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A WEB-BASED MANAGEMENT INFORMATION SYSTEM FOR ISLAMIC BOARDING SCHOOLS USING THE WATERFALL METHOD

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Abstract

This research is motivated by the limitations of administrative services and information delivery at *PP Mabit* which still uses conventional methods, so that the development of a Web-Based Service Management Information System for the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) was carried out. The Waterfall method was chosen as the system development method, which consists of the stages of needs analysis, system design, implementation, and testing. Standard web technology was chosen in the front-end based system development process to produce a simple and easy-to-use interface. The black box testing method was used to evaluate the function of each front-end feature based on user activity. The test results have an impact on the function of features in the system according to functional requirements. The developed system is expected to be a solution to improve information accessibility and support administrative services at *PP Mabit*.

Keywords: Information system, Web-based system, Waterfall method, Front-end development, Blackbox testing.

1. Introduction

In the world of education, referring to Government Regulation of the Republic of Indonesia Number 19 of 2003, it is explained that there are graduate competency standards that must be achieved by students. Educational standards can be achieved through three types of education, namely informal, formal, and non-formal education. Formal education is a form of education that is structured and organized by official institutions, such as schools or universities, with the aim of achieving certain knowledge, skills, and values through the curriculum implemented by the school or university [1].

In addition, it is contained in the Law of the Republic of Indonesia Number 11 of 2008 concerning Information and Electronic Transactions (UU ITE) which is the legal basis that regulates the use of information technology, electronic systems, and electronic transactions in Indonesia, becoming the legal basis for continuity in the development of front-end web-based management information systems for services in educational institutions in Indonesia [2].

The development of information and communication technology has driven rapid transformation in the world of education, particularly in the area of governance management in various countries [3]. One of the most significant roles is information systems, which serve as a strategic component in supporting administrative efficiency, structured data management, and can improve the quality of services in educational institutions [4]. Integrated information systems can increase transparency and support data-driven decision-making processes, resulting in more systematic management.

Management Information Systems (MIS) play a strategic role in modern educational institutions, focusing on effectiveness, efficiency, and accountability [5]. Serving as a means of data management and administration, management information systems can have a positive impact, resulting in structured and integrated data [6].

To address this need, this research aims to design and implement a structured, web-based Management Information System (MIS) specifically for Islamic boarding schools (*pesantren*). The primary objective is to engineer a robust digital platform using the systematic Waterfall methodology to streamline student service administration, centralize data management, and automate key operational workflows. The study seeks to evaluate the system's efficacy in enhancing administrative efficiency, improving service quality for students and stakeholders, and fostering data-driven decision-making within the unique, integrated educational environment of *pesantren*, thereby contributing to their digital transformation.

2. Front-End Engineering Process

2.1. System development method

The development of a web-based service management information system for the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) uses the waterfall method as the system development life cycle (SDLC) method used in this research. Waterfall was chosen because it has structured, systematic, and well-documented development stages, allowing it to adapt to relatively clear and stable needs from the initial stage [7].

The waterfall method consists of several sequential stages, each of which must be completed perfectly before proceeding to the next. In the context of educational information system development, the waterfall method is widely used because it can realize user needs in an organized manner and produce a stable and easily tested system [8]. Previous research provides information that the waterfall method is still relevant and effective for use in the development of web-based management information systems, especially in educational environments that greatly require a clear development flow and gradual functional validation.

The stages of system development using the waterfall method in this study include several stages, including needs analysis, system design, implementation, and system testing [9]. Each stage is designed with the aim of ensuring that the front-end system developed is able to meet the needs of administrative services at the Bina Tauhid Student Islamic Boarding School (*PP Mabit*), especially in managing student data and delivering information efficiently and easily accessible to users.

2.2. Requirements analysis

The requirements analysis stage is the initial stage used in system development using the waterfall method. Its purpose is to gather information and identify comprehensive system requirements. This stage focuses primarily on understanding user issues and determining the functional and non-functional requirements of the Web-Based Service Management Information System for the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) to be developed.

The needs analysis was conducted through direct observation of the ongoing administrative processes at *PP Mabit*. In addition to the observations, interviews were conducted with Islamic boarding school officials to gain an overview of the process. Student administration, information delivery, and data management at Islamic boarding schools are still carried out conventionally. Analysis shows that the current system is not yet integrated, resulting in delayed access to information, data inconsistency, and low efficiency in the service Islamic boarding school administration.

