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Developing an Efficient PPDB System Integrating Payment Gateway and Secure Exams

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Abstract- The New Student Admission (PPDB) process is a critical gateway for educational institutions. However, SMKS Jakarta 1 Pondok Kopi faced a significant 35.4% decline in applicants between 2021 and 2024 due to an inefficient and fragmented PPDB system. Key issues included an outdated information platform, a complex multi-platform registration flow, error-prone manual payment verification, and an insecure online exam system. This research aimed to develop a web-based integrated PPDB information system that consolidates all stages: registration, digital payments via a payment gateway, an online examination with anti-cheating features, and centralized announcements. Using the Waterfall development model, the system was evaluated in two stages. Black Box testing confirmed that all functionalities performed as expected. Furthermore, User Acceptance Testing (UAT) revealed a very high acceptance rate, achieving average scores of 4.48 out of 5.00 from student proxies and 4.50 from the committee, yielding a final interpretation of "Very Good." The practical implication of this system is a significant improvement in administrative efficiency, data accuracy, and modernization of the school's services. This research contributes by providing and validating an effective integrated PPDB system model, proving it to be a comprehensive solution for vocational education institutions.

Keywords: PPDB Information System, Waterfall Method, Payment Gateway, Online Exam

INTRODUCTION

The New Student Admission or Penerimaan Peserta Didik Baru (PPDB) process is a crucial annual agenda for educational institutions, acting as the primary channel for recruiting prospective students and a vital touchstone for the school's public image and sustainability (Depari et al., 2024). An effective PPDB process is characterized by efficiency, transparency, and accessibility. However, many institutions still rely on conventional or partially digitized systems that fail to meet these criteria, leading to administrative bottlenecks and a decline in public interest.

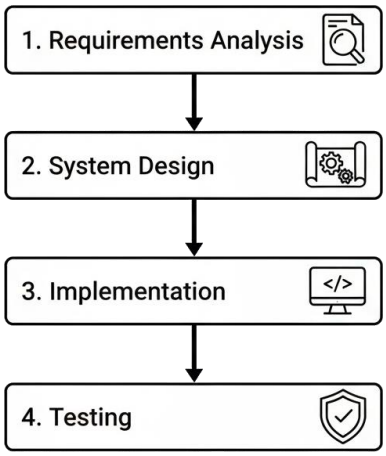
This issue is prominently observed at SMKS Jakarta 1 Pondok Kopi, which has experienced a significant decline in registrants over the past few years. Internal school data reveals a 35.4% drop in the number of applicants, from 212 in 2021 to only 137 in 2024. The root cause of this problem has been identified as an inefficient and highly fragmented PPDB system. The current system relies on a combination of an outdated Google Sites page for information, Google Forms for initial registration, and WhatsApp for payment confirmation (Chalim et al., 2025). This disjointed approach creates a convoluted process, further complicated by a manual payment verification system prone to human error and an insecure online exam method that fails to uphold academic integrity.

While previous research has explored the development of web-based PPDB systems, many focus on digitizing basic registration and announcement functionalities (Atmaja et al., 2024; Oktapiani et al., 2023). Some studies have incorporated online examinations (Simamora & Ridho, 2024), but often with limited security features. However, a significant research gap remains in the development of a fully integrated system that addresses the trifecta of modern administrative challenges: seamless automated payment verification, a secure online examination with explicit anti-cheating mechanisms, and a unified workflow from initial information seeking to final announcement. The existing literature often addresses these components in isolation, failing to provide a holistic and validated solution for institutions like SMKS Jakarta 1 that suffer from systemic fragmentation (Kumeriya et al., 2024).

Therefore, this research aims to address this gap by developing and validating a comprehensive, integrated web-based PPDB information system. The primary novelty of this study lies in the seamless integration of three critical components into a single, cohesive platform: 1) an automated payment system utilizing the Midtrans payment gateway to eliminate manual verification, 2) a secure online examination module with built-in anti-cheating features such as a countdown timer and tab-switching detection to ensure academic integrity (Huy, 2024), and 3) a centralized real-time announcement dashboard. By following the systematic approach of the Waterfall model, this study contributes a robust and validated system that not only resolves the specific inefficiencies at SMKS Jakarta 1 but also offers a replicable model for other educational institutions facing similar challenges.

