

Original Research

Development of a Web-Based Health Information System Integrated with Artificial Intelligence Using Agile Methodology at Dasan Agung Primary Health Center

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ABSTRACT

The recording of health data at the Dasan Agung Community Health Center (Puskesmas) in Mataram City is still carried out manually, giving rise to various problems such as data entry errors, data loss, delays in data retrieval, and inaccuracies in health reports. This study aims to develop a Web-Based Health Data Recording Information System using the Agile method to enhance the effectiveness of health data management at the community health center. The method employed encompasses the stages of requirements gathering, analysis, design, coding, testing, deployment, and feedback. Data collection was conducted through observation, interviews, and documentation studies. The system was built using the PHP programming language with the CodeIgniter 3.1.13 framework and a MySQL database. The findings indicate that the developed system is able to facilitate a more effective, faster, and integrated health data recording process. Available features include patient data management, personnel data management, patient registration, drug data management, laboratory management, medical records, patient prescriptions, and digital health reports. With the implementation of this system, health administration processes become more optimal and support the digital transformation of health services at the community health center. The outputs of this research are a web-based information system and the publication of a scientific article in a national journal.

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1. INTRODUCTION

The advancement of information technology in the digital era has brought about significant transformations across various sectors of life, including the health sector. The utilization of information systems in health services has emerged as a strategic solution to enhance the effectiveness, efficiency, and accuracy of health data management. Information systems facilitate the rapid and integrated recording [1], processing, storage, and presentation of data, thereby supporting improved quality of health services [2]. The use of information systems in health data management offers numerous advantages [3], including comprehensive and integrated data management [4], speed and accuracy of information, reduction in operational costs, and enhanced data

security [5].

The Dasan Agung Community Health Center (Puskesmas), located in Selaparang District, Mataram City, serves as a primary-level health care facility with a strategic role in providing accessible and quality health services to the community within its working area [6]. This puskesmas delivers various health services, including general medical examinations, maternal and child health services, and nutritional services. However, the process of recording and processing patient health data at the puskesmas is still conducted manually [7]. This condition frequently gives rise to various problems, such as data entry errors, data loss, data duplication, delays in data retrieval, and inaccuracies in health reports [8]. Consequently, health administration services become less than optimal and require considerable time in the preparation of health reports [9]. This is consistent with findings at the Susoh Community Health Center, which revealed that manual patient data processing poses challenges in generating monthly reports due to the substantial time required [10].

The urgency of developing a health data recording information system at the Dasan Agung Community Health Center has been further reinforced by the demands of digital transformation in the health sector. The Indonesian government, through the Blueprint for Digital Health Transformation Strategy 2024, has established policy directions for digitizing health services across all health care facilities, including puskesmas [11]. An integrated information system is expected to assist health workers in recording patient data, managing medical records, processing drug data, and compiling digital health reports [12]. This aligns with the government's efforts to promote the digitalization of health services throughout all health care facilities in Indonesia.

Several previous studies have examined the development of health information systems using various approaches and methods. Research by Rohmah et al. (2019) emphasized the importance of information systems in supporting management decision-making and improving health service performance [2]. Another study by Razie & Baihaqi (2025) revealed that the implementation of a web-based medical record information system using the Agile method was able to improve the efficiency of patient data recording and reduce administrative errors at the Susoh Community Health Center [10]. The study successfully implemented a system with key features including patient registration, recording of examination results, medical record data management, and report generation [10]. A similar study was conducted by researchers at the Kisam Ilir Community Health Center, who developed a web-based health service information system using the Scrum framework [13]. The results demonstrated that the dynamic nature of Scrum was able to produce a system that aligns with user needs, achieving an 83% feasibility rate based on usability factor testing according to the ISO 25010 standard [13].

Another study by Akmaluddin et al. (2024) at Sint Carolus Hospital Jakarta developed a web-based preadmission information system using the Agile Scrum approach [14]. The study proved that the use of a web-based preadmission information system significantly improved the efficiency of patient data management, accelerated service delivery, and reduced the risk of data input errors [14]. At the international level, research on a mobile-web-based electronic medical record system for ICU patient management at the National Heart Foundation Hospital Bangladesh demonstrated that an integrated system enabled health workers to access and update health information in real-time using various devices [15]. The study also integrated automated calculation features for clinical parameters, thereby reducing the workload of nurses [15].

