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Deploying SMS Gateway in the Design and Development of Web and Mobile Academic Information Systems using the Waterfall Method

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Abstract: The integration of technology in various sectors, beyond its common application in the gaming industry, has extended to the field of education. This evolution mandates parallel progress in academic institutions to keep pace with technological developments. A significant challenge identified was the reliance on manual accounting methods at SMAN 1 Kejobong, which includes teacher management, staff, and assistant administration, as well as processing student learning data. Outdated practices often lead to inaccuracies and inefficiencies, resulting in time-consuming data collection and potential losses for all stakeholders. To overcome this problem, it is proposed to implement a comprehensive information system or e-learning platform. However, the implementation of e-learning in educational institutions often encounters obstacles due to user discomfort or incompatibility with the institution's needs. This study validated all system features through Black box Testing and user satisfaction assessments, resulting in an average satisfaction level of 73.7%. The expected outcome is increased efficiency and accuracy in academic processes and student management, thereby facilitating a more effective learning and teaching environment.

Keywords: Information System; Academic; Web; Mobile.

1. Introduction

The realm of information technology, as a facilitator in creating, modifying, storing, and disseminating information, has profoundly impacted various sectors, not limited to the gaming world but also including industries like education [1][2][3]. The advancement of information technology has played a critical role in society, notably in simplifying access to information [4]. In today's fast-paced technological era, there is a prevalent trend among people to seek quick and accurate information amidst their daily activities [5]. In such an evolving landscape, system integration becomes a pivotal factor in maximizing efficiency and responsiveness within academic settings. Academic Information Systems (AIS) have become the cornerstone of higher education administration, offering a centralized platform for managing student data, academic schedules, and other pertinent information. However, the demand for more seamless integration between AIS and other systems has spurred the innovation of more comprehensive solutions.

Academic information systems are specifically designed to provide robust accessibility for students and educators [6]. They facilitate a range of academic administrative tasks, both online and offline, such as student admissions, class scheduling, grade tabulation, fee payments, and management of student and teacher databases. These systems enable educators to monitor and assess student progress effectively and provide a more efficient medium for material dissemination. Concurrently, students are afforded facilities for downloading materials, submitting assignments, and viewing grades. The integration of SMS Gateway in this context aims to enhance the integrity and accessibility of the AIS, facilitating better data exchange with other systems within and outside the educational environment.

SMAN 1 Kejobong exemplifies the educational commitment to nurturing Indonesia's future generations. With its ever-increasing student body, the school faces a growing demand for delivering precise and timely academic information without data redundancy. This situation necessitates an advanced information system tailored to SMAN 1 Kejobong

academic information dissemination needs. This research proposes the development of an Integrated Web-Based Academic Information System for SMAN 1 Kejobong, complemented by SMS Gateway technology [7]. This system is envisioned as a solution to provide swift, precise, and relevant information, greatly benefiting both educators and students. Yet, the existing academic information system at SMAN 1 Kejobong remains uncomputerized, predominantly relying on manual bookkeeping.

This reliance on traditional methods, such as bulletin boards or school magazines for information dissemination, proves inefficient, especially for students more inclined towards digital mediums [8]. This highlights a significant gap in the school's ability to effectively communicate important information to all students, particularly those with lesser interest in traditional reading formats. Consequently, the school needs to consider alternative communication strategies that align with contemporary student preferences and provide adequate facilities for comfortable access to information and learning activities. The current manual system, heavily dependent on paper documentation, is prone to data mismanagement and loss, making it challenging to access essential information like student, teacher, and grade records when needed. The proposed academic information system, empowered with SMS Gateway technology, aims to alleviate these issues by reducing manual data processing and enabling real-time access. This integration is expected to improve interoperability and coordination across various departments.

