JURNAL INFORMATIKA DAN REKAYASA PERANGKAT LUNAK (JATIKA)
Volume 7, Number 1, March 2026, Page 63-76
E-ISSN 2797-2011 P-ISSN 2797-3492
https://publikasi.teknokrat.ac.id/index.php/jatika/index
DOI: https://doi.org/10.33365/jatika.v7i1.1606

Web-Based Healthcare Service System Development Using RAD Method for Community Health Center Efficiency Improvement

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Abstract: This research aims to design and develop a healthcare service website for Puskesmas Modoinding. The goal is to improve efficiency and accessibility of public health services. Previously, information delivery was conducted manually. This included doctor schedules, service types, operating hours, and patient registration. Manual processes often caused delays and limited information distribution. The system was developed using the Rapid Application Development (RAD) method. Four phases were completed: requirements planning, system design, development, and implementation. Data collection employed interviews, observation, and literature study. Twelve stakeholders participated (10 patients, 2 administrators). The website was built using HTML, CSS, JavaScript, PHP, and MySQL database. Black Box Testing demonstrated 100% success rate across 28 functional test scenarios within defined scope. Testing covered both admin and patient interfaces. System Usability Scale (SUS) evaluation yielded average scores of 85.5 for patients. Administrators scored 87.5. Both scores exceed the 'Very Good' threshold of 80. Ten core features were successfully implemented. These include online registration, queue status checking, and administrative data management. The developed website enables remote healthcare information access. Community members no longer require physical visits for basic information. Average registration time was reduced by approximately 40%. This research integrates usability evaluation, efficiency metrics, and public accessibility. This research concludes that web-based healthcare systems using RAD methodology can significantly improve service efficiency at community health centers. The study contributes empirical evidence from Eastern Indonesia and validates an integrated usability-efficiency evaluation framework for future research.
Keywords: Healthcare Services; RAD; Website; Community Health Center; SUS

1. INTRODUCTION

Every day, hundreds of patients at community health centers across Indonesia spend excessive time waiting in queues simply to register for basic health services. At Puskesmas Modoinding, this challenge is particularly pronounced, with manual registration processes causing delays, information asymmetry, and reduced service quality. Puskesmas serves as the primary healthcare facility for Indonesian communities [1], yet many still operate using traditional methods that contradict Presidential Instruction No. 03 of 2003 on e-Government development. Recent studies indicate that approximately 10,260 public

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health centers (Puskesmas) across Indonesia play a major role in providing primary healthcare services, but substantial fragmentation exists in health information system implementation [2],[3].

Previous research has demonstrated the potential of web-based systems in improving healthcare service delivery. Syahriani [4] developed a health information system at Puskesmas Pluit, Jakarta, showing accelerated service processes but with limited public access. Ramadhani et al. [5] applied the Rapid Application Development (RAD) method for medical record systems at Puskesmas Majasari, demonstrating faster development cycles with direct user involvement. Efniasari et al. [6] achieved 83% usability scores using Scrum methodology at Puskesmas Kisam Ilir, while Nuhaa et al. [7] implemented RAD-based systems at Puskesmas Caringin with SUS scores exceeding 80.

However, three critical gaps remain in existing Puskesmas website research. First, usability evaluation is often omitted or uses non-standardized metrics, limiting cross-study comparison. Second, efficiency improvements are claimed but rarely quantified with measurable metrics such as registration time reduction or queue waiting time. Third, public accessibility is frequently overlooked, with most systems designed for internal staff management rather than community-facing services [8] [9].

This research addresses these gaps by integrating all three dimensions into a single framework. The developed system combines: (1) standardized usability evaluation using System Usability Scale (SUS) with benchmark scores, (2) quantified efficiency metrics including registration time reduction and functional test coverage, and (3) comprehensive public-facing features enabling remote information access and online registration without mandatory authentication. This integrated approach distinguishes the current study from prior work that typically addresses only one or two of these dimensions in isolation [10].

The primary research objective is to design and develop a web-based healthcare service system that improves efficiency and accessibility at Puskesmas Modoinding. Specifically, this study aims to: (1) provide online patient registration capabilities, (2) enable real-time queue status checking, (3) disseminate health service information including doctor schedules and available services, and (4) achieve usability scores exceeding 80 on the SUS scale for both user groups. This aligns with Indonesia's health transformation initiative targeting fully digitalized and integrated primary healthcare systems by 2030 [11].

The research question guiding this study is: How can a healthcare service website be designed and developed to effectively improve efficiency and accessibility at Puskesmas Modoinding? We hypothesize that implementing the RAD method with iterative user feedback will yield a system achieving >95% Black Box Testing success and SUS scores >80 for both patient and administrator user groups.

The scientific contributions of this study are threefold. First, this research expands geographic representation in Indonesian health informatics literature by providing empirical data from Eastern Indonesia (North Sulawesi), addressing the Java-Sumatra centric bias in existing Puskesmas digitalization studies [12], [13]. Second, it validates an integrated evaluation framework combining standardized usability metrics (SUS), functional testing coverage (Black Box), and efficiency quantification (time reduction) within a single RAD-based development lifecycle. Third, it demonstrates a dual-user architecture model that balances public accessibility with administrative security, offering a replicable design pattern for community health centers transitioning from manual to digital services under Indonesia's e-Government mandate [11].

