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RESEARCH ARTICLE

Design of Student Attendance User Interface using Figma at SMA Negeri 1 Sukamakmur Aceh Besar

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Abstract
This research focuses on developing an attractive, valid, practical, and effective information system based on Android applications. The primary target users are eleventh and twelfth-grade students at SMA Negeri 1 Sukamakmur who will participate in industrial work practice programs. The application features facilitate communication between industrial work practice students, teachers, and industry supervisors. These features enhance the quality and effectiveness of industrial work practice programs while creating consistent synergy between schools and industry partners. The study employs Research and Development (R&D) methodology with a waterfall development model or linear sequential model. Data collection was supported through field observations and interviews with school stakeholders, including teachers, students, and industry department heads. This methodology provided valid data for application development by identifying strengths, weaknesses, opportunities, and threats in creating the Prakerin.com application. Student questionnaires were used as research instruments, and Flutter was utilized as the development platform. The research aims to create an Android-based industrial work practice information system that is attractive, valid, practical, and effective. Additionally, it seeks to facilitate teacher-student communication during industrial work practice implementation to support optimal assessment results and enhance student competency development.

Keywords
Information System; Android; Industrial Work Practice; Waterfall Model; User Interface Design.

1 | INTRODUCTION

Education serves as the cornerstone of national development, playing a pivotal role in shaping the character and intellectual capacity of future generations (Siswono, 2009). In Indonesia's educational landscape, the management of administrative processes within schools has traditionally relied on manual systems, particularly in attendance tracking. As Sudrajat (2010) aptly defines, "Student attendance at school is the presence and physical and mental participation of students in school activities during effective school hours." This fundamental aspect of educational administration directly impacts learning outcomes and institutional effectiveness. The digital transformation of educational institutions has become imperative in the 21st century, with technology integration emerging as a crucial factor in enhancing administrative efficiency and educational quality. According to UNESCO (2015), educational institutions worldwide are increasingly adopting digital solutions to streamline administrative processes and improve educational outcomes. This global trend underscores the importance of developing user-friendly, efficient digital systems tailored to the specific needs of educational institutions.

SMA Negeri 1 Sukamakmur, located in Aceh Besar, represents many Indonesian secondary schools still utilizing traditional paper-based attendance systems. These conventional methods present numerous challenges, including data inaccuracy, inefficient time management, difficulty in generating comprehensive reports, and limited accessibility for stakeholders (Marita *et al*., 2019). The manual recording and processing of attendance data consume significant administrative resources while providing limited analytical capabilities for educational decision-making. The emergence of digital attendance systems offers a promising solution to these challenges. As demonstrated by Wiranata and Setiawan (2019), digital attendance systems can significantly enhance administrative efficiency while providing more accurate and accessible data for educational stakeholders. Their research on web-based digital attendance systems using fingerprint recognition highlights the potential benefits of technological integration in school administration. Similarly, Akbar (2012) explored GPS-based employee attendance applications, demonstrating the versatility and adaptability of digital attendance solutions across different organizational.

User Interface (UI) design plays a critical role in the successful implementation of digital attendance systems. As Hix and Hartson (1993) emphasize, ensuring usability through product and process development is essential for creating effective digital interfaces. The design principles outlined by Shneiderman and Plaisant (2017) provide a framework for developing user interfaces that facilitate effective human-computer interaction. These principles are particularly relevant in educational contexts, where users may have varying levels of technological proficiency. Figma has emerged as a powerful tool for UI/UX design, offering collaborative features and intuitive design capabilities (Krilanovich, 2020). Recent studies by Chasanah *et al*. (2024) and Heranti *et al*. (2024) demonstrate the growing adoption of Figma in developing educational and administrative applications in Indonesia. The platform's accessibility and robust design features make it particularly suitable for developing user interfaces tailored to educational. The mobile revolution has further transformed the landscape of educational administration. Nielsen and Budiu (2013) highlight the principles and techniques that can enhance usability and user experience on mobile platforms. The proliferation of smartphones among students and educators creates new opportunities for developing mobile-based attendance systems that offer greater accessibility and convenience. Effendy *et al*. (2016) explored the development of Android-based systems for attendance, leave, and claim management, demonstrating the potential of mobile platforms for administrative applications.

