention.

This system is expected to significantly improve the efficiency of patient registration and queue management, reduce waiting times, and enhance the overall quality of healthcare services at the Bunda Meifa Foundation Clinic. The selection of an appropriate system development methodology is a crucial factor in ensuring the successful implementation of the proposed solution [9]. This study adopts the Rapid Application Development (RAD) method, which emphasizes iterative development, user involvement, and rapid prototyping. RAD enables faster system delivery compared to traditional development models, making it highly suitable for environments that require quick adaptation and continuous feedback, such as healthcare services [10]. By involving end-users, both administrative staff and patients, throughout the development process, the system can be tailored to meet real operational needs, thereby increasing usability, acceptance, and overall effectiveness.

The implementation of a web-based system integrated with QR Code verification is not only a technological advancement but also a strategic step toward digital transformation in healthcare services. This transformation aligns with the broader trend of smart healthcare systems, where efficiency, accuracy, and patient-centered services are prioritized. By reducing administrative bottlenecks and enhancing service transparency, the proposed system contributes to improving patient experience and operational performance. Ultimately, this research is expected to provide both practical and theoretical contributions, particularly in demonstrating how the integration of web technologies, QR Code verification, and RAD methodology can effectively address real-world challenges in clinical service management.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research process in this study is structured into systematic stages to ensure the effective achievement of research objectives. These stages provide a clear framework, from problem identification to system implementation and evaluation, ensuring the validity and reliability of the results.
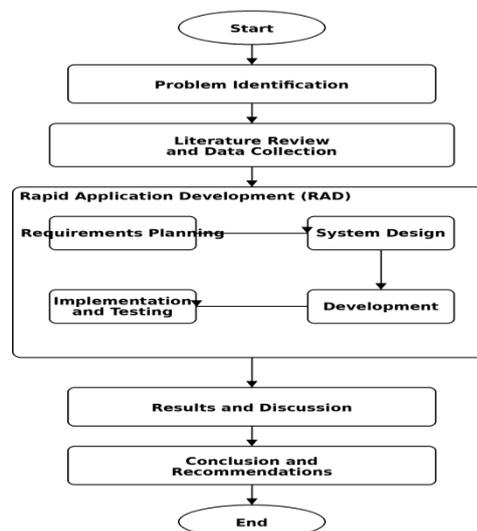

Fig 1. Research Stages [11]

The research process begins with problem identification at the Bunda Meifa Foundation Clinic, particularly the manual patient registration process. This is followed by a literature review and data collection to gain a comprehensive understanding of system requirements. The collected data then serve as the basis for system design and development using the Rapid Application Development (RAD) method. After the system is developed, functional testing is conducted to ensure its performance before it is finally implemented as a solution in the clinic.

2.2 Data Collection Techniques

To obtain accurate and relevant data, this study employs several data collection techniques derived from both primary and secondary sources [12], [13].

1. Observation
   Direct observation was conducted on the patient registration process at the clinic. This technique aims to understand the existing workflow, interactions between staff and patients, and to identify actual problems, such as long waiting times and reliance on manual data recording.
2. Interviews
   In-depth interviews were carried out with the clinic owner and administrative staff. The purpose is to explore the challenges faced, identify specific user requirements from the staff's perspective, and gather expectations regarding the system to be developed.
3. Literature Review
   Data were collected from various secondary sources, including scientific journals, books, and articles related to online registration systems, QR Code technology, and system development methodologies. This review helps strengthen the theoretical foundation and identify best practices relevant to the study.

2.3 System Development Method

The patient registration and queue management information system in this study is developed using the Rapid Application Development (RAD) method. This method is selected due to its flexible approach and its emphasis on rapid prototyping, which allows for immediate user feedback. The RAD-based development process in this study is divided into four main stages [14]:

