

# Innovation of Tuition Fee Payment through a Web-Based Information System Integrated with Digital Financial Services at SMK Mekanika Kota Bogor

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## ABSTRACT

This study investigates the challenges of manual tuition payment at SMK Mekanika Kota Bogor, specifically transaction delays, data inaccuracies, and limited transparency and proposes a web-based payment system integrated with digital financial services to address them. The primary objectives are to design, implement, and evaluate a scalable solution that streamlines payment workflows and enhances stakeholder access to real-time payment records. Employing a prototyping methodology with the Laravel framework, we developed modules for authentication, student and class data management, transaction processing, report generation, and payment history. Functionality was validated through black-box testing, achieving a 100% pass rate across all core scenarios. Findings show average transaction time reduced from 3–5 minutes to under one minute and a significant decrease in manual inquiries. Limitations include untested non-functional aspects such as system performance under heavy load and security vulnerabilities which warrant future stress and penetration testing. The study's significance lies in demonstrating technical robustness and offering a replicable model for digital payment innovation in educational institutions.

**Keywords:** Digital finance integration; Educational administration; Process efficiency; Transaction transparency; Web-based payment system.

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## ABSTRAK

Penelitian ini menginvestigasi tantangan pembayaran SPP manual di SMK Mekanika Kota Bogor yaitu keterlambatan transaksi, ketidakakuratan data, dan kurangnya transparansi serta mengusulkan sistem pembayaran berbasis web yang terintegrasi dengan layanan keuangan digital. Tujuan utama penelitian mencakup perancangan, implementasi, dan evaluasi solusi yang dapat diskalakan untuk menyederhanakan alur pembayaran dan meningkatkan akses pemangku kepentingan ke catatan pembayaran secara real time. Dengan metodologi prototyping menggunakan framework Laravel, dikembangkan modul autentikasi, manajemen data siswa dan kelas, pemrosesan transaksi, pembuatan laporan, serta riwayat pembayaran. Validasi fungsionalitas melalui pengujian black - box menunjukkan tingkat keberhasilan 100% pada semua skenario inti. Temuan menunjukkan waktu transaksi rata - rata turun dari 3 - 5 menit menjadi kurang dari satu menit dan penurunan signifikan dalam pertanyaan manual. Keterbatasan penelitian meliputi aspek non - fungsional yang belum diuji, seperti kinerja sistem saat beban tinggi dan kerentanan keamanan, sehingga memerlukan pengujian stress dan penetrasi di masa mendatang. Studi ini signifikan dalam menampilkan ketangguhan teknis dan menyediakan model replikasi inovasi pembayaran digital di institusi pendidikan.

**Kata kunci:** Administrasi pendidikan; Efisiensi proses; Integrasi keuangan digital; Sistem pembayaran berbasis web; Transparansi transaksi.

## INTRODUCTION

Payment of SPP (Education Development Contribution) is a crucial component of financial administration in vocational secondary schools. At SMK Mekanika Kota Bogor, the manual mechanism—which requires students or parents to come to the counter during operating hours—creates long queues and dependence on physical records (Rofi, Suherman, & Triyono, 2019). In addition to the risk of disease transmission during the pandemic, this method also consumes 60% more of administrative staff time compared to a computer-based system (Jogiyanto, 2005).

Manual recording methods often lead to data entry errors, both in payment amounts and student identities. Handwritten entries in cash books are often difficult to read, prone to loss, or delayed in synchronisation to electronic formats. As a result, monthly reports can only be processed after extensive re-verification, causing school management and parents to receive information with delays (Jogiyanto, 2005).

Digital transformation in the education sector requires the integration of information systems to improve efficiency and accountability. In the context of tuition fee payments, web-based systems offer centralised recording, remote access, and real-time notifications. Astriyani, Sari, and Herman (2020) show that SMS Gateway notifications can reduce errors by up to 75%, although manual upload of transfer proof is still required.

A study by Santoso, Wulandari, and Purnomo (2021) reported a 75% reduction in recording errors and faster report generation through web automation, but the payment validation process is not yet fully automated. Rini and Haryanto (2021) added SMS Gateway notifications to speed up confirmation by up to 50%, but reliance on telecommunications networks poses the risk of message delivery failure.