The integration of digital attendance systems in educational institutions aligns with broader educational development goals. As outlined in UNESCO's Framework for Action on Education 2030 (2015), technology integration in education should aim to promote inclusive and equitable quality education. Digital attendance systems can contribute to these goals by enhancing administrative efficiency, improving data accuracy, and providing valuable insights for educational decision-making. The development of a student attendance user interface using Figma for SMA Negeri 1 Sukamakmur represents a significant step toward digital transformation in educational administration. This initiative builds upon the theoretical foundations established by previous research while addressing the specific needs and challenges of the local educational context. The design thinking approach, as implemented by Nathanael *et al*. (2024) and Panggabean and Megawaty (2024), provides a methodological framework for developing user-centered designs that prioritize usability and user experience. The application of design thinking methodology in educational technology development has gained significant traction in recent years. Murniati *et al*. (2024) demonstrated the effectiveness of design thinking in developing school information systems, highlighting the importance of user-centered approaches in educational technology development. Similarly, Ravelino and Susetyo (2023) applied User-Centered Design methodology in UI/UX design, emphasizing the importance of aligning technological solutions with user needs and preferences.

The evaluation of UI/UX designs represents another critical aspect of developing effective digital attendance systems. Nugroho and Nugroho (2024) employed User-Centered Design methodology to evaluate and analyze website UI/UX, providing valuable insights into the assessment of digital interfaces. These evaluation approaches ensure that digital attendance systems meet the needs and expectations of their intended users. The development of mobile applications for educational purposes has demonstrated significant potential for enhancing administrative efficiency and

educational outcomes. Sartono and Fachri (2024) developed a mobile digital library application, while Satria and Waluyo (2024) created an augmented reality application for traditional weapon recognition. These examples illustrate the versatility and adaptability of mobile applications in educational. The integration of information systems in educational administration extends beyond attendance tracking to encompass broader administrative functions. Septiadi *et al*. (2023) designed a microservices-based congregation data management application, while Hidayat *et al*. (2023) implemented a citizen services information system. These examples demonstrate the potential for comprehensive digital solutions in administrative contexts. The implementation of digital attendance systems in SMA Negeri 1 Sukamakmur aligns with the broader goals of educational development in Indonesia. As Hadisaputro (2005) emphasizes, secondary education plays a crucial role in preparing students for higher education and professional careers. Efficient administrative systems, including digital attendance tracking, contribute to creating conducive learning environments that support these educational goals. The development of a student attendance user interface using Figma represents a significant opportunity to enhance administrative efficiency and educational quality at SMA Negeri 1 Sukamakmur. By leveraging the principles of user-centered design and the capabilities of modern design tools, this initiative aims to create a digital attendance system that meets the specific needs of the school community while contributing to broader educational development goals.

2 | BACKGROUND THEORY

2.1 Software Engineering and Programming Fundamentals

The development of effective digital systems is fundamentally rooted in software engineering principles and programming methodologies. According to Wali (2020) in "Modul Praktikum Rekayasa Perangkat Lunak," software engineering encompasses systematic, disciplined, and quantifiable approaches to software development, operation, and maintenance. This structured approach is essential for creating robust, reliable, and maintainable software systems, particularly in educational contexts where system reliability directly impacts administrative efficiency. Programming algorithms serve as the foundation for implementing software solutions. Purbasari *et al*. (2024) in "Algoritma Pemrograman" emphasize that well-designed algorithms enable efficient problem-solving and optimal resource utilization in software development. In the context of attendance systems, algorithmic efficiency is crucial for handling large volumes of student data while maintaining system responsiveness and reliability. The implementation of efficient data structures and algorithms ensures that attendance tracking systems can scale effectively to accommodate growing student populations and expanding administrative requirements. Operational research methodologies provide valuable frameworks for optimizing system performance and resource allocation. Alfaris *et al*. (2022) in "Riset Operasi" highlight the application of mathematical modeling and analytical methods in solving complex operational problems. These approaches can be particularly valuable in designing attendance systems that efficiently allocate computational resources while meeting the diverse needs of educational stakeholders. By applying operational research principles, developers can create attendance systems that balance technical performance with user experience considerations.