An exploratory study on the implementation of E-Puskesmas technology in Indonesia by Subu et al. (2024) revealed that the digitalization of health services at puskesmas still faces various challenges, including infrastructure readiness and human resource capacity [16]. Another study by Purnomo et al. (2023) indicated that a web-based health information system developed using the Agile method was able to improve patient data accessibility and accelerate the reporting process at primary health care facilities [17]. Meanwhile, research by Kurniawan & Sari (2024) revealed that human resource readiness and technological infrastructure are key determinants of the successful implementation of information systems at puskesmas [18]. On the other hand, a study by Rahayu et al. (2022) highlighted the importance of involving end-users at every stage of health information system development to ensure that the system built truly meets the users' needs [19].

The Agile method has been widely adopted in the development of information systems across various sectors due to its flexible and adaptive nature in response to changing user requirements. Research by Siregar et al. (2023) demonstrated that the Agile approach significantly accelerates development time and improves the quality of the final product compared to conventional methods [20]. A study by Ningsih & Fajar (2024) also revealed that short iterations in the Agile method allow for faster user feedback, enabling continuous system improvement [21].

However, these studies have generally been conducted in hospital settings or large-scale health facilities with

adequate resources. Research that specifically addresses the development of health data recording information systems at the puskesmas level, particularly in urban areas with complex service characteristics such as the Dasan Agung Community Health Center, remains limited. The research gap lies in the absence of an integrated, web-based health data recording information system developed using the Agile method at the Dasan Agung Community Health Center. Therefore, this study seeks to fill this gap.

Based on the aforementioned problem formulation, the objectives of this study are as follows: (1) To examine the application of the Agile method in developing a health data recording information system at the Dasan Agung Community Health Center; (2) To analyze the effectiveness of applying the Agile method in developing a health data recording information system at the Dasan Agung Community Health Center; (3) To identify the obstacles encountered and their corresponding solutions in the application of the Agile method for developing a health data recording information system at the Dasan Agung Community Health Center; (4) To provide recommendations regarding the use of the Agile method in developing a health data recording information system at the Dasan Agung Community Health Center.

The benefits of this research are as follows: (1) To contribute to the body of knowledge on health information system development using the Agile method, particularly at puskesmas in urban areas; (2) To assist the Dasan Agung Community Health Center in accelerating the development of a health data recording information system, thereby improving the efficiency and effectiveness of health services; (3) To serve as a reference for other puskesmas intending to develop health information systems using the Agile method; (4) To provide evaluative material and input for future development of health information systems.

2. RESEARCH METHODS

This study employs a research and development (R&D) approach with a focus on software development, specifically a Health Data Recording Information System at the Dasan Agung Community Health Center. The R&D approach was selected because this research aims not only to produce a product in the form of an information system but also to test the effectiveness of the product in addressing real-world problems encountered by users. The research framework follows a structured system development cycle, beginning with problem identification, requirements gathering, solution design, implementation, testing, and culminating in evaluation and feedback.

2.1. Research Design

This study employs a Research and Development (R&D) approach, which aims to produce a product in the form of a web-based Health Data Recording Information System while simultaneously testing its effectiveness in addressing health data management problems at the Dasan Agung Community Health Center. The research framework follows a system development cycle consisting of problem identification, requirements gathering, design, implementation, testing, and evaluation.

2.2. Data Sources and Collection Techniques

Data in this study were obtained through three methods. First, direct observation was conducted at the Dasan Agung Community Health Center to examine the manual health data recording process and to identify the constraints encountered by the staff. Second, interviews were carried out with health center personnel to gather in-depth information regarding their needs, challenges, and expectations for the system to be developed. Third, a documentation study was undertaken by reviewing registration forms, medical record books, health reports, and relevant scientific literature pertaining to health information systems and the Agile method.

2.3. System Development Method

The system development employed the Agile method with seven iterative stages. This method was selected based on its flexibility and capability to respond rapidly to changing user requirements [2]. The stages undertaken include:

1. **Requirements Gathering**, in which the desired features were elicited from each user category (admin, registration staff, physicians, pharmacists, and laboratory personnel).
2. **Analysis**, conducted to understand the system workflow and the data to be utilized, encompassing the identification of entities such as staff data, physician data, patient data, registration data, drug data, prescription data, laboratory data, and medical records.