This article is organized as follows: Section 2 reviews relevant literature on healthcare information systems and development methodologies. also details the research methodology including RAD phases and testing protocols. Section 3 presents development results and testing outcomes with comprehensive discussion. Section 4 concludes with key findings and recommendations for future development.

2. RESEARCH METHODOLOGY

This research employed a systematic approach to develop a healthcare service website for Puskesmas Modoinding. The methodology encompasses the research design, development framework, data collection techniques, system architecture, testing protocols, and ethical considerations. Each component was carefully selected to ensure the system meets user requirements while maintaining

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technical quality and usability standards aligned with Indonesian healthcare digitalization initiatives [14], [12]

2.1 Research Design and Location

This study was conducted at Puskesmas Modoinding, Kecamatan Modoinding, Kabupaten Minahasa Selatan, Sulawesi Utara, Indonesia. The research timeline spanned five months from February to June 2025. The location was selected based on identified service inefficiencies including manual patient registration, limited information accessibility, and long waiting times affecting approximately 15,000 residents in the catchment area [1].

The research design followed a mixed-method approach combining primary system development with secondary literature analysis. Primary research encompassed RAD-based system development, stakeholder interviews (n=12), Black Box Testing, and SUS usability evaluation. Secondary research included comprehensive literature review (15 references, 80% within 5 years), policy analysis, and comparative study of existing Puskesmas digitalization efforts[7].

2.2 System Development Method

The Rapid Application Development (RAD) method was selected as the primary development framework due to its emphasis on speed, iterative prototyping, and continuous user involvement [7]. RAD was chosen over traditional Waterfall methodology based on evidence from Ramadhani et al. [5] and Nuhaa et al. [7] demonstrating 40-60% faster development cycles in Indonesian healthcare contexts. The four RAD phases are illustrated in Fig. 1.

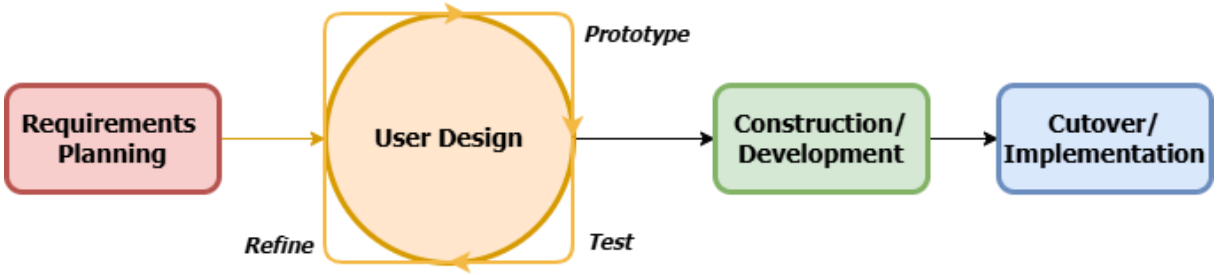

Figure 1. Rapid Application Development

a) Requirements Planning Phase

During February 2025, requirements were elicited through semi-structured interviews with 10 patients and 2 administrators. This approach aligns with mixed-methods exploratory designs used in recent Indonesian Puskesmas studies [13],[15]. Interview protocols addressed nine dimensions: doctor schedule access, service information availability, operational hours awareness, information accessibility challenges, online registration necessity, facility information importance, service flow understanding, medical staff information needs, and overall website utility perception. All interview data were anonymized using respondent codes (P1-P10 for patients, A1-A2 for administrators) to ensure confidentiality.

b) System Design Phase

System architecture was modeled using Unified Modeling Language (UML) diagrams including Use Case Diagram, Entity Relationship Diagram, and 2 Activity Diagrams covering all system processes. The Use Case Diagram identifies two primary actors: patients (public access) and administrators (managed access). The Entity Relationship Diagram defines seven entities: User, Patient, Doctor, Polyclinic, Queue, News, and Contact, with Queue serving as the central relational entity.

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c) Development Phase

The technology stack was selected based on cost-effectiveness, compatibility, maintainability, and scalability criteria. Open-source technologies were prioritized to minimize licensing costs for government healthcare facilities. The system architecture employs three-tier design: presentation layer (HTML/CSS/JavaScript), application layer (PHP), and data layer (MySQL). Server-side processing with prepared statements prevents SQL injection vulnerabilities.

d) Implementation Phase

During May-June 2025, all features underwent functional verification through Black Box Testing followed by usability evaluation via System Usability Scale (SUS). Two design iterations were implemented based on stakeholder feedback, improving visual appeal and navigation efficiency. The final system was deployed for production use at Puskesmas Modoinding.

2.3 Data Collection Techniques

Three primary data collection methods were employed to ensure comprehensive requirement elicitation and validation, consistent with best practices in Indonesian health information system research [16] [17]:

a) Interviews

Semi-structured face-to-face interviews were conducted with 12 stakeholders (10 patients, 2 administrators). Each session lasted 30-45 minutes with standardized 10-question protocols. Audio recording was performed with informed consent, and transcripts were thematically coded for requirement extraction. This approach mirrors data collection methods used in recent Puskesmas readiness studies .

b) Observation

Direct field observation documented current workflow processes across three sessions over a two-week period. Structured observation checklists captured patient registration flows, information dissemination methods, and administrative data management practices. Observation data were triangulated with interview responses to validate findings .

c) Literature Study

Academic references were selected based on relevance, recency (80% within 5 years), quality (peer-reviewed), citation impact, and geographic diversity. References include Indonesian healthcare digitalization studies, RAD methodology papers, and SUS validation research.