2.2 User Interface and User Experience Design

The success of digital attendance systems heavily depends on effective user interface (UI) and user experience (UX) design. As highlighted by Hix and Hartson (1993), ensuring usability through product and process development is essential for creating effective digital interfaces. This perspective emphasizes the importance of integrating usability considerations throughout the development process rather than treating them as an afterthought. Shneiderman and Plaisant (2017) provide a comprehensive framework for designing user interfaces that facilitate effective human-computer interaction. Their eight golden rules of interface design—strive for consistency, enable frequent users to use shortcuts, offer informative feedback, design dialogs to yield closure, offer simple error handling, permit easy reversal of actions, support internal locus of control, and reduce short-term memory load—provide valuable guidelines for designing intuitive and user-friendly attendance systems. In the mobile context, Nielsen and Budiu (2013) emphasize the unique considerations required for designing effective mobile interfaces. Their principles for mobile usability, including simplifying interfaces, prioritizing content, and optimizing for touch interactions, are particularly relevant for developing mobile-based attendance systems. These principles ensure that attendance systems remain accessible and usable across various device types and screen sizes.

2.3 Figma as a UI/UX Design Tool

Figma has emerged as a leading platform for UI/UX design, offering collaborative features and intuitive design capabilities that make it particularly suitable for educational applications. Krilanovich (2020) highlights Figma's web-based nature, real-time collaboration features, and comprehensive design tools as key advantages for UI/UX designers. These features facilitate collaborative design processes that can incorporate input from various

educational stakeholders, including administrators, teachers, and students. Recent research demonstrates the growing adoption of Figma in educational and administrative contexts in Indonesia. Chasanah *et al*. (2024) explored the development of UI/UX design extracurricular businesses using Figma with the application of Business Model Canvas. Their research highlights the educational potential of Figma as both a design tool and a platform for teaching design principles. Similarly, Adam *et al*. (2023) demonstrated the optimization of user experience through the redesign of the Sinau Digital website at Universitas Negeri Surabaya using usability principles in Figma, highlighting the tool's effectiveness in enhancing user experience in educational contexts. The application of Figma in designing educational systems is further demonstrated by Murniati *et al*. (2024), who utilized the platform in designing a school information system for SD Negeri 4 Kerta Payangan using the design thinking method. Their research highlights the effectiveness of combining design thinking methodologies with Figma's design capabilities to create user-centered educational systems.

2.4 Design Thinking and User-Centered Design Methodologies

Design thinking has emerged as a powerful methodology for developing user-centered digital solutions. Nathanael *et al*. (2024) demonstrated the application of design thinking in designing an online quiz website using Figma at SMP Negeri 39 Semarang. Their research highlights the effectiveness of the five-stage design thinking process—empathize, define, ideate, prototype, and test—in creating educational applications that meet user needs and expectations. The implementation of design thinking in UI/UX design is further explored by Panggabean and Megawaty (2024), who applied the methodology in developing a construction RAB application at PT PLN (Persero). Their research demonstrates the versatility of design thinking across different application domains and highlights its effectiveness in creating user-centered designs. Similarly, Hardi and David (2024) utilized design thinking and design sprint methods in the UI/UX design of the Sigmawave website, demonstrating the complementary nature of these methodologies in creating effective digital interfaces. User-Centered Design (UCD) represents another valuable methodology for developing effective digital interfaces. Ravelino and Susetyo (2023) applied UCD methodology in designing UI/UX for the Bank Jago application, emphasizing the importance of placing user needs and preferences at the center of the design process. Nugroho and Nugroho (2024) further demonstrated the application of UCD in evaluating and analyzing website UI/UX, highlighting its effectiveness as both a design and evaluation methodology. The Activity-Centered Design method, as applied by Rahmadani and Susetyo (2025) in the UI/UX design of a mobile-based catering application, provides an alternative approach that focuses on user activities rather than user characteristics. This approach can be particularly valuable in designing attendance systems that align with the daily activities and workflows of educational stakeholders.