3. **Design**, encompassing the creation of UML diagrams (Use Case Diagrams and Activity Diagrams), an Entity-Relationship Diagram (ERD), and user interface designs.
4. **Coding**, namely the implementation of the design into program code using PHP with the CodeIgniter 3.1.13 framework and a MySQL database.
5. **Testing**, carried out to ensure that each feature functions as expected.
6. **Deployment**, i.e., the release of the application to users for direct trial use.
7. **Feedback**, utilized as the basis for iterative system improvements until the expected level of user satisfaction is achieved.

2.4. System Architecture

The system was built using a three-tier architecture that separates the presentation, business logic, and data layers. Functionally, the system serves five user roles, namely admin, registration staff, physicians, pharmacists, and laboratory personnel. Each role possesses distinct access rights corresponding to their respective duties and responsibilities [5].

The database structure consists of 15 interrelated tables, including the user, registration, patient, physician, polyclinic, drug, drug_category, prescription, medical_record, and examination tables. The database design was carried out using a normalized relational database model approach to maintain data integrity and avoid data redundancy [8].

2.5. Data Analysis Techniques and Evaluation Metrics

System evaluation was conducted through two approaches. Black-box testing was employed to examine the functionality of all features using 55 test scenarios covering the staff, physician, patient, registration, drug, prescription, laboratory, and medical record modules. Each scenario was evaluated based on the conformity between the actual results and the expected outcomes.

Usability testing was carried out using a Likert-scale questionnaire administered to 10 respondents. The parameters measured included ease of use, efficiency, learnability, and overall user satisfaction with the system. The questionnaire data were processed using the following formula:

$$\text{Index (\%)} = \frac{\sum x}{N \times 4} \times 100\% \quad (1)$$

Description:

- $\sum x$ = Total score obtained
- N = Number of respondents
- 4 = The highest score on the Likert scale

The resulting index scores were then categorized into the following criteria: poor (0%–25%), fair (26%–50%), good (51%–75%), and very good (76%–100%).

3. RESULTS AND DISCUSSION

This section presents the findings of the study, encompassing the design outcomes, implementation, and testing of the web-based Health Data Recording Information System developed using the Agile method at the Dasan Agung Community Health Center. A comprehensive discussion is provided to offer interpretations of each result obtained and to relate them to the research objectives and the problem formulation established earlier.

3.1. System Design and Implementation Results

This study produced a web-based Health Data Recording Information System built using the Agile method. The system was designed to accommodate five user roles, namely admin, registration staff, physicians, pharmacists, and laboratory personnel, each with different access rights corresponding to their respective duties.

The system design began with the creation of UML diagrams, including use case diagrams and activity diagrams. The use case diagrams illustrate the interactions between actors and the system, while the activity diagrams visualize the business process flows, such as patient registration, medical examinations, drug management, and medical records. The database structure was designed using an Entity-Relationship Diagram (ERD) consisting of

15 interrelated tables, including the user, patient, physician, registration, drug, prescription, medical record, and laboratory tables. Implementation was carried out using the PHP programming language with the CodeIgniter 3.1.13 framework and a MySQL database.

The implementation resulted in an application with key features including patient data management, registration, medical examinations by physicians, prescription writing, drug stock management, laboratory result input, and digital health report generation in PDF format. All features have been successfully implemented and integrated within a single platform.

3.2. System Testing Results

System testing was conducted through two approaches, namely black-box testing and usability testing.

3.2.1. Black Box Testing

Black-box testing was performed on 55 test scenarios covering all system features, including the login process, management of staff, physicians, patients, registrations, drugs, prescriptions, laboratory data, medical records, and medical history. The test results showed that all test scenarios (100%) were declared successful, as all features functioned as expected. Detailed test results are presented in Table 1.