RESEARCH METHOD

This research employed a structured software development approach using the Waterfall model. The Waterfall model was specifically selected due to its suitability for projects with well-defined, stable, and clearly understood requirements from the outset (Ghani et al., 2023; Khan & Mahadik, 2022). Unlike iterative models such as Agile, the sequential and linear nature of Waterfall ensures a disciplined progression that is ideal for developing a system where the core business process—student admission—is already established and not subject to frequent changes. The development lifecycle followed a series of distinct phases, as illustrated in Figure 1.

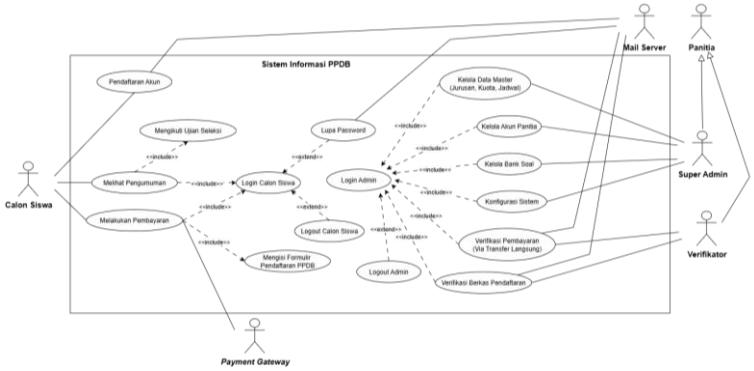


Source: Research Results (2025)
Figure 1. Research Methodology Flowchart (Waterfall Model)

The primary phases of the model were adapted for this research as follows:

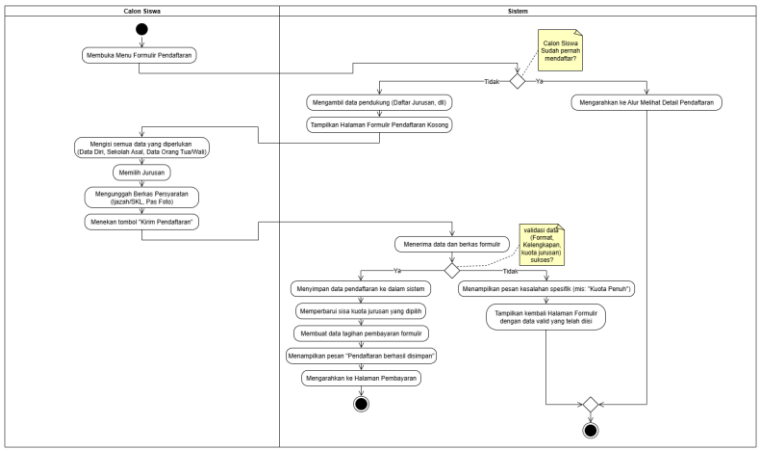
1. Requirements Analysis: The initial stage focused on systematically gathering and documenting functional and non-functional requirements. This was accomplished through a combination of semi-structured interviews with the SMKS Jakarta 1 PPDB committee, direct observation of the existing manual workflow, and a literature review.
2. System Design: In this phase, the documented requirements were translated into a technical blueprint. This involved designing the system architecture (MVC), data structures (ERD), and modeling the system's behavior and interactions using Unified Modeling Language (UML) diagrams, which will be detailed in the following sections.
3. Implementation: This phase involved writing the actual program code based on the approved designs, utilizing a specific stack of technologies.
4. Testing: The final phase comprised a rigorous two-stage testing process: Black Box Testing to verify functionality and User Acceptance Testing (UAT) to validate usability and user satisfaction.

Following the requirements analysis, a comprehensive design was formulated covering the functional, technical, and database aspects of the system. To define the system's scope and behavior, a functional design was created using standard UML diagrams. The functional scope was modeled from the user's perspective using a Use Case Diagram, as depicted in Figure 2. This diagram defines the interactions between external actors and the system's core functionalities (Nurlelah et al., 2023). The actors are categorized into human actors (Prospective Student, Verifier, Super Admin) and two crucial external system actors: a Mail Server for sending automated email notifications, and a Payment Gateway (Midtrans) for processing secure digital payment transactions. This model provides a clear separation of duties and maps all internal and external interactions required for the system.