2. Research Method

The Waterfall model, a classic approach characterized by its sequential nature in software design, serves as the foundation of this study [9]. Adi Pradana Fata and Budi Apriyanto describe the Waterfall model as a systematic and sequential approach to software development [10]. This model, also known as the Sequential Linear Model or the Waterfall Model, is one of the oldest and most widely used paradigms in software engineering. It proposes a systematic, sequential development approach starting from the concept level and progressing through all stages including analysis, design, coding, testing, and maintenance.

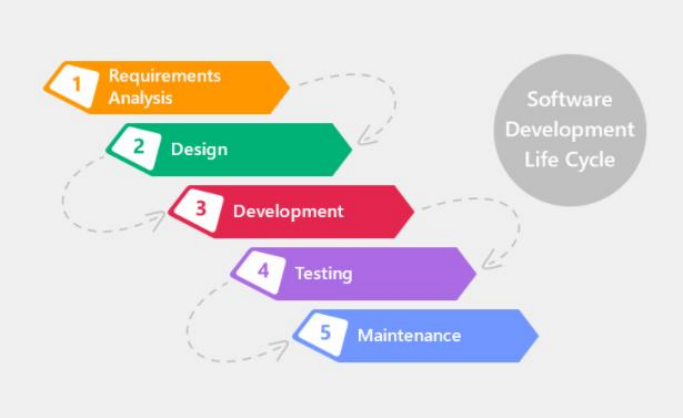


Figure 1. Waterfall method

The application of the Waterfall method in the design of the academic application includes the following stages:

1) Requirement Analysis The initial stage involves comprehending user requirements for the software. Methods such as discussions, observations, surveys, and interviews are employed to gather information. This information is then processed and analyzed to acquire a comprehensive understanding of user specifications.
2) System and Software Design Post Requirement Analysis, this stage analyzes the gathered specifications to guide the development design. The objective is to provide a detailed outline of the tasks to be executed. It also aids developers in preparing the necessary hardware for the overall system software architecture.
3) Implementation and Unit Testing This stage involves programming and dividing the software into smaller modules for subsequent integration. Concurrently, functionality tests are conducted on each module to ensure they meet the desired criteria.
4) Integration and System Testing Following the implementation phase, all developed units or modules are integrated into the complete system. This is followed by thorough system testing to identify any potential failures or errors.
5) Operation and Maintenance In the final stage of the Waterfall Method, the completed software is put into operation and maintenance is conducted. This stage allows for the correction of any undetected errors from previous stages. Maintenance includes error rectification, system unit implementation improvements, and system upgrades and adjustments as per evolving needs. For academic data processing needs, presenting information through a website can facilitate strategic organizational activities and provide necessary reports.