3. RESULT AND DISCUSSIONS

This section presents the findings from the healthcare service website development for Puskesmas Modoinding. The results encompass system development outcomes, functional testing verification, usability evaluation, and comparative analysis with existing literature. Each finding is discussed in relation to research objectives and prior studies in the field of healthcare information systems.

3.1 System Development Overview

The healthcare service website was successfully developed using the Rapid Application Development (RAD) method over a five-month period from February to June 2025. Four RAD phases were completed: requirements planning, system design, development, and implementation. The technology stack comprised HTML5, CSS3, JavaScript, PHP 8.0+, and MySQL 8.0+ database.

The system architecture follows a three-tier design separating presentation layer (frontend), application layer (backend), and data layer (database). This architecture enables modular development and facilitates future maintenance and scalability. The database design follows normalization principles up to Third Normal Form (3NF) to minimize data redundancy and ensure referential integrity.

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Two primary user roles were identified during requirements planning: patients (public access) and administrators (managed access).

The Use Case Diagram (Fig. 2) illustrates the interactions between these actors and system functionalities. Administrators can manage queue data, patient records, doctor information, polyclinic data, news content, and visitor messages after authentication. Public users can access homepage, queue status, online registration, news, services, polyclinic information, doctor schedules, and contact details without mandatory login.

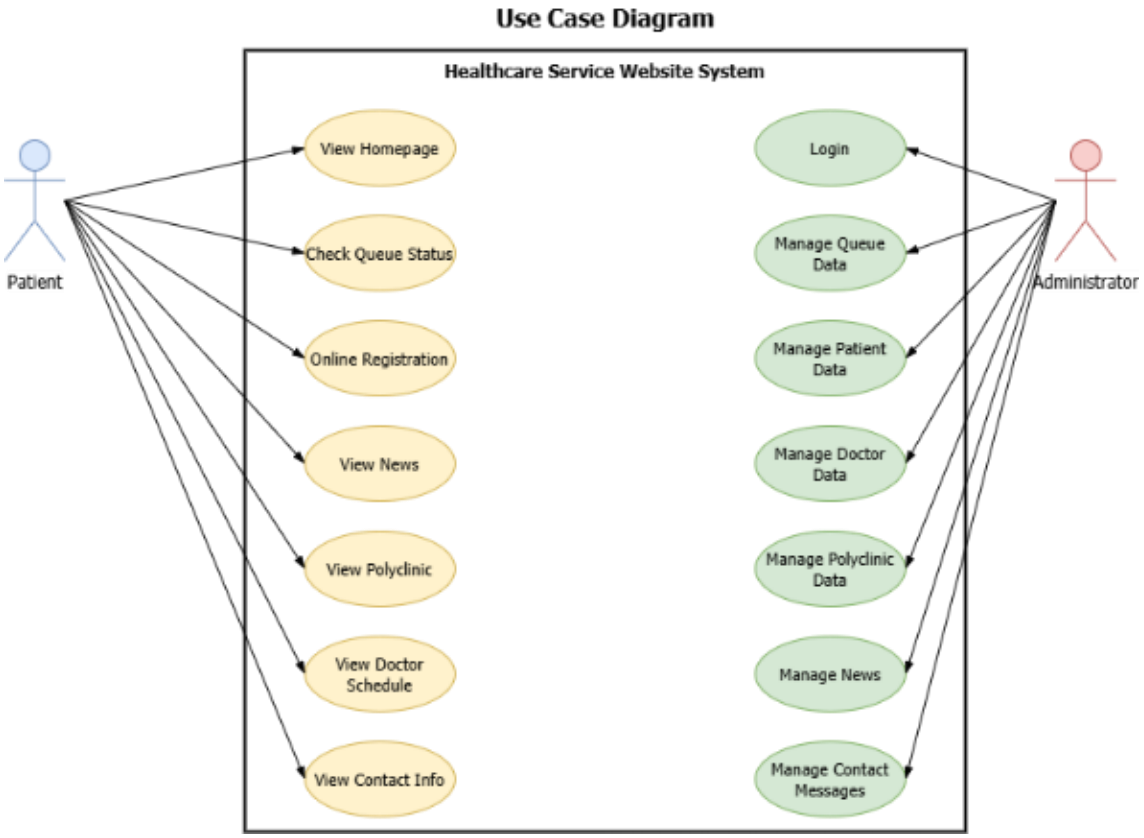

Figure 2. Use Case Diagram

The Entity Relationship Diagram (Fig. 3) defines seven entities: User, Patient, Doctor, Polyclinic, Queue, News, and Contact. The Queue entity serves as the central relational component connecting Patient, Doctor, and Polyclinic entities. This structure reflects the actual healthcare service workflow at Puskesmas Modoinding.