Source: Research Results (2025)
Figure 2. System Use Case Diagram

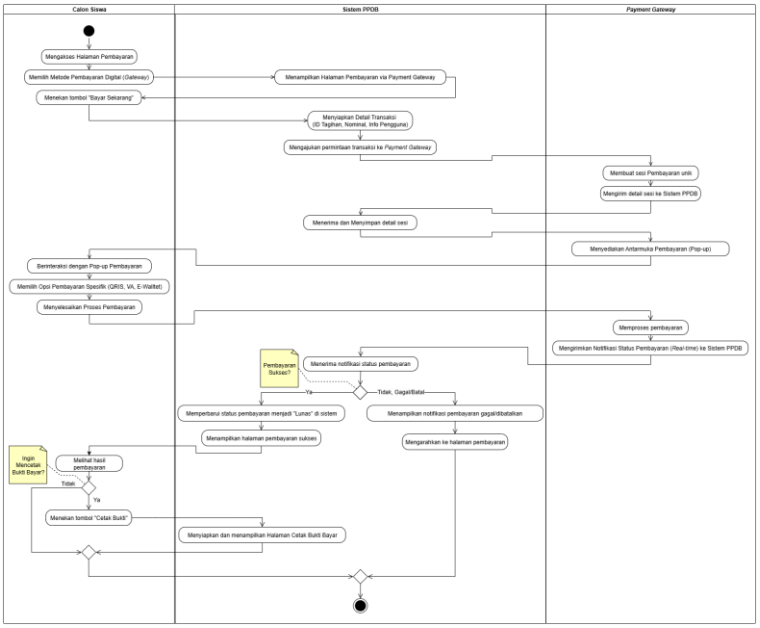
To detail the workflow of key use cases, Activity Diagrams were created. These diagrams visually represent the flow of control and the sequence of actions for major processes within the system (Saputro et al., 2023). Swimlanes delineate responsibilities between actors and the system, offering a step-by-step depiction of processes. Figure 3 illustrates the integrated process for a student submitting the registration form.



Source: Research Results (2025)
Figure 3. Activity Diagram for Registration Form Submission

Figure 3 shows how the system automates crucial validations, such as checking the admission quota for the selected major. If the quota is available, the system saves the data, updates the quota, generates a payment invoice, and seamlessly redirects the student to the payment page.

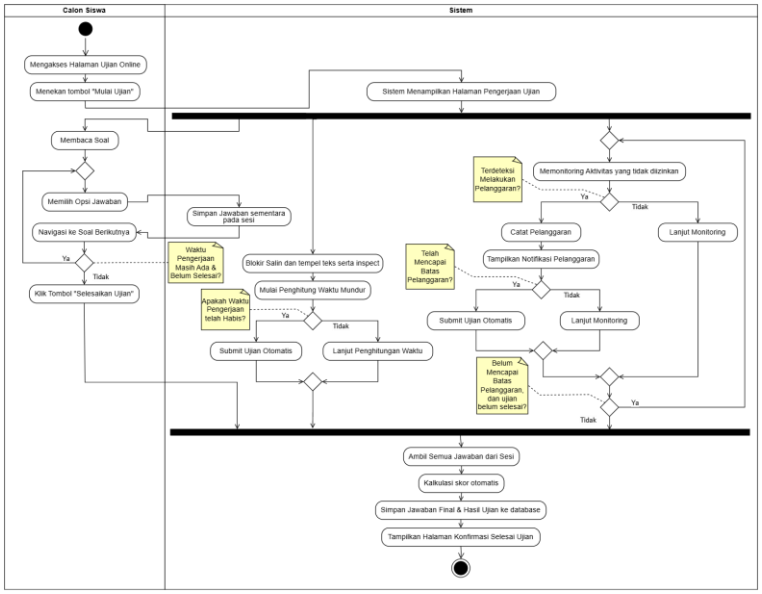
The automated payment process, a core innovation of this system, is detailed in Figure 4. When a student selects the payment gateway option, the system interacts with the external Midtrans service. After the transaction is complete, Midtrans sends a real-time notification (webhook) to the system, which automatically updates the payment status, thus eliminating the need for manual verification.