Based on the analysis, the system's functional requirements include providing a front-end capable of displaying and processing student data, supporting Islamic boarding school administrative services, and providing structured and easily understandable information to users. Furthermore, the system must offer transparent navigation to allow users to access each service easily and quickly. This requirements analysis stage serves as a foundational step that continues with the next stage, system design. Clearly defined requirements are expected to minimize changes encountered during the implementation phase and ensure the developed system meets the administrative service needs at *PP Mabit*.

2.3. System design

The system design phase aims to translate the identified system requirements. The identified system was obtained in the initial requirements analysis stage, which will then be used to develop a structured technical design. System development focuses on the front-end development of the Web-Based Service Management Information System for the Bina Tauhid Student Islamic Boarding School (*PP Mabit*). The developed information system is expected to effectively support the Islamic boarding school's administrative processes, enabling users to access it easily and quickly.

Figure 1 illustrates the front-end system architecture of the Web-based Service Management Information System developed for the Bina Tauhid Student Islamic Boarding School (*PP Mabit*). Website users can access the website through available software such as Chrome, Microsoft Edge, and Firefox, which function as a link between the user and the front-end application. The language used in building the front-end of the *PP Mabit* web-based management information system utilizes simple programming languages, namely HTML, CSS, and JavaScript, which are used to manage user activities. The backend and database only serve as external supports that have a function as data storage, not as the main objective of this research is to emphasize interface design and user experience to make the Islamic boarding school administration services easier to use.

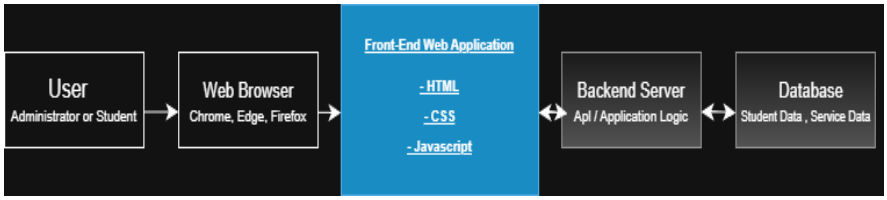

Fig 1. Front-end system architecture of *PP Mabit*.

Front-end design consists of navigation structure, page layout, and user interface design. The navigation structure is arranged hierarchically to ensure optimal access to each service. The interface design takes into account usability and user-centred design principles, ensuring users can easily understand and operate the system without requiring special training [10].

At this stage, the visual design and structure of the system pages are based on the creation of wireframes and mock ups as a basic reference for application or implementation. With a clear and well-documented system design, the implementation phase can be carried out in a more focused manner and in accordance with predetermined needs [11]. The system design stage serves as a bridge between requirements analysis and system implementation. The resulting design is expected to minimize errors during the development stage and achieve high usability and accessibility resulting from the front-end system.

2.4. Implementation

The implementation stage is the stage of implementing the design, carried out after the system design has been prepared at the system design stage, so that the system can be run. In this study, implementation focuses on the front-end development of a web-based service management information system for the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) in accordance with the established functional requirements.

Front-end implementation uses standard web development languages: HTML for page structure, CSS for interface layout and display, and JavaScript to support user interface interactions [12, 13]. These programming languages are chosen to produce a system that is easy to develop and can be implemented in web browsers. This implementation phase was developed based on the wireframe and mock up designs that had been created [14].

The main page was designed as a navigation centre that directs users to various *PP Mabit* administrative services. Meanwhile, the authentication page was used to restrict access according to user roles. The student administration service and information delivery pages were developed with a structured and systematic display, with the aim of presenting them clearly and easily understood [15, 16].

The implementation also pays attention to consistency in design and usability, ensuring that each interface component has clear benefits and is easy to operate [17-19]. The result of the implementation phase is a front-end web-based Service Management Information System for the Bina Tauhid Student Islamic Boarding School that functions visually and interactively. The system, designed and developed after the implementation phase, enters the testing phase to ensure all functions run smoothly and meet the neatly organized user needs.

2.5. Testing method

The testing phase aims to ensure that the web-based service management information system of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) functions as intended. System testing focuses on the front-end, verifying the system's design appearance, user interface interactions, and the functional suitability of the developed system.

Blackbox testing was chosen as the testing method used in this study because it focuses on behaviour based on provided input without using internal program code [20]. Blackbox testing aligns with functionality testing, particularly on the front-end, and ensures that each feature can be used effectively by users [21].