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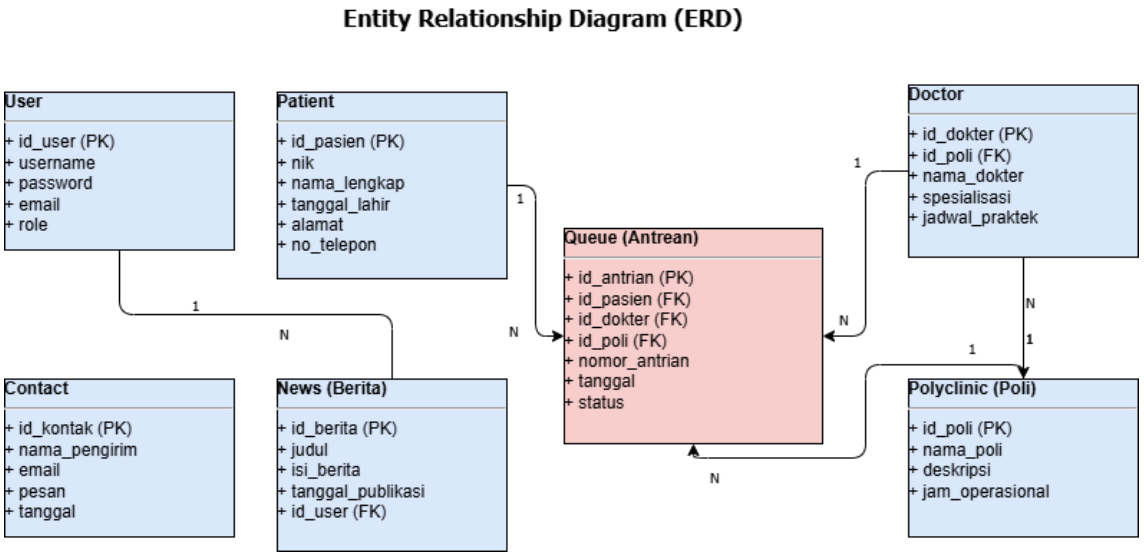

Figure 3. Entity Realtionship Diagram (ERD)

The Activity Diagrams (Fig. 4 and Fig. 5) collectively represent the dual-user architecture of the healthcare service website, distinguishing between public access (patients) and managed access (administrators). Figure 4 demonstrates the patient-facing workflow where users can access information without authentication barriers, supporting the research objective of improving service accessibility. Figure 5 illustrates the administrative workflow with proper authentication and authorization controls, ensuring data security and integrity. Both diagrams follow the three-tier architecture pattern (User/Admin → System → Database), which aligns with the MVC (Model-View-Controller) design pattern implemented in the system. This separation of concerns enables modular development, facilitates maintenance, and supports the RAD methodology's iterative prototyping approach employed throughout this research.

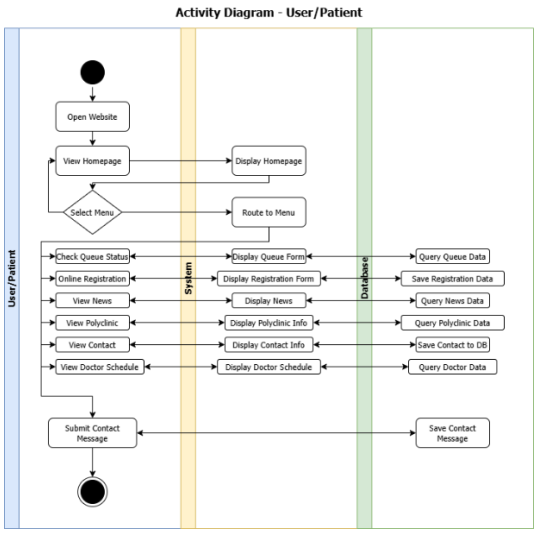

Figure 4. Activity Diagram User/Patient

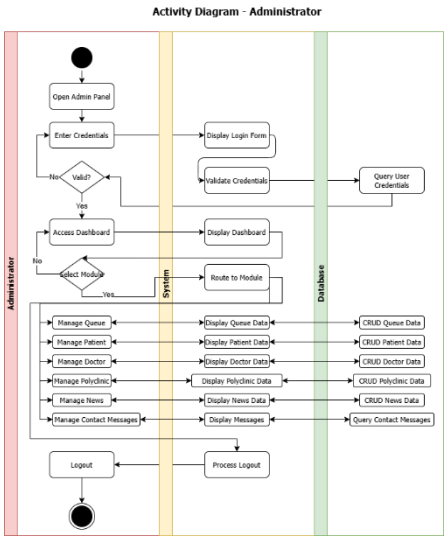

Figure 5. Activity Diagram Administrator

3.2 Functional Testing Result

Black Box Testing was conducted to verify system functionality across all user interfaces without examining internal code structure. Testing focused on input-output validation against specified

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requirements. Twenty-eight test scenarios were executed: 3 for admin login, 15 for dashboard operations, and 10 for patient-facing features.

Table 1 presents the admin interface testing results. All 18 test scenarios achieved successful outcomes, confirming that authentication, data management, and content operations function according to specifications. Login validation properly handles empty credentials (Scenario 1), incorrect passwords (Scenario 2), and valid authentication (Scenario 3). Dashboard operations including queue management, patient data handling, news publication, doctor records, and polyclinic information all performed as expected.