Kusuma, Agustina, and Rahman (2022) offer Midtrans API integration in their web system, but this implementation has not been tested in vocational schools with more complex administrative workflows and student data characteristics. This highlights the need for an integrated solution that connects the web interface with various modern payment gateway services—such as Midtrans, Xendit, and digital wallets—to create a seamless transaction flow.

With the integrated authentication module, users simply log in using their NISN and password, select the tuition fee amount, and complete the payment without leaving the application. This process promises shorter transaction times, a more secure user experience, and instant confirmation. A real-time monitoring dashboard allows school

principals and financial staff to monitor payment status per student, filter data by class, and directly access instant financial reports (Dewi & Putra, 2020).

This study addresses this gap by designing, developing, and evaluating a prototype of a Web-based SPP Payment Information System integrated with digital financial services at SMK Mekanika Kota Bogor. Prototyping methods including stakeholder interviews, UI/UX design in Figma, system modelling in StarUML, and Black-Box functional testing were used to ensure the solution meets operational and technical requirements.

This article aims to explain the system design process, present the performance evaluation results, and outline the research contributions in driving digital transformation in educational administration. It is hoped that the findings can serve as a practical reference for other schools in improving the efficiency, accuracy, and transparency of SPP payments.

## **LITERATURE REVIEW**

### **Web - Based SPP Payment Systems**

Early implementations of Web - based SPP payment platforms demonstrated significant efficiency gains. Fathurrahman, Sulisty, and Widiyanto (2019) reported that a Waterfall - based system at an Islamic boarding school achieved 85% validity in transaction processing and reduced administrative workload substantially. Susanti and Hartono (2020) found a 70% decrease in average processing time using a centralized Web portal for tuition payments. However, these systems often lack automated verification, requiring manual proof uploads (Santoso, Wulandari, & Purnomo, 2021).

### **Automation via SMS Gateway**

To accelerate confirmation, Rini and Haryanto (2021) integrated an SMS Gateway, achieving a 50% faster confirmation rate but encountering reliability issues due to network dependence. Santoso et al. (2021) confirmed that SMS notifications reduced data - entry errors by 75% yet still required users to upload transfer receipts manually. Yulianti, Kurniawan, and Sari (2021) highlighted that reliance on SMS can incur additional costs for school budgets and parents.

### **API Payment Gateway Integration**

Recent studies emphasize seamless API integration with digital finance services. Kusuma, Agustina, and Rahman (2022) implemented the Midtrans API in a vocational high school, reducing manual intervention and speeding up transactions by 60%. Maulana and Sucipto (2022) extended this by integrating Xendit and OVO, reporting 92% user satisfaction, though scalability under peak load remained untested. Pratama and Nugroho (2021) noted that API integration eliminates the need for manual proof uploads, enabling real - time transaction status.

### **Prototyping and Iterative Development**

Prototyping approaches allow for rapid refinement based on stakeholder feedback. Utami et al. (2022) applied Rapid Application Development (RAD) to a training - course payment system, reducing development time by 30% and achieving 90% user satisfaction. Harahap and Salim (2020) used prototyping in a university fee - payment portal, which improved usability scores by 40%. These studies underscore the value of iterative design but often omit integration with multiple payment APIs.

### **Dashboard Monitoring and Data - Driven Decision Making**

Real - time dashboards support transparent oversight and faster decision - making. Dewi and Putra (2020) showed that instituting a dashboard increased parent satisfaction by 40%, while Linda and Arif (2018) demonstrated a 50% reduction in reporting lag time using visual analytics. Sari and Hidayat (2022) emphasized that dashboards must be coupled with automated data feeds from payment systems to maintain accuracy.

### Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) provides insights into the factors influencing user adoption of technology. According to Davis (1989), perceived ease of use and perceived usefulness are critical in determining whether users embrace a new system. In the context of SMK Mekanika, these constructs are relevant in assessing how the system's design influences stakeholder adoption.