1. Requirements Planning
   In this stage, system requirements are analyzed based on data obtained from observations and interviews. It is determined that the system must include three core functions: (1) an online patient registration system integrated with the doctor's schedule, (2) patient arrival verification using QR Code technology, and (3) an administrative dashboard to monitor queues and manage schedules.
2. System Design
   The defined requirements are then translated into system design. At this stage, system modeling is conducted using Unified Modeling Language (UML), including Use Case Diagrams, Activity Diagrams, and Class Diagrams to visualize workflows and data structures. In addition, user interface (UI/UX) prototypes are designed to ensure ease of use and user-friendliness.
3. Construction
   This stage involves implementing the system design into functional program code. The system is developed using PHP for server-side logic, MySQL for database management, and HTML, CSS, and JavaScript to build an interactive and responsive user interface.
4. Implementation
   After the system is fully developed, the implementation phase is carried out. This stage includes functional testing using the Black Box Testing method to ensure that all features operate as expected. Once the system passes testing, it is deployed to a server and made ready for use by both staff and patients at the Bunda Meifa Foundation Clinic [15].

3. RESULT AND DISCUSSION

At the initial stage of system development, the researcher conducted a data collection process to identify system requirements in a specific and comprehensive manner. In accordance with the research methodology, the techniques employed include direct observation, in-depth interviews with two main groups of informants (clinic staff and patients), and a literature review. This process aims to map the existing workflow, identify challenges from both the service provider and user perspectives, and formulate the functional requirements that must be fulfilled by the proposed system.

The results of direct observation indicate that the current registration process is entirely manual, starting from recording patient data to assigning queue numbers. This process is time-consuming and prone to human errors, such as inaccurate data entry or illegible handwriting. Patients are often seen waiting without clear information regarding their queue positions, while administrative staff must simultaneously handle data recording and respond to patient inquiries, which can lead to inefficiencies and longer queues. To gain deeper insights, in-depth interviews were conducted with clinic stakeholders, including patients and administrative staff.

3.1 System Design

At this stage, the system design aims to provide a clear representation of the system architecture, workflow, data structure, and visual interface before proceeding to the development phase. The researcher utilizes Unified Modeling Language (UML) to visualize the system in a structured and systematic manner.
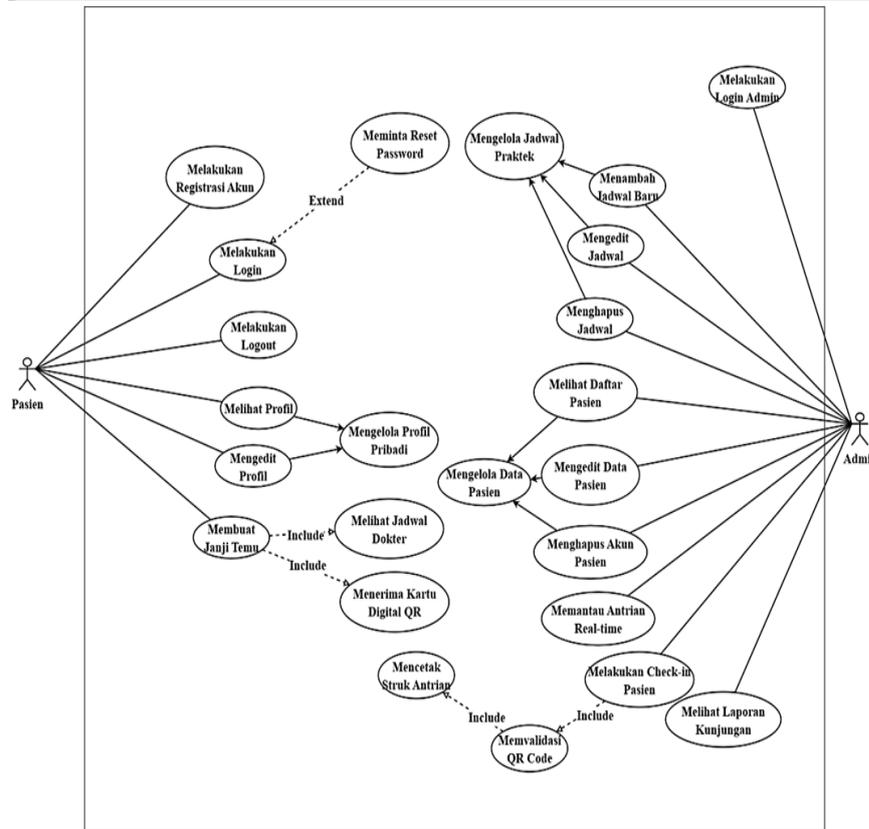

Fig 2. Use Case Diagram

Based on the diagram above, the overall system functionality can be mapped through the interactions of two main actors, namely the Patient and the Admin, who operate within the defined system scope. The diagram visualizes all actions that can be performed by each actor as well as the interconnected workflows between them.