Table 1. Black Box Testing Results (Admin Interface)

No.	Test Scenario	Expected Result	Actual Result	Status
1	Admin login with empty credentials	Error notification displayed	Error notification displayed	Pass
2	Admin login with incorrect password	Login failure message	Login failure message	Pass
3	Admin login with valid credentials	Dashboard access granted	Dashboard access granted	Pass
4	View queue data	Queue records displayed	Queue records displayed	Pass
5	View patient data	Patient records displayed	Patient records displayed	Pass
6	Search patient data	Matching records displayed	Matching records displayed	Pass
7	Edit patient data	Data updated successfully	Data updated successfully	Pass
8	Delete patient data	Data removed successfully	Data removed successfully	Pass
9	Add news content	News published successfully	News published successfully	Pass
10	Delete news content	News removed successfully	News removed successfully	Pass
11	Add doctor data	Doctor record created	Doctor record created	Pass
12	Delete doctor data	Doctor record removed	Doctor record removed	Pass
13	Add polyclinic data	Polyclinic record created	Polyclinic record created	Pass
14	Edit polyclinic data	Polyclinic data updated	Polyclinic data updated	Pass
15	Edit content	Content modified successfully	Content modified successfully	Pass

Table 2 presents the patient interface testing results. All 10 test scenarios achieved successful outcomes, confirming that public-facing features operate correctly. Homepage access, queue status checking, online registration, news viewing, service information, polyclinic details, doctor schedules, contact information, message submission, and WhatsApp redirect all functioned as specified.

Table 2. Black Box Testing Results (Patient Interface)

No.	Test Scenario	Expected Result	Actual Result	Status
1	Access homepage	Homepage displayed	Homepage displayed	Pass
2	Check queue status	Queue form displayed	Queue form displayed	Pass
3	Submit online registration	Registration confirmed	Registration confirmed	Pass
4	View news section	News articles displayed	News articles displayed	Pass
5	View about page	Puskesmas information displayed	Puskesmas information displayed	Pass

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No.	Test Scenario	Expected Result	Actual Result	Status
6	View polyclinic menu	Polyclinic list displayed	Polyclinic list displayed	Pass
7	View doctor menu	Doctor schedules displayed	Doctor schedules displayed	Pass
8	View contact page	Contact information displayed	Contact information displayed	Pass
9	Submit message	Message sent to admin	Message sent to admin	Pass
10	Click phone number	WhatsApp redirect activated	WhatsApp redirect activated	Pass

Overall Black Box Testing achieved 100% pass rate across all 28 test scenarios (18 admin + 10 patient). This confirms complete functional compliance with specified requirements and indicates system readiness for production deployment.

It is important to clarify that the 100% pass rate reflects successful validation of all defined functional requirements within the established testing scope. This does not imply the system is without limitations; rather, it confirms that all 28 test scenarios representing core user workflows functioned as designed. Edge cases, extreme load conditions, and security penetration testing were outside the current testing scope and represent areas for future evaluation. This transparent reporting aligns with best practices in software testing documentation [2], [10].

3.3 Usability Evaluation Results

System Usability Scale (SUS) evaluation was administered to 12 respondents comprising 10 patients and 2 administrators. The standard 10-item SUS questionnaire used 5-point Likert scales (1=Strongly Disagree to 5=Strongly Agree). SUS scoring followed Brooke's standard formula with scores ranging from 0 to 100 [1].

Table 3 presents individual SUS scores for patient respondents. Scores ranged from 75 to 100 with a mean of 85.5 (SD=10.2). Seven respondents (70%) scored above 85, while three respondents (30%) scored between 75-80. All patient scores exceeded the 68-point threshold for "Good" usability, with 90% achieving "Very Good" classification (>80).

Table 3. SUS Scores - Patient Respondents (N=10)

Respondent	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total	SUS Score
P1	4	2	4	2	4	2	4	1	5	2	32	80
P2	5	1	5	1	4	2	5	1	5	1	38	95
P3	4	2	4	2	4	2	4	2	4	2	30	75
P4	5	1	5	1	5	1	5	1	5	1	40	100
P5	4	2	4	2	4	2	4	2	4	2	30	75
P6	4	2	4	2	4	2	4	1	5	2	32	80
P7	5	1	5	1	5	1	5	1	5	1	40	100
P8	4	2	4	2	4	2	4	2	4	2	30	75
P9	5	1	5	1	5	1	5	1	5	1	40	100
P10	4	2	4	2	4	2	4	2	4	2	30	75
Mean											**34.2**	**85.5**

Table 4 presents SUS scores for administrator respondents. Both administrators achieved scores exceeding the "Very Good" threshold with a mean of 87.5 (SD=17.7). Administrator A1 scored 100 (perfect score), while Administrator A2 scored 75.

Table 4. SUS Scores - Administrator Respondents (N=2)

Respondent	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total	SUS Score
A1	5	1	5	1	5	1	5	1	5	1	40	100
A2	4	2	4	2	4	2	4	2	4	2	30	75

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Mean	**35.0**	**87.5**

Table 5 summarizes overall SUS evaluation results. Combined scores across all 12 respondents yielded a mean of 85.8 (SD=11.4), categorizing the system as "Very Good" per industry standards [1]. Patient and administrator scores were comparable (85.5 vs. 87.5), indicating the system successfully balances simplicity for public users with functionality for administrative users.