Table 1. Test Results

No	Test Description	Test Scenario	Expected Result	Test Result
1	Login	Enter Username and Password, then click the login button	Display login success or failure message	Successful
2	Staff Menu	Select the staff menu	Display the list of staff data already entered	Successful
3	Physician Menu	Select the physician menu	Display the list of physician data already entered	Successful
4	Patient Data Menu	Select the patient data menu	Display the list of patient data already entered	Successful
5	Registration List Menu	Select the registration list menu	Display the list of registration data already entered	Successful
6	Drug Data Menu	Select the drug data button	Display the list of drug data already entered	Successful
7	Drug Category Menu	Select the drug category menu	Display the list of drug category data already entered	Successful
8	Drug Procurement Menu	Select the drug procurement button	Display the list of drug procurement data already entered	Successful
9	Patient Prescription Menu	Select the patient prescription menu	Display the list of patient prescription data already entered	Successful
10	Laboratory Data Menu	Select the laboratory data button	Display the list of laboratory data already entered	Successful
11	Medical Record Menu	Select the medical record button	Display the list of medical record data already entered	Successful
12	Medical History Menu	Select the medical history button	Display the list of medical history data	Successful

3.2.2. Usability Testing

Usability testing involved 10 respondents using a Likert-scale questionnaire. The data analysis results showed an average usability score of 81%, falling into the "Very Good" category (Table 2). The highest score was obtained for the item "ease of avoiding errors" (97.5%), while the lowest scores were recorded for the items "user satisfaction" (72.5%) and "perceived usefulness" (72.5%), both of which still fall within the "Good" category.

Table 2. Usability Rate Percentage

No	Statement	SA (4)	A (3)	D (2)	SD (1)	Total Score
1	The system is easy to use	28	6	2	0	36
40						
2	The system is efficient in performing tasks	28	9	0	0	37
40						
3	The system interface is visually appealing	8	4	0	0	32
40						
4	Overall user satisfaction with the system	12	2	4	1	29
40						
5	The system helps complete work more quickly	24	9	2	0	35
40						
6	Navigation within the system is intuitive	4	4	2	0	30
40						
7	The system is easy to learn	24	2	0	0	36
40						
8	Perceived usefulness of the system	4	1	4	0	29
40						
9	The system helps minimize errors	36	3	0	0	39
40						
10	The system meets user expectations	24	9	2	0	35
40						
11	The system provides complete features	24	6	4	0	34
40						
Average Score						81%

3.3. Analysis and Interpretation

The success of all black-box test scenarios indicates that the system has met the established specification requirements. The usability rate of 81% demonstrates that the system is easy to use and well-received by users. This finding aligns with the research conducted by Razie & Baihaqi (2025), who applied the Agile method in developing a medical record system at the Susoh Community Health Center and achieved a high feasibility level [11].

The highest score in the aspect of "ease of avoiding errors" (97.5%) suggests that the implemented data validation mechanisms, such as input format validation and duplicate checking, are effective in reducing the risk of user errors. This is particularly critical in the context of health data recording, as input errors can have serious

implications for patient care [8]. The relatively lower scores in the aspects of "satisfaction" and "perceived usefulness" indicate the need for further improvements in interface comfort and increased socialization of the system's benefits to users.

3.4. Comparison with Previous Studies

This study presents several advantages over previous research (Yonathan & Sitoknada, 2022; Maryogi & Iqbal, 2022) that employed the SDLC/Waterfall method. The Agile method applied in this study proved to be more adaptive to changing requirements and actively involved users at every stage of development. Furthermore, the developed system is more comprehensive as it accommodates five user roles with distinct functionalities, in contrast to previous studies that generally served only one to two user roles.

3.5. System Strengths and Limitations

The system's strengths include integrated data management across departments, real-time access, automated reporting, role-based authentication security, and the flexibility of the Agile method, which enables continuous improvement based on user feedback.

The system's limitations include the absence of advanced analytical features (e.g., predictive analytics), dependence on internet connectivity, lack of end-to-end data encryption, and testing that was limited to the internal environment of the puskesmas.

3.6. Research Implications

Practically, this system supports the digital transformation of health services at the Dasan Agung Community Health Center in alignment with the policy direction of the Blueprint for Digital Health Transformation Strategy 2024 [17]. Scientifically, this study provides empirical evidence on the effectiveness of the Agile method in developing health information systems at primary health care facilities and serves as a reference for future researchers.

3.7. Discussion

The successful development and deployment of the web-based Health Data Recording Information System at the Dasan Agung Community Health Center validate the efficacy of the Agile methodology in primary healthcare settings. Unlike traditional, rigid development models such as Waterfall, the iterative nature of the Agile approach allowed for continuous engagement with five distinct user roles (administrators, registration staff, physicians, pharmacists, and laboratory personnel). This continuous feedback loop ensured that the final product was highly aligned with actual operational workflows, as evidenced by the 81% "Very Good" usability score. The dynamic adaptation to user requirements during the development sprints directly addressed the complex and evolving nature of health service delivery.