The Patient actor represents users who intend to register for services. The interaction flow begins with basic functions such as Account Registration to create a new account and Login to access the system. The login process includes an optional (extend) function, Request Password Reset, in case the patient forgets their password. After successfully logging in, patients can Manage Personal Profile, which is a general function consisting of specific actions such as View Profile and Edit Profile. The primary objective of the patient is to Make an Appointment, a process that necessarily includes (include) the function View Doctor Schedule, and concludes with Receiving a Digital QR Code Card as proof of registration.

The Admin actor has access to the administrative section of the system after performing Admin Login. The admin holds broad managerial responsibilities, represented by several core functions. The admin can Manage Practice Schedules, which includes specific tasks such as Add Schedule, Edit Schedule, and Delete Schedule. In addition, the admin is responsible for Managing Patient Data, which involves the ability to View Patient List, Edit Patient Data, and Delete Patient Accounts.

For daily operations, the admin can Monitor the Queue in Real Time and execute the core process of Patient Check-in. This check-in process includes a mandatory workflow (include), where the system must first Validate the QR Code. Once validation is successful, the process proceeds to another required step (include), namely Print Queue Receipt. Finally, the admin also has the capability to View Visit Reports as a recapitulation function. Overall, this diagram provides a comprehensive overview of the system requirements from the user's perspective.

The data architecture of this system is designed using six main classes that are interconnected to model the entire workflow, ranging from clinic management to patient registration and queue handling. Each class contains attributes to store relevant data and methods that define the functions it can perform.

First, there are two classes representing system users, namely the Admin and the Patient. The Admin class stores staff login credentials and includes various methods to manage the system as a whole, such as createSchedule(), managePatients(), and the crucial function scanQR(). On the other hand, the Patient class stores user personal data and

provides methods that support self-service functionalities, including register(), login(), and most importantly, createAppointment().

The core of the registration process lies in the interaction between the Patient, Doctor, PracticeSchedule, and Registration classes. The Doctor class serves as an entity that stores doctor-related data, which is then associated with the PracticeSchedule class. The PracticeSchedule class plays a critical role as it represents all available consultation sessions that can be created and managed by the Admin. When a patient schedules an appointment, a new object is created from the Registration class, which acts as a transactional record linking a single Patient to a specific PracticeSchedule.

The final stage of the workflow, namely the queue management process at the clinic, is modeled by the Queue class. A new Queue entry is generated only when the Admin successfully executes the scanQR() function on the unique_registration_code associated with a Registration object. The Queue class then stores attributes such as queue_number and scan_time, effectively transforming a digital appointment into a physical queue that can be monitored in real time by the Admin.