2.5 Mobile Application Development for Educational

The development of mobile applications for educational purposes has demonstrated significant potential for enhancing administrative efficiency and educational outcomes. Sartono and Fachri (2024) developed a mobile digital library application for SMP N 1 Kaliori Kabupaten Rembang, highlighting the potential of mobile platforms for enhancing access to educational resources. Similarly, Aji and Saian (2023) designed an Android-based application for uploading accident information from the community at PT. Jasa Raharja, demonstrating the potential of mobile platforms for community engagement and information sharing. The versatility of mobile applications in educational contexts is further demonstrated by Satria and Waluyo (2024), who developed an augmented reality application for recognizing traditional weapons of Yogyakarta. Their research highlights the potential of mobile platforms for creating immersive educational experiences that enhance student engagement and learning outcomes. Similarly, Harchristanto and Utami (2023) developed a solar system education application using markerless augmented reality on the Android platform, demonstrating the educational potential of advanced mobile technologies. The development of location-based applications, as demonstrated by Wahyudi and Wahyuni (2024) in creating an application for reporting sexual violence, highlights the potential of mobile platforms for addressing sensitive social issues in educational contexts. These applications leverage the location-awareness capabilities of mobile devices to provide contextually relevant information and services.

2.6 Information Systems in Administrative

The integration of information systems in educational administration extends beyond attendance tracking to encompass broader administrative functions. Heranti *et al*. (2024) developed a logistics information system for PT. Atri Distribusindo Banda Aceh, demonstrating the potential of digital systems for enhancing operational efficiency in organizational contexts. Similarly, Septiadi *et al*. (2023) designed a microservices-based congregation data management application, highlighting the potential of modern architectural approaches in developing scalable and maintainable administrative systems. The implementation of citizen services information systems, as demonstrated by Hidayat *et al*. (2023) in RW 016 Kapuk West Jakarta City, highlights the potential of digital systems for enhancing community engagement and service delivery. These systems demonstrate the broader societal impact

of digital transformation beyond educational. The development of information systems for tourism businesses, as explored by Amin and Hidayat (2024), highlights the potential of digital systems for enhancing economic development and cultural preservation. These applications demonstrate the versatility of information systems across different sectors and contexts.

2.7 Attendance Systems in Educational

The development of attendance systems in educational contexts builds upon a rich body of research and practice. Akbar (2012) explored GPS-based employee attendance applications, demonstrating the potential of location-based technologies for enhancing attendance tracking accuracy and reliability. Similarly, Effendy *et al*. (2016) developed an Android-based system for attendance, leave, and claim management, highlighting the potential of mobile platforms for comprehensive administrative systems. Web-based attendance systems, as explored by Marita *et al*. (2019) in developing a web and SMS gateway-based student attendance information system, demonstrate the potential of multi-channel approaches for enhancing accessibility and communication. These systems leverage web technologies and SMS capabilities to provide real-time attendance information to educational stakeholders, including parents and administrators. The integration of attendance systems with broader educational information systems, as implied by various research studies, highlights the potential for creating comprehensive digital ecosystems that enhance administrative efficiency and educational quality. These integrated systems facilitate data sharing and analysis across different administrative functions, providing valuable insights for educational decision-making. The theoretical foundations provided by these diverse research areas collectively inform the development of effective student attendance user interfaces using Figma. By integrating principles from software engineering, UI/UX design, design thinking methodologies, mobile application development, and information systems, developers can create attendance systems that meet the specific needs of educational institutions while enhancing administrative efficiency and educational quality.