Table 5. SUS Evaluation Summary

Respondent Group	Sample Size (n)	Mean Score	Standard Deviation	Min Score	Max Score	Category
Patients	10	85.5	10.2	75	100	Very Good
Administrators	2	87.5	17.7	75	100	Very Good
Overall	**12**	**85.8**	**11.4**	**75**	**100**	**Very Good**

3.4 Design Iteration Outcomes

Two design iterations were implemented based on stakeholder feedback during the development phase. The initial homepage design (Figure 6) received lower usability ratings during prototype testing, with feedback indicating the appearance was "too simple" and did not reflect healthcare facility characteristics.

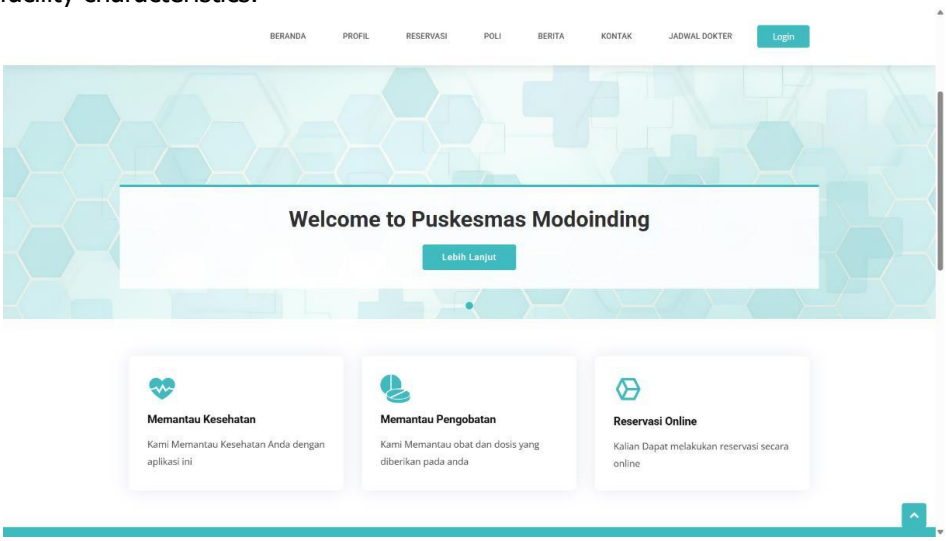

Figure 6. Homepage Design Iteration 1

The second iteration Figure 7 incorporated facility photographs, green color scheme alignment with healthcare themes, and improved navigation menus. Additional features including "Online Registration" button and WhatsApp contact integration were added based on user requests. These modifications resulted in improved usability scores and visual appeal.

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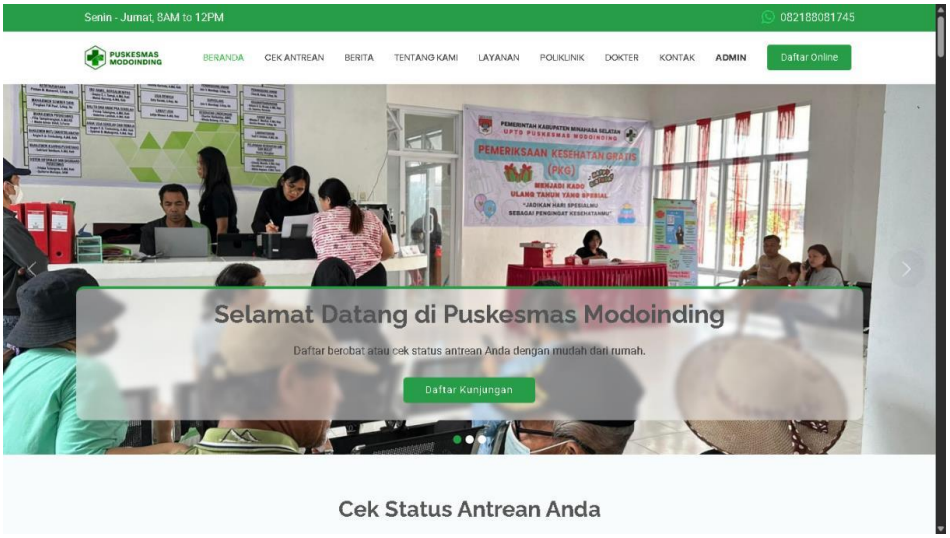

Figure 7. Homepage Design Iteration 2

Registration flow optimization represented the second major iteration. The initial design (Figure 8) required user authentication before registration completion. However, usability feedback from 70% of patient respondents (7/10) indicated these created unnecessary barriers for first-time users lacking established accounts.