The relationships among these classes are defined using specific cardinalities to maintain data integrity. One-to-many (1-to-*) relationships are evident between the Doctor and PracticeSchedule classes, as well as between the Patient and Registration classes, indicating that one doctor or one patient can be associated with multiple schedules or registrations. The most critical relationship exists between the Registration and Queue classes, which follows a one-to-zero-or-one (1-to-0..1) cardinality. This ensures that each registration can produce at most one queue entry, and only if the patient has completed the check-in process. Overall, this structured design provides a logical and robust foundation for system development.
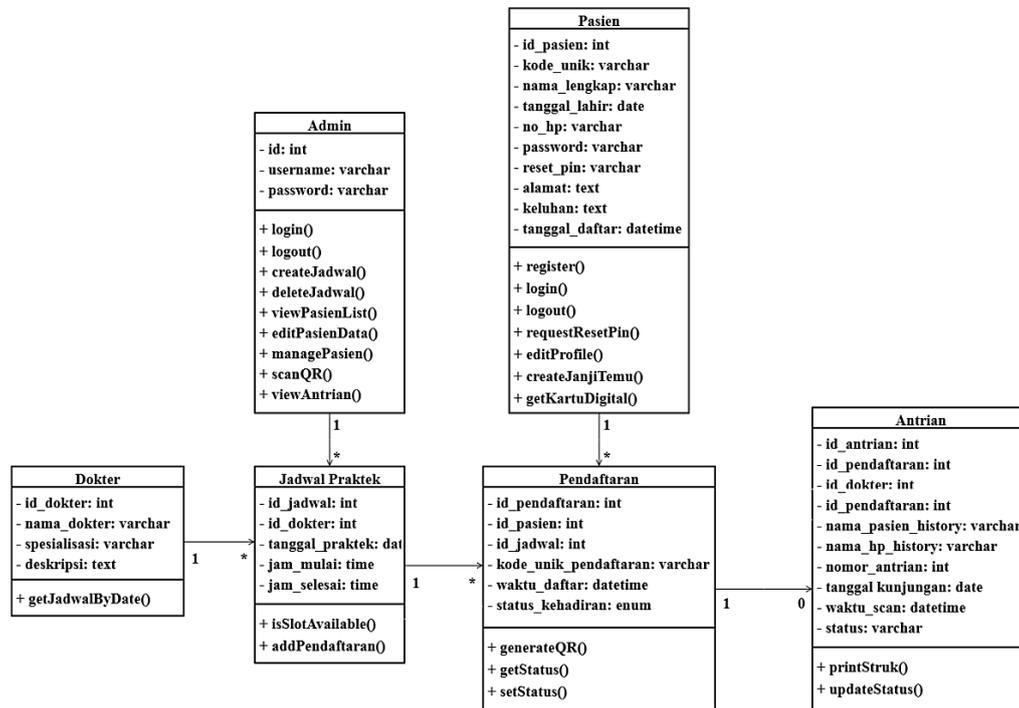

Fig 3. Class Diagram

3.2 Development

At this stage, the results of the design and planning processes are transformed into a fully functional system interface through implementation carried out by the researcher. This phase involves translating the system design, including architecture, data structures, and user interface prototypes, into executable program code using the selected technologies. The development process focuses on ensuring that all defined functional requirements are properly integrated into the system, while also maintaining usability, responsiveness, and system performance. Furthermore, attention is given to aligning the implemented features with user needs identified in the earlier stages, so that the system can effectively support both patients and administrative staff in their respective tasks. The overall system implementation is divided into two main parts:

Fig 4. Home Page (Main Page)

The Home Page serves as the primary information gateway for all visitors and represents the initial point of interaction with the system. At the top section, a navigation bar (navbar) is provided, containing links to the "Home" and "About Us" sections, as well as action buttons for "Login / Register" for patients and "Admin Login" for staff. The main section of the page (hero section) features a background image of the clinic, accompanied by a title, slogan, and call-to-action buttons that guide visitors to either create a new account or log into the system. This section is designed to attract user attention while providing clear directions for accessing the system's core functionalities. Below the hero section, an "About Us" section is presented, which contains a brief profile of the Bunda Meifa Foundation Clinic. This section aims to provide visitors with essential information about the clinic, thereby increasing user trust and familiarity with the services offered.

Fig 5. Patient Registration Page

The Patient Registration Page is designed using a two-column layout, where the left side serves as a static branding element and the right side functions as an interactive form area. The registration form is intended to collect comprehensive patient information, including full name, date of birth, phone number, and address.
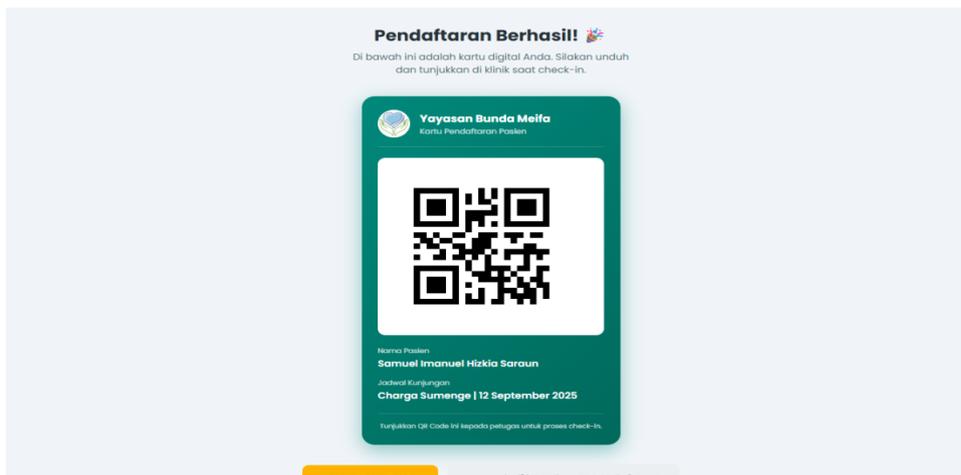