Testing was conducted by testing each menu and features contained in the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*), such as the main page, registration, dashboard, achievements, news, and announcements, and the PKD page. Each function was tested based on the needs that had been reviewed and determined to ensure that the developed system was able to display information that was in accordance with the needs and respond to user access properly and correctly.

Table 1 presents the results of the black box testing on the front-end of the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*). The focus of the black box testing method was to evaluate the functions of the existing features by observing the system's response without using programming code. Testing was conducted on all menus of the developed system, such as the main page, login page, dashboard, achievements, news and announcements, and the menu page about PKD. The test results had a positive impact on both the system itself and the users, who were expected to be able to provide answers to all user needs and respond to user actions well and optimally.

The test results provided positive results, indicating that all of the system's main features functioned well and met its functions and requirements. The developed front-end system was declared valid because no functional errors were found that could hinder its use. Therefore, the system is ready to be used as a tool for administrative services and information delivery at *PP Mabit*. Through systematic testing, frequently occurring errors were minimized, resulting in a high level of usability for the resulting system.

Table 1. Blackbox testing result of the front-end system.

Feature/Page	Test Scenario	User Input/ Action	Expected Result	Test Result
Main Page	Accessing the main page	Open System URL	Main page is displayed with correct layout and menus	Pass
Login Page	Display login form	Click login menu	Login form is displayed properly	Pass
Login From	Empty input validation	Click login button without input	Warning message is displayed	Pass
Registration Page	Display registration from	Click registration menu	Registration from is displayed correctly	Pass
Menu Navigation	Page navigation	Click dashboard/ news menu	Target page is displayed correctly	Pass
Dashboard Page	Display main information	Access dashboard page	Information is displayed in a structured manner	Pass
Achievements Page	Display achievements information	Click achievements menu	Achievements are displayed	Pass
News and Announcement	Display Information list	Click news menu	News and announcements are displayed	Pass
User Interface Interaction	Button and menu interaction	Click buttons and menus	System responds correctly to user interactions	Pass

2.6. Experimental setup

The experimental setup was conducted to evaluate the functionality of the developed front-end system [22]. Testing was conducted using computers and laptops with standard operating systems commonly used in administrative activities. Popular web tools such as Google Chrome and Microsoft Edge were utilized to ensure the system ran consistently across different browser environment [23]. The testing focused on the system's behaviour from a user perspective without involving source code

analysis. Therefore, this experimental setup served to ensure that the front-end system responded appropriately to every user action and met user needs [24].

2.7. Performance metrics

System performance measurements are conducted to assess the extent to which the front-end system can meet the established functional requirements. In this study, the performance assessment focuses on qualitative metrics related to the characteristics of the user interface-based system. The main metrics used to assess performance include functional accuracy, interface responsiveness, and navigation consistency. Functional accuracy assesses the extent to which system output matches user input for each tested feature. A feature is considered successful if the system can produce output that meets functional requirements without error [25, 26].

Interface responsiveness assesses how well the system can respond to user actions, such as pressing buttons, moving pages, and submitting forms, accurately and without interruption during interactions. Meanwhile, navigation consistency evaluates the stability of the flow of movement between pages, allowing users to continuously access all system features without encountering navigational obstacles.

A system feature is considered to meet performance standards if all test scenarios can be executed with the expected results. The application of these qualitative metrics provides a technical foundation for assessing the reliability and usability of the front-end system that supports administrative services at the Bina Tauhid Student Boarding School (*PP Mabit*).

2.8. System Functional Evaluation

The functional evaluation of the system aims to assess the front-end capability of the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) to effectively respond to all user needs. Each main menu including the main page, registration, dashboard, achievements, news, and announcements, and the PKD page will be evaluated to ensure the system developed meets its functionality and ease of access. The evaluation results show that the system is able to present consistent information, making it easier for users to access the services they need. In addition, the evaluation also prioritizes the responsiveness of the user interface implemented across various devices.

The system provides excellent adaptability to varying screen sizes, significantly enhancing the user experience [27]. This demonstrates that the front-end system has a high level of usability sufficient to support administrative activities at Islamic boarding schools. Overall, the functional evaluation results showed a positive result, indicating that the developed front-end system is capable of meeting design objectives and significantly improving the quality of Islamic boarding school administrative services [28].

2.9. System Validation and Verification

System validation and verification were conducted to ensure that the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) met user needs and was implemented according to the system

design. This stage aims to ensure system quality assurance and system readiness before implementation in the Islamic boarding school's operational environment.