Source: Research Results (2025)

Figure 4. Activity Diagram for Payment via Payment Gateway

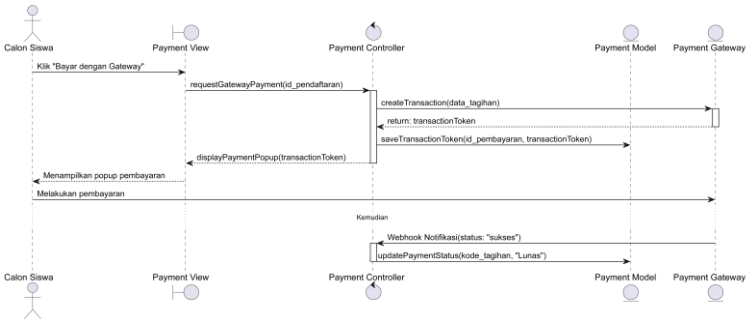
Finally, the online examination workflow, which incorporates anti-cheating measures, is depicted in Figure 5. The system actively monitors for violations, such as navigating away from the exam tab. If the number of violations exceeds a predetermined limit, the system automatically submits the exam to ensure academic integrity.



Source: Research Results (2025)

Figure 5. Activity Diagram for the Online Examination Process

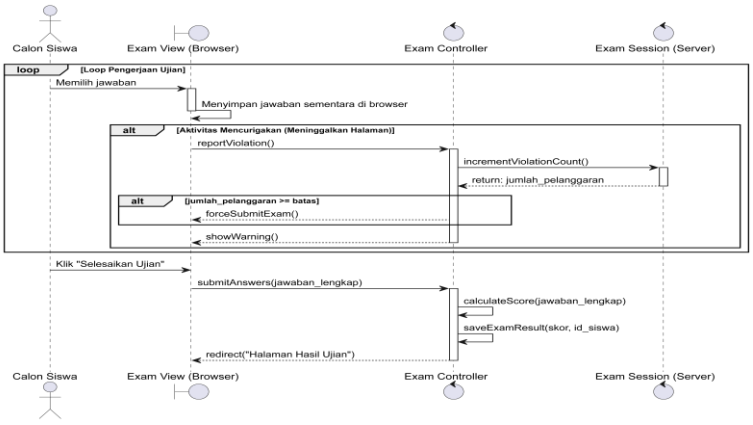
After defining the functional workflows, the next step was to detail the technical interactions between system components. As the system was built using the Model-View-Controller (MVC) architectural pattern, it was crucial to model the dynamic behavior and communication between these components. Sequence Diagrams were used to illustrate the chronological exchange of messages between different objects (View, Controller, Model) for key processes (Nurlelah et al., 2023). These diagrams provide a technical blueprint for implementation. The interaction for the automated payment process is shown in Figure 6.



Source: Research Results (2025)
Figure 6. Sequence Diagram for Payment Gateway Interaction

Figure 6 depicts two critical interactions. First, a synchronous process where the Payment_Controller requests a transaction token from the external Payment Gateway to be displayed to the user via the View. Second, an asynchronous process where the Payment Gateway sends a webhook notification to a dedicated endpoint in the Payment_Controller, which then instructs the Payment_Model to update the transaction status in the database automatically.

Furthermore, the technical implementation of the anti-cheating mechanism in the online exam is detailed in Figure 7. The diagram visualizes how the Exam_View sends an asynchronous reportViolation() message to the Exam_Controller each time a tab-switching event is detected. The controller manages the violation count within the user's session. An alt (alternative) fragment shows that if the violation count reaches the predefined maximum limit, a forceSubmitExam() message is triggered, terminating the exam and submitting the user's answers.