Fig 6. Digital Card Page (Registration Result)

After successfully creating an appointment, the system automatically displays the Digital Registration Card Page, which serves as a digital ticket containing essential information such as the patient's name and the selected

doctor's schedule. The main component of this card is a unique QR Code that functions as a digital token for the check-in process at the clinic, allowing patients to be quickly verified without the need for manual data entry. In addition, the page provides a "Download Card" button that enables patients to save the digital card as an image on their device, enhancing convenience by allowing easy access and presentation of their registration details when needed.
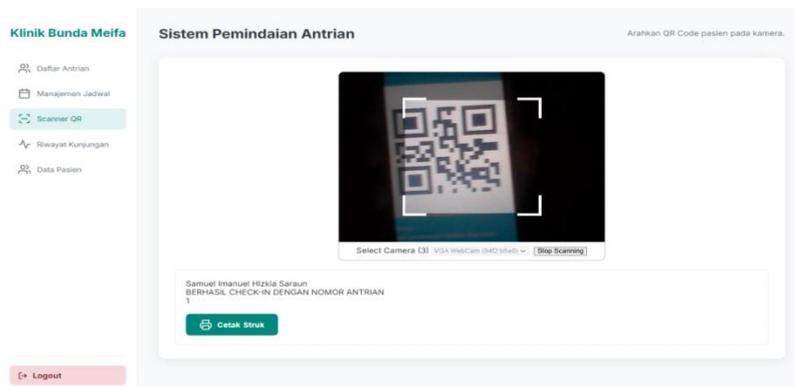

Fig 7. QR Code Scanner Page

The QR Code Scanner Page serves as the primary operational tool for the patient check-in process, featuring a simple interface in the form of a camera view. The admin only needs to direct the device's camera toward the QR Code displayed on the patient's digital card. Once the scan is successfully completed, the system immediately displays a notification containing the patient's name and the newly assigned queue number, along with an option to print the queue receipt using a thermal printer.

3.3 System Testing Results

System testing was conducted using the Black Box Testing method to ensure that all main functionalities operate in accordance with the defined functional requirements. This testing approach focuses on validating the input and output of each feature without examining the internal code structure, in order to verify that the system meets end-user needs. The testing process is divided into two main parts based on user access levels, namely the Admin Page and the Patient Page. The results of all testing scenarios indicate that all developed features function optimally and perform as expected.

Table 1. System Testing Results (Black Box Testing)

No	Feature Tested	Test Scenario	Expected Result	Observed Result	Status
1	Account Registration	A new user fills out the form with valid data and a unique phone number, then clicks "Create Account".	The system should successfully store the new user data in the database and redirect the user to the login page.	Data is stored successfully and the user is redirected to the login page.	Success
2	Account Registration	A user attempts to register using a phone number that already exists in the system.	The system should reject the registration, not store the data, and display an error message: "Phone number already in use".	Appropriate error message appears and data is not stored. User remains on the registration page.	Success
3	Account Registration	A user partially fills out the registration form and leaves the page without submitting.	The system should ensure no partial or new account data is stored in the database.	Database check confirms no new data entry is created.	Success
4	Patient Login	A patient enters a valid phone number and password, then clicks "Login".	The system should validate credentials, create a secure session, and redirect to the Patient Dashboard.	Authentication is successful and user is redirected to the dashboard.	Success
5	Patient Login	A patient enters a correct phone number but an incorrect password.	The system should deny access, not create a session, and display error message: "Invalid phone number or password".	Error message is displayed and access is denied.	Success
6	Make Appointment	A logged-in patient selects an available doctor schedule, fills in complaint details, and	The system should store appointment data, generate a unique QR Code, and display the Digital Card.	Appointment is saved, QR Code generated, and Digital Card displayed.	Success