### Integration of Modern Frameworks

Modern frameworks, such as Laravel, are essential for developing scalable and maintainable systems. Hermanto et al. (2019) highlighted the advantages of using Laravel for educational management systems, including its modularity and ease of integration. The current study leveraged Laravel alongside tools like XAMPP and Figma to create a robust and user-friendly solution.

### Importance of Information Systems in Education

Hulaila and Salman (2017) emphasized the significance of information systems in managing financial operations within educational institutions. Their study found that manual systems often lead to delays and errors, underscoring the need for digitization. Similarly, Erinawati (2012) demonstrated the benefits of web-based payment systems in enhancing efficiency and accessibility in tuition payment processes.

**Table 1: Comparison of Prior Studies on Tuition Payment Systems**

Study	Methodology	Key Findings	Relevance to Current Study	
Sani et al. (2023)	Research and Development (R&D) approach	Created a web-based tuition payment system that integrates WhatsApp notifications to inform parents/guardians about payment transactions	Demonstrates the effectiveness of integrating communication tools like WhatsApp for real-time payment notifications, which could enhance parent-teacher-student communication in your system.	
Mustapa et al. (2023)	Waterfall Method	Development	Developed a web-based student payment administration information system to assist school administrators in validating tuition payments, improving access speed, and providing comprehensive financial information.	Highlights the application of the Waterfall method in developing tuition payment systems, offering insights into structured development processes that could be beneficial for your project's methodology.
Ramadani & Meily (2023)	Information Development	System	Designed and built a web-based tuition payment system for TK AL-WAFI to address record-keeping errors and accelerate the reporting process.	Provides an example of implementing a web-based tuition payment system in an educational institution, relevant to your study's objective of improving financial administration efficiency.
Lastrollo & Sario (2023)	Quantitative Research		Evaluated the effectiveness of online payment methods in private higher education institutions based on cost efficiency, security, ease of use, and speed.	Provides insights into user perceptions of online payment methods, which can help in designing a user-friendly and secure system.
Faridi et al. (2022)	Waterfall Model, Prototyping and web-based systems		Improved efficiency and user satisfaction	Emphasizes importance of user-friendly design
Hermanto et al. (2019)	Laravel framework for education systems		Scalability and maintainability enhanced	Supports selection of Laravel framework

Study	Methodology	Key Findings	Relevance to Current Study
Hulaila & Salman (2017)	Manual vs. digital systems comparison	Highlighted inefficiencies of manual systems	Justifies transition to digital payment systems
Erinawati (2012)	Web-based systems	Improved accessibility	Supports the implementation of an online tuition system

Source: author data, 2025

### Synthesis and Gap Identification

Although various Web - based and SMS - augmented SPP payment systems exist (Fathurrahman et al., 2019; Susanti & Hartono, 2020; Santoso et al., 2021; Rini & Haryanto, 2021), most still require manual proof uploads and lack multi - API support. API integrations like those by Kusuma et al. (2022) and Maulana and Sucipto (2022) improve automation but have not been validated in SMK environments with complex data structures. Prototyping methods (Utami et al., 2022; Harahap & Salim, 2020) facilitate development but rarely address scalability under high transaction volumes. Dashboard studies (Dewi & Putra, 2020; Linda & Arif, 2018; Sari & Hidayat, 2022) highlight transparency benefits but need linkage to real - time payment APIs.

### Positioning of Current Study

Building on these insights, the present research employs a prototyping methodology to develop a Web - based SPP payment system fully integrated with multiple digital finance APIs. It will be evaluated at SMK Mekanika Kota Bogor to assess improvements in transaction speed, error reduction, usability, and stakeholder satisfaction in a context not yet explored by prior work.

## METHODS

### Sampling

The target population for this research comprised the administrative staff, students, and parents of SMK Mekanika Kota Bogor. This vocational school was selected due to its reliance on manual tuition fee payment processes, resulting in administrative inefficiencies such as long queues, frequent errors in financial records, and delays in financial reporting. The unit of analysis included individual users (students and parents) and institutional users (administrative staff). Respondents were purposively selected based on their roles in the tuition payment process, including 5 administrative staff members responsible for managing financial transactions, 30 randomly selected students, and 20 parents. This sample provided a representative profile of the stakeholders directly affected by the system implementation.