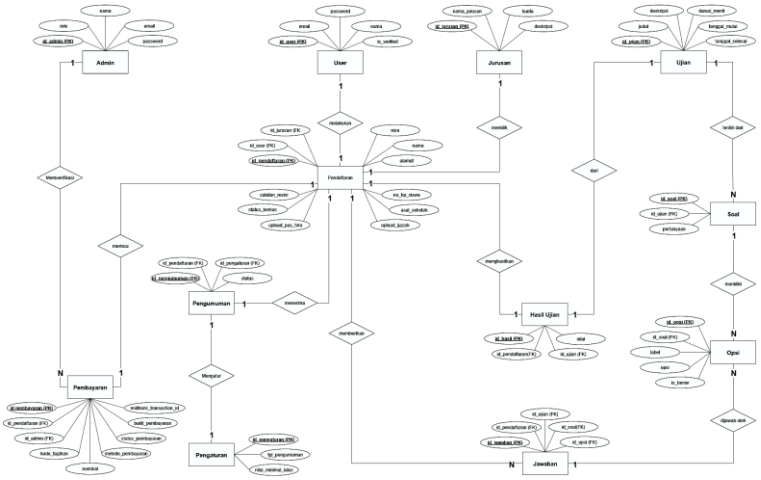


Source: Research Results (2025)
Figure 7. Sequence Diagram for the Online Examination Process

To provide full transparency on the implementation, the system was developed using the following stack of technologies, tools, and external services:

1. Back-End Development: The server-side logic was built using PHP version 7.4 and the CodeIgniter 3 framework, which provided a robust MVC architecture for modular development.
2. Front-End Development: The user interface was developed with HTML5, CSS3, and JavaScript. The Bootstrap 5 framework was utilized to ensure a responsive, mobile-first design that is accessible across various devices.
3. Database Management: MySQL was chosen as the relational database management system. The local development environment was managed using the XAMPP server package, which includes an Apache server and MariaDB (a fork of MySQL).
4. External Services Integration: The system was integrated with two key third-party services: the Midtrans Payment Gateway API for automated online payment processing and an SMTP Mail Server for handling system-generated email notifications.

The foundation of the information system is a well-structured database designed to ensure data integrity, consistency, and efficient retrieval. The database design process began with a conceptual model and was then translated into a logical and physical structure. The conceptual data model was created using an Entity-Relationship Diagram (ERD), as shown in Figure 8. The ERD models the main entities involved in the PPDB process, their attributes, and the relationships between them (Nurlelah et al., 2023). Key entities such as Pendaftaran (Registration), User, Jurusan (Major), Pembayaran (Payment), and Ujian (Exam) are identified. The relationships—such as one User can only have one Pendaftaran, and one Pendaftaran is linked to one Pembayaran—establish the business rules and logical structure of the database.



Source: Research Results (2025)
Figure 8. Entity-Relationship Diagram (ERD)

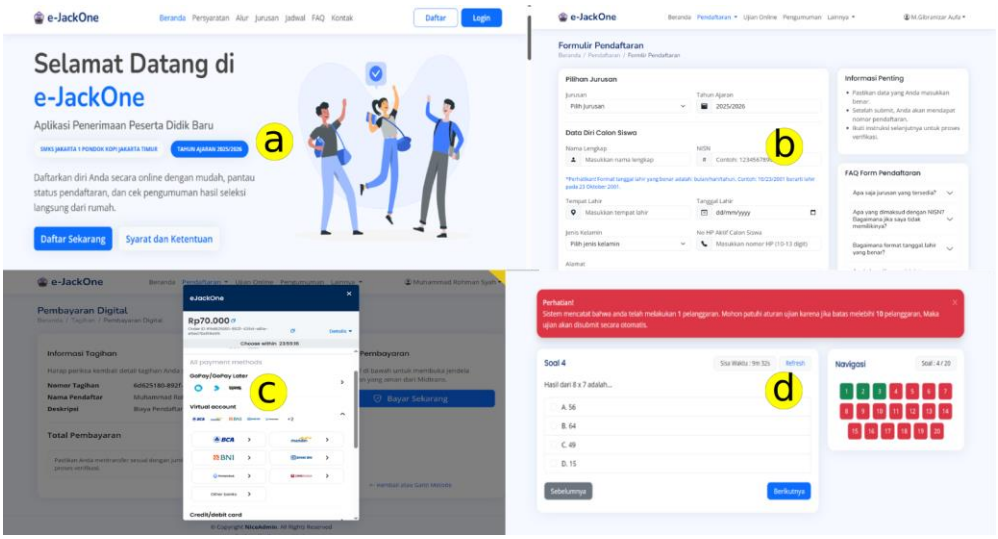
RESULTS AND DISCUSSION

This section presents the results of the system development, encompassing the user interface design as the tangible output of the implementation phase, followed by the findings from the comprehensive functional and user acceptance testing.