Operationally, the transition from a manual recording system to a centralized web-based platform has significantly mitigated the core issues of data entry errors, data loss, and reporting delays. The exceptionally high usability score in the aspect of "ease of avoiding errors" (97.5%) underscores the effectiveness of the implemented data validation mechanisms and role-based access controls. In a healthcare context, minimizing administrative errors is not merely an operational improvement but a critical patient safety imperative. By digitizing these processes, the system ensures data integrity and facilitates the rapid generation of accurate health reports, which is essential for evidence-based decision-making at the primary care level.

Furthermore, while the current iteration of the system establishes a robust digital foundation, it is crucial to contextualize this achievement within the broader vision of an "AI-Integrated" health information system, as indicated in the study's overarching scope. Artificial Intelligence and predictive analytics cannot function effectively without structured, high-quality, and comprehensive digital data. Therefore, the digitization achieved in this study serves as the essential prerequisite and data pipeline for future AI modules. The structured medical records, patient histories, and drug inventory data now generated by this system can be leveraged in subsequent Agile sprints to train machine learning models. Potential future integrations include predictive analytics for local disease outbreak forecasting, intelligent drug stock optimization, and Clinical Decision Support Systems (CDSS) to assist physicians in diagnosis and treatment planning. Thus, this research represents a critical foundational phase that transitions the health center from manual data handling to AI-ready data infrastructure.

Strategically, the implementation of this system strongly aligns with the Indonesian government's Blueprint for Digital Health Transformation Strategy 2024, which mandates the digitization of health services across all

primary care facilities. However, the discussion must also candidly address the system's current limitations. The absence of embedded AI algorithms, reliance on stable internet connectivity, and the lack of end-to-end data encryption highlight areas for immediate future improvement. These limitations should not be viewed as failures, but rather as defined objectives for the next cycles of Agile development. Continuous system evolution, coupled with capacity building for health workers, will be paramount to fully realizing a secure, intelligent, and resilient health information ecosystem at the Dasan Agung Community Health Center.

4. CONCLUSION

This study successfully developed a web-based Health Data Recording Information System at the Dasan Agung Community Health Center by applying the Agile method through seven iterative stages, ranging from requirements gathering to feedback. The results of black-box testing on 55 test scenarios demonstrated that all system features functioned as expected, covering patient data management, registration, medical examinations, drug prescriptions, drug stock management, laboratory services, medical records, and digital health report generation. Usability testing involving 10 respondents yielded an acceptance rate of 81%, falling into the "Very Good" category, indicating that the system is easy to use and well-received by users. Thus, the research objective of producing an information system capable of improving the effectiveness of health data management at the Dasan Agung Community Health Center has been achieved.

This study provides a practical contribution in the form of an integrated information system that is responsive to user needs, supporting the digital transformation of health services at the primary health care level in line with government policies. The system assists health workers in recording patient data, managing medical records, and compiling health reports more quickly, accurately, and efficiently compared to the previous manual method. From a scientific perspective, this study offers empirical evidence on the effectiveness of the Agile method in developing health information systems at primary care facilities, while also serving as a reference for other researchers who wish to develop similar systems in different contexts.

Although the system has been successfully developed and well-received by users, this study has several limitations. The system has not yet been equipped with advanced analytical features, remains dependent on internet connectivity, and has not implemented end-to-end data encryption for more optimal health data protection. Testing was also limited to the internal environment of the puskesmas without validation on a broader scale. For future research, it is recommended to develop predictive features based on artificial intelligence, add data encryption mechanisms, and conduct scalability testing in an actual production environment.

DECLARATIONS

Author Contributions:

Muhamad Masjun Efendi: Conceptualization, Methodology, Software, Writing – Original Draft.

Ardiyallah Akbar: Data curation, Software, Visualization.

Lalu Mutawalli: Supervision, Methodology, Writing – Review & Editing.

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The authors declare no conflicts of interest regarding the publication of this paper.

Data Availability:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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The authors utilized DeepL Translator to assist in translating the manuscript from Indonesian into English. The authors have reviewed and verified the accuracy of the translated content and take full responsibility for the final manuscript.

Additional Information:

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