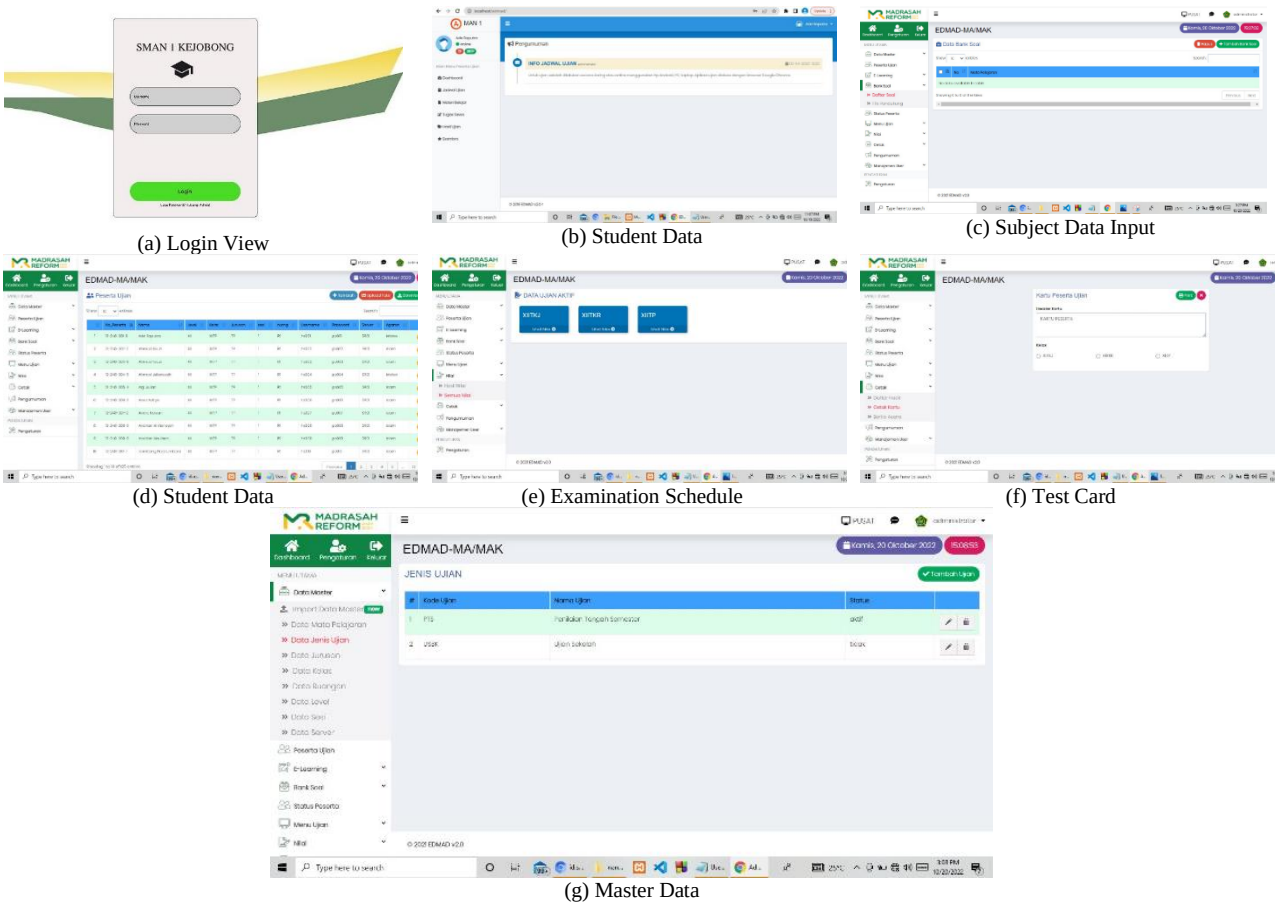
3. Result and Discussion

3.1 Results

Following the implementation in Visual Studio Code and XAMPP, the application was tested for its functionalities and features to ensure they align with the expected objectives.

Table 1. Application Testing Results

No	Feature Name	Expected Result	Actual Result	Status
1	Login	Successful login leading to the dashboard	Successful login and transition to dashboard	Success
2	Input Student Data	Successful input recorded in student table	Successful data entry shown in student table	Success
3	Input Course Data	Successful input recorded in course table	Successful data entry in course table	Success
4	Display Student Data	Successful display and input of student data	Successful display of student data	Success
5	Display Exam Schedule	Successful display of exam schedule	Successful display of exam schedule	Success
6	Display Exam Card	Successful display of exam card	Successful display of exam card	Success
7	Display All Master Data	Successful display and modification of master data	Successful display and edit of master data	Success



(a) Login View (b) Student Data (c) Subject Data Input

(d) Student Data (e) Examination Schedule (f) Test Card

(g) Master Data

Figure 2. Application View

Figures 2.a to 2.g depict various interface screens of the application, including Login, Student Data, Course Data Input, and others, demonstrating the successful implementation of each feature.

3.1.1. User Satisfaction Analysis

User satisfaction or user experience (UX) of a system can be measured using various methods, one being a questionnaire, an efficient tool for quantifying UX [11]. The survey was conducted among 20 respondents, comprising

10 IT professionals and 10 teachers from SMAN 1 Kejobong, aged between 25 to 50 years. The questionnaire consisted of questions as listed in Table 2, with responses ranging from 'strongly agree' to 'strongly disagree'.