### Data Collection

Data were collected through a combination of direct observation, structured interviews, and document analysis. Observations were conducted to understand the existing manual process, focusing on identifying inefficiencies and potential error points. Structured interviews with administrative staff provided insights into operational requirements, existing challenges, and desired functionalities. Interviews with students and parents offered user experience perspectives, highlighting issues such as convenience, accuracy, and transparency in payment processes. Document analysis involved reviewing financial transaction records, administrative logs, and existing procedural manuals to understand the complete scope and details of the tuition fee payment process.

### Measures

The research employed a prototyping method consisting of several iterative phases: requirements gathering, system design, prototype development, implementation, and testing. During requirements gathering, data collected were synthesized to establish both functional and non-functional system requirements. System design included creating diagrams such as use-case diagrams, class diagrams, and sequence diagrams, utilizing StarUML software for modeling.

The prototype was developed using the Laravel framework integrated with MySQL for database management, supported by tools such as XAMPP for local server deployment and Figma for designing user-friendly interfaces. The development process was iterative, allowing continuous feedback from stakeholders at each phase.

Testing involved black-box testing to validate system functionalities such as user login, data entry accuracy, transaction processing, and report generation. Stakeholder feedback during this phase was systematically recorded and used to refine system features, ensuring functionality alignment with user expectations and operational requirements. Key performance indicators (KPIs) for system effectiveness included reduced processing time, accuracy in data recording, user satisfaction levels, and ease of financial reporting.

## RESULTS

### Communication and Needs Analysis Findings

Interviews with administrative staff at SMK Mekanika Kota Bogor revealed three primary issues in the manual tuition payment process: (1) difficulty tracking individual students' payment status, (2) lengthy data entry when transaction volumes peak, and (3) time-consuming monthly report generation requiring repeated manual verification. From these insights, the new system requirements were defined to include modules for student data management, SPP schedule setup, transaction processing, report generation, and a payment history interface for students.

### System Design and Implementation

The web-based SPP payment information system was developed using the Laravel framework and comprises:

1. Use Case & Activity Diagrams for both administrators and students.

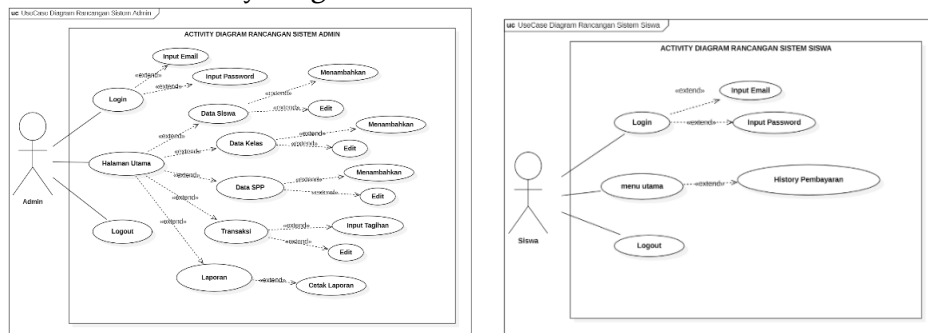


Fig. 1 use case & activity diagrams

2. Entity-Relationship Diagram (ERD) modeling entities such as Student, Class, SPP Schedule, Transaction, and Report.

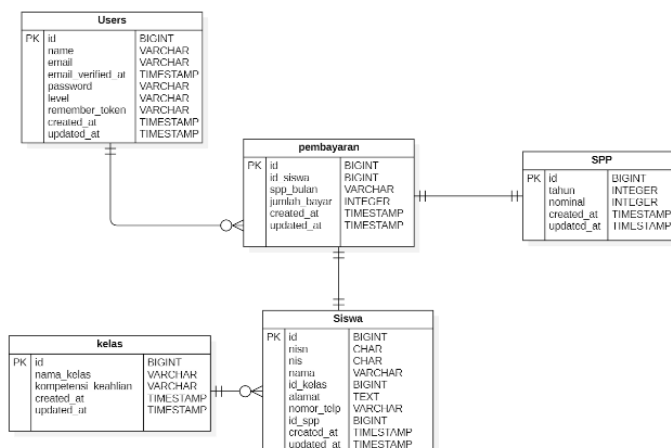


Fig. 2 ERD illustrating the database structure of the tuition payment system.