1. User Interface Design

The user interface (UI) was meticulously designed to be intuitive, clean, and responsive, directly addressing the usability issues of the previous fragmented system. The UI is divided into two primary components: the front-end, accessible to prospective students, and the back-end, designed for the administrative committee.

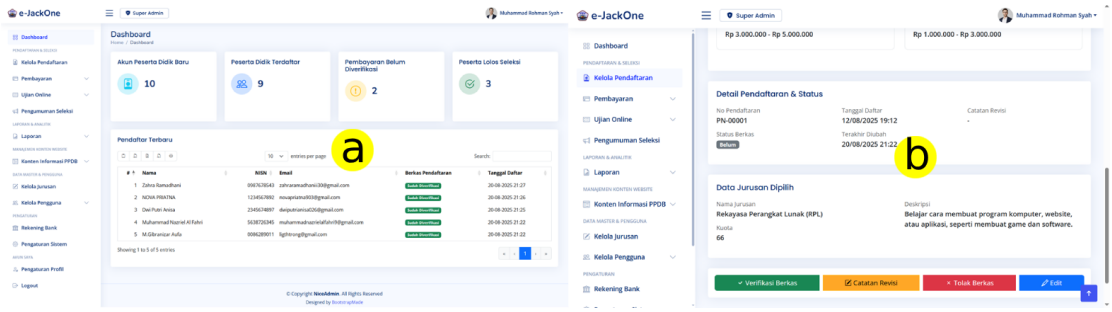
The front-end interface (Figure 9) guides prospective students through a unified workflow. It begins with the landing page (Fig. 9a), which serves as a centralized information hub, replacing the outdated Google Sites page. After creating an account, students are directed to the online registration form (Fig. 9b), which consolidates all data and document uploads into a single step. Next, the payment page (Fig. 9c) is specifically designed for automated transactions, integrating directly with the Midtrans payment gateway. Finally, the online examination interface (Fig. 9d) is designed to maintain academic integrity, featuring a countdown timer and a tab-switching detection mechanism.



Source: Research Results (2025)
Figure 9. Front-End User Interface: (a) Landing Page, (b) Registration Form, (c) Payment Gateway Interface, (d) Online Exam Interface

For the committee, the back-end interface (Figure 10) provides centralized management tools. The main admin dashboard (Fig. 10a) presents a real-time statistical overview of registrations, payments, and admission results for data-driven monitoring. The registration management page (Fig. 10b) serves as the applicant data hub, allowing

the committee to search, filter, and perform verification actions (Approve, Revise, Reject, Edit) with a single click. This feature drastically reduces the administrative workload and minimizes the risk of human error from manual processing.



Source: Research Results (2025)
Figure 10. Back-End Admin Interface: (a) Admin Dashboard, (b) Registration Management Page.

2. System Testing Results

To validate the developed system, a comprehensive evaluation was conducted through two distinct testing stages: Black Box Testing to assess functional correctness and User Acceptance Testing (UAT) to measure usability and user satisfaction.

Black Box Testing was conducted by the developer to verify that all system functionalities performed according to the technical specifications without inspecting the internal code structure (Ayuningtyas et al., 2023; Yudhistira, 2024). A total of 32 test scenarios were executed, covering all critical modules from user authentication to administrative functions. All 32 scenarios passed successfully, confirming that the system was functionally robust and free of critical errors. Key test scenarios and their outcomes are summarized in Table 1.

Table 1. Summary of Key Black Box Testing Scenarios

ID	Feature	Scenario	Expected Result	Actual Result	Status
TC-F-AUTH-02	Registration	User registers with an email that already exists.	System prevents registration and displays an "email already registered" error.	As Expected	Passed
TC-F-PAY-01	Payment Gateway	User completes a payment via Midtrans. The system's webhook listener receives a "settlement" notification.	The payment status in the database is automatically updated to "Paid".	As Expected	Passed
TC-F-EXAM-03	Anti-Cheating	During the exam, the user switches browser tabs.	The system detects the event, displays a warning, and increments the violation count.	As Expected	Passed
TC-B-VER-01	Admin Verification	Verifier approves a student's registration file.	The registration status is updated, and an automated approval email is sent to the student.	As Expected	Passed

Source: Research Result (2025)

User Acceptance Testing was conducted to assess the system's usability and acceptability from the perspective of its end-users (Wahyudi et al., 2023). This final validation phase aimed to confirm that the system not only works correctly but also effectively meets the real-world needs of its intended audience.