Table 2. Respondent Assessment of the System

No	Question
1	I plan to use this system in the respective institution.
2	I find this system complex to use.
3	I find this system easy to use.
4	I need assistance from others or a technician to use this system.
5	I feel that the features of this system function as intended.
6	I feel there are many inconsistencies in the system.
7	I believe others will quickly understand how to use this system.
8	I find this system confusing.
9	I encounter no obstacles in using this system.

Figure 3 presents the user satisfaction levels towards the Web and Mobile-based Academic Information System. The results indicate that 5.3% of respondents were very dissatisfied, 15.8% dissatisfied, 5.3% moderately satisfied, 63.2% satisfied, and 10.5% very satisfied, resulting in an overall user satisfaction rate of 73.7%.

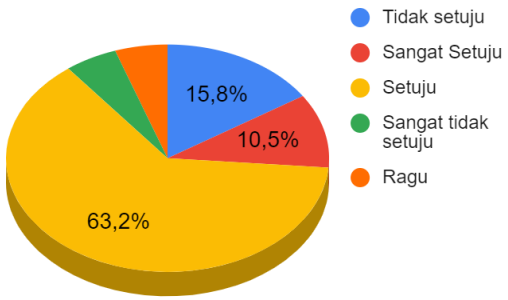


Figure 3. Level of user satisfaction with the system

3.2. Discussion

The development and implementation of the web and mobile-based Academic Information System at SMAN 1 Kejobong, employing the Waterfall methodology, have yielded significant insights into both the technical and user experience aspects of the system. The application's functionalities, as tested in Visual Studio Code and XAMPP, demonstrated a high degree of alignment with the predetermined objectives. Key features, including user login, data entry for students and courses, display of student data, exam schedules, exam cards, and master data, were implemented successfully, as evidenced by the positive outcomes in the application testing results (Table 1). This success is indicative of the system's technical feasibility and robustness, validating the effectiveness of the Waterfall model in guiding the software development process in a structured and systematic manner. However, the sequential nature of the Waterfall model also brings certain limitations, particularly in its inflexibility to accommodate changes once a stage is completed. This aspect could be a point of consideration for future projects, especially in dynamic educational environments where requirements may evolve during the development process. The user satisfaction analysis, conducted via a questionnaire among a diverse group of IT professionals and teachers, revealed a generally positive reception of the system. Most of the users (73.7%) expressed satisfaction with the system's usability and features. Notably, the simplicity and intuitiveness of the system were highlighted as key strengths, aligning with the goal of creating a user-friendly academic information platform. However, the feedback also brought to light areas for improvement. A small yet notable percentage of users found the system somewhat complex and confusing, indicating a need for more intuitive design or user training. The inconsistencies pointed out by some users suggest the potential for refining the system's interface and functionality to ensure a more seamless user experience.

The implementation of this system at SMAN 1 Kejobong represents a significant step towards digital transformation in the educational sector. The move from traditional, manual methods of information dissemination to a comprehensive, digitalized system not only enhances operational efficiency but also aligns the institution with modern educational standards. This transition is particularly crucial in catering to the needs of a digital-savvy student population, who are more inclined towards engaging with digital platforms for their educational needs. Future iterations of the system could benefit from incorporating agile methodologies, which offer more flexibility and adaptability to change. Additionally, continuous user feedback and iterative development could further refine the system, addressing the identified issues and evolving user requirements. Expansion of the system's capabilities, such as integration with more advanced data analytics tools and mobile app development, could also be explored to enhance its utility and reach. The development of the Academic Information System at SMAN 1 Kejobong, while successful in its current scope, opens avenues for further

enhancements and adaptations. The positive user response and the technical proficiency demonstrated in this project lay a strong foundation for ongoing improvement and innovation in academic information management.