The suitability of the system's functions to the identified user needs discussed in the requirements analysis stage is the primary focus of system validation. System validation is performed by testing each of the system's main features based on user flow [29]. The validated features are the main page, student registration, dashboard, achievement page, news, and announcements, and the PKD page. The validation results have a positive impact, indicating that the system is able to provide administrative services and information delivery in accordance with the main objective, namely development.

System verification is performed to ensure that the front-end implementation aligns with the system design reviewed and established during the system design phase. Verification includes examining the menu structure, interface navigation, system display consistency, and system responsiveness. The purpose of verification is to ensure each component within the system functions as intended. The system validation and verification process are conducted using black box testing as the primary method. Testing is conducted by providing input for each feature without viewing the program code [30]

3.System Implementation Result

Based on the results of the implementation carried out to assess the performance of the front-end of the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*), it was stated that the developed system successfully adapted to the stages that had been reviewed and determined. Each menu contained in the system was well designed to provide administrative services and information delivery capabilities in a structured and easily accessible manner to users.

Figure 2 shows the main interface of the *PP Mabit* Web-Based Service Management Information System. This page serves as an initial guide for users to access the features and other menus available within the system. The main page contains interface elements that facilitate user understanding of the system's structure such as navigation, general information, and visual components. The simple design is designed to allow users to interact with the system easily.

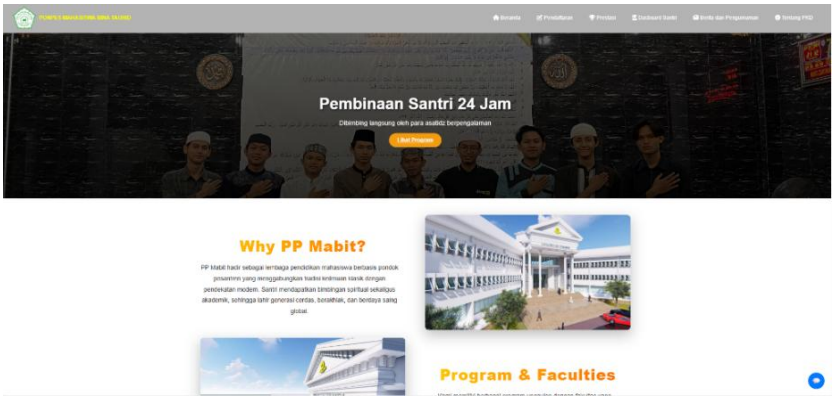

Fig 2. User interface of the main page.

A system that is built consistently and organized. This will make it easier for users to access their desired services. Based on functional testing results, all system features performed as planned and provided security against errors that could disrupt system usage. Thus, the front-end implementation met the requirements established during the system requirements analysis phase.

4. System Impact on Services

Implementation results for the developed system show that the system has successfully provided a positive impact and contributed to the increasing administrative services of Islamic boarding schools. The realization of a web-based service management information system can reduce system operations using manual methods, thereby providing time efficiency, and accelerating the performance of Islamic boarding schools.

The implementation of the front-end has a fast and accurate impact in disseminating information to students and Islamic boarding schools, which is displayed through news and announcement menus that are useful for increasing the effectiveness of communication facilities in the Islamic boarding school environment. In addition to the news and announcement menus, the dashboard menu and other menus can help managers to monitor information more systematically.

The results found in this study and in line with previous research resulted in increased efficiency, service, and the quality of data processing and information caused by the implementation of the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*), which uses the waterfall method as a system development method and black box testing as a system testing method. Thus, the Web-Based Service Management Information System of the Bina Tauhid Student Islamic Boarding School (*PP Mabit*) developed in this study can be a very influential solution in supporting digital transformation for educational institutions, especially Islamic boarding school educational institutions.

5. Conclusions

This study implemented the Waterfall method to engineer a front-end web-based Management Information System. Key conclusions are:

- The structured Waterfall methodology provided essential rigor for requirements analysis and design, enabling the development of a stable and well-documented system architecture.
- Comprehensive black-box testing validated all front-end functionalities, confirming the system's efficacy in enhancing information accessibility and streamlining administrative service delivery.

Abbreviations

Blackbox Testing	Software testing method focusing on functional behaviour without examining source code
CSS	Cascading Style Sheets
HTML	HyperText Markup Language
JavaScript	Client-side scripting language used for web interaction
MIS	Management Information System

PP Mabit	Pondok *Pesantren* Mahasiswa Bina Tauhid
SLDC	System Development Life Cycle
UI	User Interface
UX	User Experience

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