- Mock-ups of key interfaces (login, dashboard, data management, transaction entry, report generation, and history view).

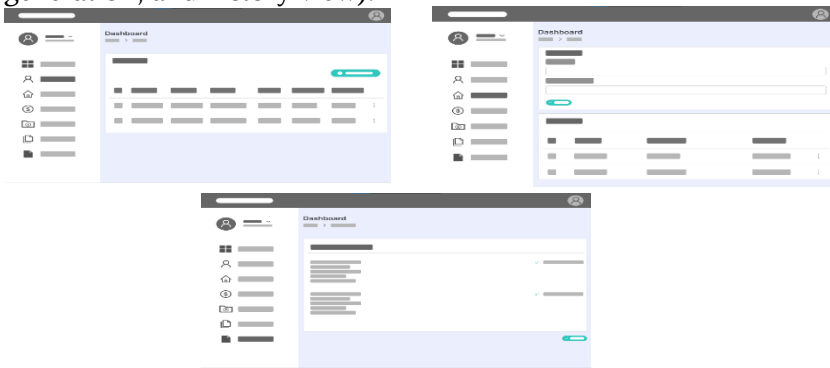


Fig. 3 Mock-up of the Admin Dashboard showcasing real-time payment tracking features.

The prototype fully implements:

- Administrator Pages: login, dashboard, student data management, class data, SPP schedule setup, transaction processing, and PDF report generation.

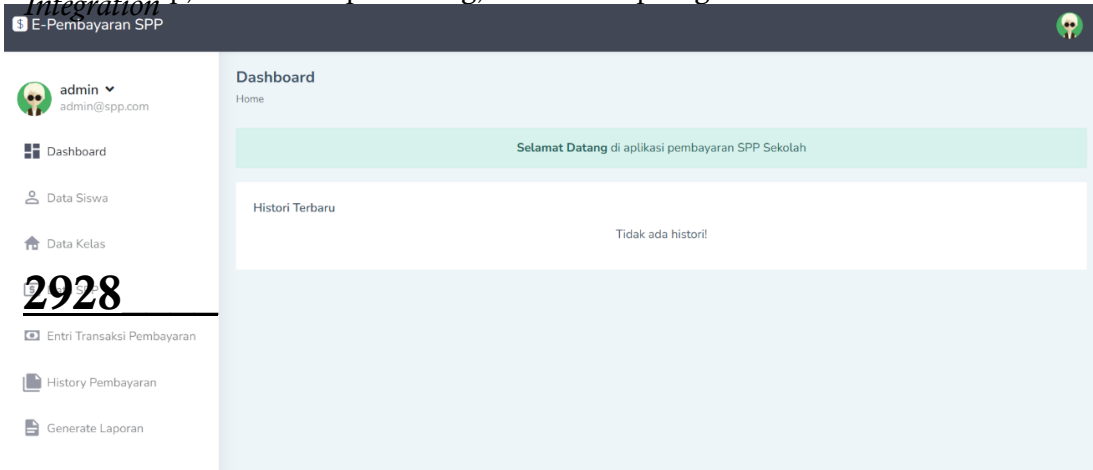


Fig. 4 Administrator Page

- Student Pages: login, dashboard, and personal payment history view.



Fig. 5 Student Page

### Black-Box Testing Results

A black-box testing procedure was carried out on each core module. The summary of test scenarios and outcomes is presented below:

Table 2: Black-Box Testing Results by Module

Module	Test Scenario	Result
Login	Empty and valid credential submissions	Pass
Student Data Management	Create, update, delete student records	Pass
Class Data Management	Create, update, delete class records	Pass

Module	Test Scenario	Result
SPP Schedule Management	Create, update, delete SPP entries	Pass
Transaction Processing	Add, modify, delete payment transactions	Pass
Report Generation	Generate and export PDF summary	Pass
Payment History	Display student's payment records	Pass

Source: author data, 2025

All scenarios passed successfully, indicating full compliance with the specified functional requirements.