4. Related Work

The development of academic information systems has been the focus of various research efforts, each employing distinct methodologies and targeting unique aspects of academic administration. In their 2021 study, Nita Ayunandita and Sampurna Dadi Riskiono explored the use of Extreme Programming in developing an academic information system for Madrasah Aliyah Mambaul Ulum Tanggamu. Their work emphasized simplifying the academic management system, integrating a feature for students to receive disciplinary points via SMS Gateway, highlighting the potential of agile methodologies in educational settings [12]. This approach aligns with the emerging trend of incorporating flexibility and rapid feedback in system development. Similarly, Muhammad Solahudin (2021) research focused on the design of a web-based School Academic Information System (SIA). The study underscored the importance of digitizing data processing and grade tabulation to minimize manual errors. However, the system faced challenges due to its ongoing development stage, emphasizing the need for comprehensive development and testing in educational software [13].

Firlo Amazon, Widiatry, and Viktor Handrianus Pranatawijaya (2021) utilized the Waterfall methodology to develop an academic information system for the Faculty of Mathematics and Natural Sciences. Their study demonstrated the effective use of ICT in educational administration, with successful black-box testing indicating the reliability of their website-based system [14]. This resonates with the broader context of academic information systems, where structured methodologies like Waterfall are employed to ensure systematic development and thorough testing. The role of websites as facilitators of information is crucial in this context. As Hakim (2004) explains, websites connect documents across local and distant scopes, enabling users to navigate between web pages through hyperlinks. This functionality forms the backbone of web-based academic information systems, allowing for the efficient dissemination of educational content and resources across various platforms [15]. Leitch and Davis definition of information systems as frameworks coordinating resources to transform inputs into outputs provides a foundational understanding of academic information systems. These systems are designed to meet the daily transactional, operational, managerial, and strategic needs of educational institutions, providing a structured approach to managing academic activities and information dissemination [15].

The need for rapid, accurate information in academic settings necessitates systems that are efficient and user-friendly. The development of academic information systems often involves replacing outdated systems or enhancing existing ones to address inefficiencies or problems. Using methodologies like Waterfall in this process ensures a systematic approach to system development, catering to the unique needs of academic institutions. In addition to these traditional approaches, the use of web-based SMS Gateways as a medium for delivering information on attendance and school fee payments exemplifies the integration of modern technology in academic systems. The adoption of prototyping and the SDLC model, employing tools like UML diagrams for initial design phases, further underscores the evolving nature of system development in education. This approach, with its emphasis on user interaction and feedback, as seen in the use of Gammu for SMS Gateway implementation, PHP frameworks for interface design, and MySQL for database management, reflects a trend towards more interactive and responsive educational systems [16].

5. Conclusion

This research has successfully achieved its goal of designing a web-based academic information system for SMAN 1 Kejobong, employing the Waterfall methodology. The developed system has proven effective in supporting the learning process, facilitating student data management, and providing structured end reports for students, administrators, and the school principal. These results indicate that the system can integrate the day-to-day school operations into an organized and efficient digital platform. The implementation of this system is expected to bring about significant changes in the teaching and learning processes at SMAN 1 Kejobong. With a focus on accuracy and precision of information, the system offers a solution that allows school principals, staff, and students to access and interact with academic data more efficiently. Furthermore, the digitization of reports and adherence to accounting principles contribute to the enhancement of data integrity and evidence-based decision-making processes. The final testing results of the application demonstrate its substantial potential in aiding the school's operations to become more systematic and computerized. This not only improves the operational efficiency of the school but also supports the school's vision in adopting digital technology to enhance educational quality. This study reaffirms the importance of integrating information technology in the academic environment. With the adoption of a web-based academic information system, SMAN 1 Kejobong has taken a significant step towards digital transformation, setting a new standard in effective and organized educational management.

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