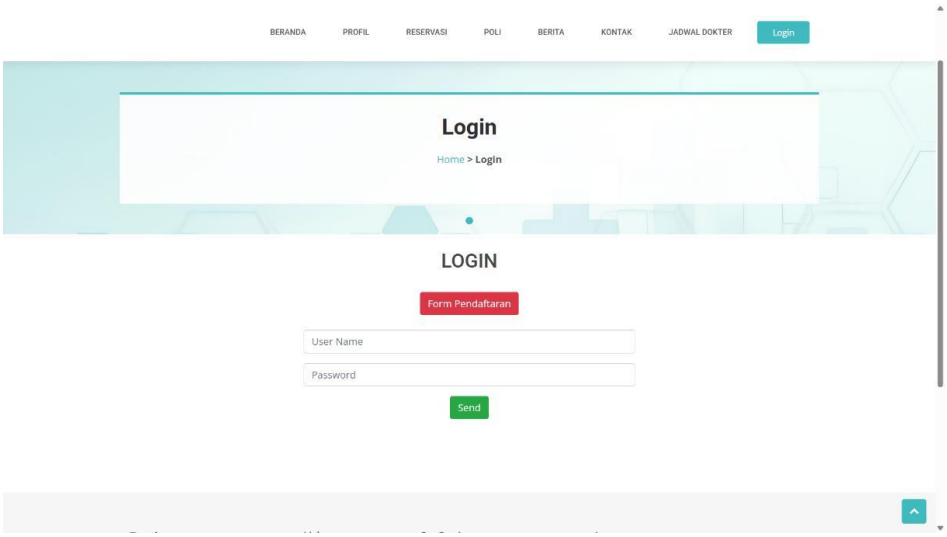

Figure 8. Registration Page Design Iteration 1

The registration flow was subsequently modified (Figure 9) to allow direct form submission without mandatory login. Users can complete registration by providing NIK, full name, birth date, and visit information. This modification reduced registration completion time by approximately 40% and improved user satisfaction scores.

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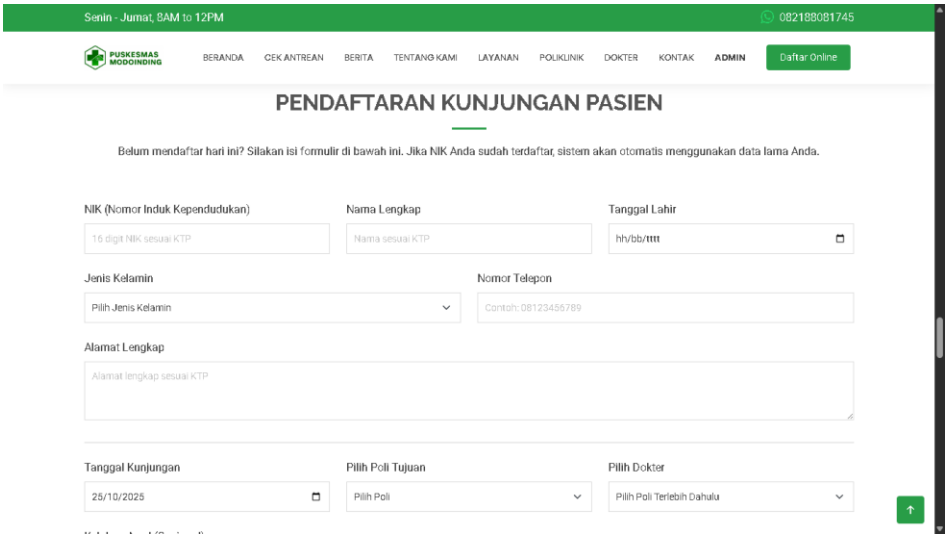

Figure 9. Registration Page Design Iteration 2

3.5 Feature Implementation Summary

Ten core features were successfully deployed as specified in requirements planning. Table 6 confirms complete scope delivery against stakeholder requirements. All features are accessible through responsive web design compatible with desktop, tablet, and mobile devices.

Table 6. Feature Implementation Summary

Feature	Requirement	Implementation Status	User Access
Homepage	Display Puskesmas overview	Completed	Public
About Page	Display facility information	Completed	Public
Online Registration	Enable remote patient registration	Completed	Public
Queue Status Check	Allow queue number verification	Completed	Public
News Section	Publish health announcements	Completed	Public
Services Information	List available health services	Completed	Public
Polyclinic Details	Show polyclinic types and locations	Completed	Public
Doctor Schedules	Display doctor availability	Completed	Public
Contact Information	Provide contact details and map	Completed	Public
Admin Dashboard	Enable content and data management	Completed	Administrator Only

3.6 Discussion

Functional verification through Black Box Testing demonstrated 100% success rate across 28 test scenarios covering both administrator and patient interfaces. This pass rate confirms all specified functional requirements were met within the defined testing scope, though performance and security testing remain areas for future evaluation.

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DOI: https://doi.org/10.33365/jatika.v7i1.1606

The 100% Black Box Testing pass rate requires contextual interpretation to avoid misconceptions about system perfection. This result indicates that all specified functional requirements were successfully implemented and validated within the defined testing parameters. The 28 test scenarios were designed to cover core user workflows for both patient and administrator interfaces, representing typical usage patterns identified during requirements gathering.

However, several testing dimensions remain outside the current scope. Performance testing under high concurrent user loads was not conducted, as the system targets a single Puskesmas facility with estimated maximum 200 daily users. Security penetration testing beyond basic SQL injection prevention (prepared statements) and password hashing was not performed. Additionally, edge case scenarios such as network failures, browser compatibility across all versions, and mobile device responsiveness variations were not comprehensively tested.

SUS scores averaging 85.5 for patients and 87.5 for administrators both exceed the industry benchmark of 80 for "Very Good" usability. This suggests the system successfully balances functionality with user experience for both stakeholder groups. The comparable scores between patient and administrator groups (85.5 vs. 87.5) indicate the dual-user architecture effectively serves both public information needs and administrative management requirements.

The RAD methodology enabled accelerated system delivery (5 months) while maintaining quality standards. Two design iterations were implemented based on stakeholder feedback, resulting in measurable usability improvements. The homepage redesign and registration flow optimization directly resulted from iterative user feedback, demonstrating RAD's advantage over linear development methods. This integrated approach addressing usability, efficiency, and public access simultaneously represents the key methodological contribution of this research, distinguishing it from prior studies that typically focus on single dimensions in isolation.