The UAT involved 10 participants representing all key roles: 6 student proxies (active students from SMKS Jakarta 1, as the testing was conducted outside the PPDB period), 2 Verifiers (committee staff), and 2 Super Admins (committee leads). The testing was conducted in a controlled environment where each participant was given a set of scenario-based tasks relevant to their role. Upon completion, feedback was collected through a structured questionnaire utilizing a 5-point Likert scale (1=Very Poor, 5=Very Good) (Arif & Soko, 2022). The average score for each user group was calculated and interpreted against a predefined scale where scores between 4.21–5.00 are considered "Very Good".

The quantitative results from the UAT questionnaire demonstrated an overwhelmingly positive reception from

all user groups. The system achieved a "Very Good" rating across the board, indicating high levels of satisfaction with its functionality, ease of use, and overall design. The summarized results are presented in Table 2.

Table 2. Summary of User Acceptance Testing (UAT) Results

No.	User Role	Participants	Key Aspects Assessed	Average Score	Interpretation
1	Student Proxies	6	Clarity of information, ease of registration, payment process, and online exam experience.	4.48	Very Good
2	Verifiers	2	Efficiency of the admin dashboard, ease of document and payment verification.	4.50	Very Good
3	Super Admins	2	Effectiveness of master data management, system configuration, and overall control.	4.89	Very Good

Source: Research Result (2025)

The results from both testing phases strongly validate the effectiveness of the developed system. The flawless execution in Black Box testing confirms its technical robustness, while the "Very Good" ratings from the UAT (average scores of 4.48, 4.50, and 4.89) underscore its high usability and relevance in a real-world context.

The qualitative feedback gathered during the UAT sessions provided deeper insights. Student proxies highlighted that the integrated workflow significantly reduced the confusion and complexity of the previous multi-platform process. Features like automated payment verification and a secure online exam were praised for modernizing the school's image and providing a more professional user experience. For the administrative committee, the system was perceived as a transformative tool. Verifiers explicitly stated that the centralized dashboard and automated notifications would drastically cut down manual verification time, reducing both workload and the potential for human error. Similarly, Super Admins lauded the system's control and transparency, particularly the ability to manage master data and system settings dynamically.

These findings directly demonstrate that the integrated system successfully addresses the core problems—system fragmentation, information obsolescence, and manual inefficiencies—that contributed to the decline in applicants at SMKS Jakarta 1. The seamless integration of a payment gateway and a secure online exam, which constitutes the primary novelty of this research, was empirically proven to be both functionally effective and highly accepted by its end-users.

CONCLUSION

This research has successfully developed and validated a web-based integrated PPDB information system that effectively transforms the inefficient and fragmented student admission process at SMKS Jakarta 1 Pondok Kopi. By consolidating a dynamic information portal, a streamlined online registration flow, an automated payment gateway, a secure online examination, and a real-time announcement system into a single platform, this study has addressed the critical issues of administrative inefficiency and poor user experience. The system's technical robustness was confirmed through Black Box testing, and its high usability and user acceptance were empirically verified through UAT, which yielded an overall "Very Good" interpretation from all user groups.

The implementation of this system is poised to significantly enhance administrative efficiency, improve data accuracy and transparency, and provide a more professional experience for prospective students. This research contributes a validated, comprehensive, and replicable model for other vocational institutions seeking to modernize their admission processes.

While the results are positive, this research has several limitations. The UAT was conducted with student proxies rather than actual prospective applicants, which may not fully capture the perspectives of external users. Additionally, the anti-cheating feature is foundational and does not include advanced mechanisms like active proctoring.

Therefore, several avenues for future research and development are recommended. First, a longitudinal study could be conducted to quantitatively measure the system's impact on applicant numbers and administrative efficiency after its implementation in a full PPDB cycle. Second, the system's functionality could be expanded by incorporating a fully digital re-registration module to create a complete end-to-end admission cycle. Finally, the

security of the online exam could be further enhanced by exploring the integration of a safe exam browser or lightweight proctoring tools.

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