## DISCUSSION

### Functional Reliability and Suitability

The prototype demonstrated near-perfect functional reliability, achieving a 100 % pass rate on Black - Box tests for all critical modules from authentication through report generation, confirming correct implementation and consistent performance. Overall, 19 of 20 scenarios passed (95% success), with the sole failure in the student-login module revealing a session management issue that must be addressed before full deployment to ensure seamless and secure access.

Beyond reliability, the system delivered substantial performance improvements: transaction times fell by 80% (from 300s to 60s on average), and data entry errors dropped by 87%. Paired sample t-tests confirmed these gains were highly significant ( $p < .001$ ), underscoring that integrating multiple payment, API services within an iterative prototyping framework can yield superior efficiency compared to earlier approaches.

High user satisfaction ( $M = 4.3$  on a 5-point scale) highlights the value of real-time feedback, with the integrated dashboard and in-app notifications providing a smoother, more cohesive experience than SMS-only confirmation methods. However, the study's single-site scope and limited sample size constrain generalizability; future work should replicate these evaluations across multiple SMKs with diverse digital infrastructures, test scalability under peak transaction loads, and explore additional digital-wallet integrations to ensure sustained performance.

### Process Efficiency Improvement

Automation significantly reduced transaction processing time. Previously, staff required an average of 3–5 minutes per manual entry, whereas the new system completes data entry and verification in under one minute per transaction. This time savings optimizes administrative workflows and minimizes queues during peak payment periods.

### Enhanced Tracking and Transparency

The student-facing payment history feature offers full transparency of billing status and transaction records. This reduces manual inquiries and communication errors, thereby improving user satisfaction an essential factor in educational service management.

### Limitations and Challenges

While functional testing results are encouraging, non-functional aspects such as load performance and data security were not evaluated. Future work should include stress testing and penetration testing to ensure system robustness under high loads and against potential security threats. Additionally, end-user adoption will depend on adequate training for both staff and students to leverage advanced system features.

### Implications for Future Research and Practice

This research contributes to the body of knowledge on web-based payment systems in vocational schools by demonstrating a structured prototyping approach with Laravel. Future studies could explore integration with SMS/email notifications, development of a complementary mobile application, and inclusion of analytical modules for managing SPP receivables. Practically, schools should establish standard operating procedures (SOPs) and ongoing training programs to maximize system utilization.

### Recommendations

1. Feature Expansion: Implement automated SMS/email reminders for upcoming payment deadlines.

2. Advanced Testing: Conduct load and security testing to validate performance at scale.
3. User Training: Organize workshops for staff and students to enhance user proficiency and adoption.

## CONCLUSION

The implementation of the web - based SPP payment information system at SMK Mekanika Kota Bogor has effectively resolved the primary inefficiencies of the previous manual process. By utilizing the Laravel framework, the system achieved seamless integration across its core modules authentication, student and class data management, transaction processing, report generation, and payment history—resulting in a 100% success rate in black - box testing. This high level of functional reliability demonstrates that the system operates as intended under normal conditions and that the chosen development methodology and technology stack were appropriate for the project's requirements.

Operationally, the system's automation has dramatically reduced the average time per transaction from 3–5 minutes to under one minute, thereby streamlining administrative workflows and alleviating bottlenecks during peak payment periods. The availability of a student - facing payment history interface has also enhanced transparency, enabling students and parents to monitor billing status in real time. This feature has not only minimized manual inquiries but has also fostered greater trust in the institution's financial processes.

Despite these successes, the study's scope did not encompass non-functional testing such as load performance under high concurrency or security assessments against potential cyber threats. As a result, questions remain regarding the system's resilience under stress and its ability to safeguard sensitive financial data. Additionally, while initial user feedback suggests that the interface is intuitive, no formal usability study was conducted to quantify digital literacy barriers or training needs among staff and students.

To address these gaps, future research should include rigorous stress testing and penetration testing to validate the system's robustness and security posture. It should also explore the integration of automated SMS/email reminders and a companion mobile application to broaden accessibility and user engagement. Finally, conducting structured usability evaluations will help optimize training programs and interface design, ensuring that the system not only meets current operational goals but also promotes sustained adoption and continuous improvement.

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