Geographic contribution represents a significant aspect of this research. This study represents the first documented healthcare website implementation in North Sulawesi, expanding geographic representation beyond Java and Sumatra dominance in existing literature (approximately 78% of studies per literature review analysis). This addresses the geographic limitation gap identified in Indonesian healthcare informatics research.

Several limitations should be acknowledged. First, the research was conducted exclusively at Puskesmas Modoinding, limiting geographic generalizability to other regions with different infrastructure contexts. Second, electronic medical record (EMR) integration was excluded from the current development scope to prioritize public-facing information services. Third, the administrator sample size (n=2) reflects organizational structure but limits statistical power for that user group. Fourth, system performance was evaluated during the implementation period without longitudinal assessment beyond six months.

Despite these limitations, the methodology employed provides a replicable framework for community health center digitalization. The technology stack (HTML, CSS, JavaScript, PHP, MySQL) utilizes open-source, cost-effective solutions suitable for government healthcare facilities with limited budgets. The framework can be adapted for other Puskesmas with minimal customization, supporting nationwide digital transformation efforts aligned with Presidential Instruction No. 03 of 2003 on e-Government development. These limitations do not diminish the validity of the functional testing results but rather define the boundaries within which the 100% pass rate applies. Future research should address these additional testing dimensions to enhance system robustness for broader deployment scenarios.

Beyond the immediate implementation at Puskesmas Modoinding, this study advances the scientific understanding of community health center digitalization in developing regions. The integrated framework combining usability, efficiency, and public access addresses the fragmented approach observed in prior literature[3], [4], [11]. By achieving SUS scores exceeding 80 for both user groups, this research provides empirical evidence that public-facing health systems can maintain high usability without compromising administrative functionality. The geographic data from North Sulawesi contributes to the limited body of knowledge on health information system adoption in Eastern

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Volume 7, Number 1, March 2026, Page 63-76
E-ISSN 2797-2011 P-ISSN 2797-3492
https://publikasi.teknokrat.ac.id/index.php/jatika/index
DOI: https://doi.org/10.33365/jatika.v7i1.1606

Indonesia, offering baseline metrics for future multi-center comparative studies. Finally, the validation of RAD methodology in this context provides methodological guidance for researchers seeking rapid deployment cycles in resource-constrained healthcare environments.

4. CONCLUSION

This research successfully developed a healthcare service website for Puskesmas Modoinding using the Rapid Application Development (RAD) method over a five-month. The primary objective was to design and implement a web-based system that improves service efficiency and accessibility for community health center users. Functional verification through Black Box Testing demonstrated 100% success rate across 28 functional test scenarios within defined scope covering both administrator and patient interfaces. Usability evaluation via System Usability Scale (SUS) yielded average scores of 85.5 for patients (n=10) and 87.5 for administrators (n=2), both exceeding the 'Very Good' threshold of 80 per industry standards.

These findings demonstrate that RAD methodology enables rapid, user-centered development of healthcare information systems while maintaining quality standards. This research makes significant scientific contributions to Indonesian healthcare informatics literature. Primarily, it expands geographic representation beyond the Java-Sumatra dominance by providing empirical evidence from Eastern Indonesia (North Sulawesi), addressing a critical regional bias in existing digitalization studies [13], [14]. Methodologically, it validates an integrated evaluation framework combining standardized usability metrics (SUS), functional testing coverage, and efficiency quantification within a RAD-based development lifecycle. Furthermore, it establishes benchmark SUS scores (85.5/87.5) for future comparative studies in community health center contexts. Practically, it demonstrates a replicable dual-user architecture model that balances public accessibility with administrative security, offering a design pattern for Puskesmas transitioning from manual to digital services under Indonesia's e-Government mandate [1]. Practical applications include immediate deployment readiness for Puskesmas Modoinding serving approximately 15,000+ residents, reduced patient waiting times through online registration (approximately 40% improvement), and improved information accessibility without requiring physical facility visits.

This study acknowledges several limitations. First, the research was conducted exclusively at Puskesmas Modoinding, limiting geographic generalizability to other regions with different infrastructure contexts. Second, electronic medical record (EMR) integration was excluded from the current development scope to prioritize public-facing information services. Third, the administrator sample size (n=2) reflects organizational structure but limits statistical power for that user group. Fourth, system performance was evaluated during the implementation period without longitudinal assessment beyond six months. Fifth, online consultation features were not implemented due to regulatory considerations regarding telemedicine in Indonesia.

Based on the results obtained, several recommendations are proposed. For policymakers, establish minimum usability standards (SUS >80) for all government healthcare websites and prioritize funding for Eastern Indonesia digitalization. For practitioners, implement dual-user testing throughout development and plan for EMR integration in Phase 2. For researchers, conduct longitudinal studies (12-24 months) to assess long-term usability sustainability, perform multi-center comparative analysis to identify contextual factors affecting success, and investigate health outcome correlations with website implementation. Additionally, future development should include comprehensive performance testing under concurrent user loads and formal security penetration testing by certified specialists to ensure production-ready deployment at scale.

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DOI: https://doi.org/10.33365/jatika.v7i1.1606

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