7	Make Appointment	A patient attempts to book an unavailable doctor schedule.	The system should prevent booking and notify that the schedule is unavailable.	Booking is rejected and availability message is shown.	Success
8	Forgot Password	A patient enters correct phone number and PIN, then sets a new password.	The system should validate the PIN, update the password, and redirect to login page.	PIN validated, password updated, and user redirected to login page.	Success
9	Forgot Password	A patient enters correct phone number but incorrect PIN.	The system should reject validation and display error: "Invalid PIN".	Error message displayed and process stopped.	Success
10	Edit Profile (Initial Test)	User updates address and clicks "Save Changes".	The system should update database and immediately reflect changes on the page.	Database updated, but changes not reflected without manual refresh.	Failed
11	Edit Profile (Retest)	(After fix) User updates address and clicks "Save Changes".	The system should update database and reflect changes instantly.	Data updated and changes reflected immediately.	Success

3.4 Discussion

The main problem addressed in this study is the manual registration and queue management process at the Bunda Meifa Foundation Clinic. The proposed system successfully replaces manual record-keeping with a structured self-service registration platform, thereby reducing the administrative workload and minimizing the risk of data entry errors. In addition, the system is designed to accommodate dynamic doctor schedules, where patients can only select appointment slots that have been made available by the administrator, ensuring that registrations align with actual doctor availability.

One of the key strengths of this system lies in the implementation of a QR Code–based scan-to-queue verification mechanism. Unlike conventional online queue systems, this approach utilizes QR Codes as digital proof of appointment, where queue numbers are assigned only when patients arrive at the clinic and perform the scanning process. This mechanism creates a more accurate and fair queue system, as it is based on actual arrival time rather than the time of online registration. Furthermore, the check-in process becomes significantly faster, as staff only need to perform a single scan without manually searching for patient data, which ultimately reduces patient waiting time [16].

The implementation of this system provides significant benefits for both the clinic and patients. For the Bunda Meifa Foundation Clinic, the admin dashboard offers a powerful management tool to monitor queues in real time, manage practice schedules flexibly, and access patient visit histories stored digitally. This represents a substantial improvement over manual record-keeping systems, which are prone to loss or damage. For patients, the system offers convenience and accessibility through self-service registration that can be performed from anywhere. The digital card with QR Code provides a modern and reliable confirmation of appointments, contributing to a more structured service flow and enhancing overall patient experience and satisfaction [17].

In accordance with the defined scope of the study, the system development is intentionally focused on handling registration workflows, schedule management, and queue management. Therefore, the system does not include additional features such as electronic medical records management, online consultation services, or payment processing modules, in order to maintain focus on addressing the most critical operational issues.

The developed system successfully transforms the workflow at the Bunda Meifa Foundation Clinic from a manual, paper-based process into a more structured and manageable digital system. Repetitive administrative tasks are now automated, and the implementation of QR Code verification ensures a fairer queue system based on actual patient arrival time.

4. CONCLUSION

Based on the results of the research and development conducted, it can be concluded that the web-based patient registration and queue management information system has been successfully designed and developed to address the main problems at the Bunda Meifa Foundation Clinic. Through the implementation of a user-friendly self-service registration interface, the system effectively replaces the time-consuming manual process. Furthermore, the integration of QR Code verification with a scan-to-queue mechanism has proven to accelerate the check-in process and organize the queue flow in a more structured and fair manner. All core functionalities of the system, from both the patient and admin perspectives, have been validated and confirmed to operate in accordance with the defined functional requirements based on the results of Black Box Testing. In addition, the implementation of this system contributes to improving operational efficiency, reducing administrative workload, and enhancing data accuracy within the clinic environment. The system also supports better service management through real-time monitoring and digital data storage, which facilitates decision-making and long-term data management. From the patient's perspective, the system

provides greater convenience, accessibility, and transparency throughout the service process. Therefore, this study demonstrates that the integration of web-based technology and QR Code verification can serve as an effective solution for modernizing healthcare service workflows and improving overall service quality.

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