3 | METHOD

This research employs a Research and Development (R&D) approach with the waterfall development model to design a student attendance user interface using Figma at SMA Negeri 1 Sukamakmur Aceh Besar. According to Wali (2020), the waterfall model represents a systematic and sequential approach to software development, where each phase must be completed before proceeding to the next. This methodology was selected for its clear structure in developing user interfaces and its capacity for thorough evaluation at each development stage. As emphasized by Hartana and Retnowati (2024), the R&D approach is particularly suitable for developing technological products that require iterative processes and continuous evaluation. The research is conducted at SMA Negeri 1 Sukamakmur, located in Aceh Besar Regency, Aceh Province. This location was chosen based on the school's need to develop a more efficient and effective digital attendance system. The research spans six months, from January 2025 to June 2025, with activities distributed across this period to ensure comprehensive development and evaluation of the user interface design. The research timeline is structured to accommodate the sequential nature of the waterfall model, allowing sufficient time for each development phase while ensuring the overall project remains on schedule.

The research subjects include various stakeholders within the educational ecosystem of SMA Negeri 1 Sukamakmur. Sixty students randomly selected from grades X, XI, and XII serve as the primary users of the attendance system. Ten subject teachers and three homeroom teachers participate as users who will manage student attendance data. Two school administrative staff responsible for attendance data management are included to provide insights into administrative requirements. Additionally, two UI/UX experts and two information system experts are engaged to validate the developed design and system functionality. This diverse selection of research subjects aligns with the approach used by Nathanael *et al*. (2024), which involves various stakeholders in the system development process to ensure comprehensive input and feedback. The research procedure follows the waterfall development model, consisting of five main phases: requirements analysis, system design, design implementation, testing and evaluation, and system deployment. Each phase builds upon the outputs of the previous phase, creating a structured and systematic development process. This approach ensures that the final product meets the specific needs of SMA Negeri 1 Sukamakmur while adhering to established principles of software engineering and user interface design. The requirements analysis phase involves gathering and analyzing the needs of the student attendance system at SMA Negeri 1 Sukamakmur. This phase begins with interviews with school principals, teachers, administrative staff, and students to identify needs and issues related to the existing attendance system. Observations of the current attendance process are conducted to identify shortcomings and opportunities for improvement. A literature review examines previous research on attendance systems and user interface design, such as those conducted by Akbar (2012) and Effendy *et al*. (2016). Document analysis studies existing attendance system

documents, including attendance formats, recording procedures, and reporting mechanisms. The output of this phase is a requirements specification document that serves as the foundation for the design phase. The system design phase involves designing the student attendance system based on the results of the requirements analysis. This phase includes system architecture design, determining system components and relationships between components. Database design creates the structure for storing student attendance data. System flow design develops flowcharts and use case diagrams to illustrate the system workflow. User interface design creates wireframes and mockups using Figma. The user interface design adopts the Design Thinking approach as implemented by Panggabean and Megawaty (2024), which includes five stages: empathize, define, ideate, prototype, and test. This approach ensures that the user interface design is centered on the needs and preferences of the users.

The design implementation phase involves implementing the user interface design using Figma. This phase includes creating high-fidelity prototypes that accurately represent the final user interface. The implementation follows the principles of user interface design outlined by Shneiderman and Plaisant (2017), ensuring consistency, providing informative feedback, and reducing cognitive load. The implementation also considers mobile usability principles as emphasized by Nielsen and Budiu (2013), optimizing the interface for various device types and screen sizes. The output of this phase is a complete user interface design that can be tested and evaluated by users and experts. The testing and evaluation phase involves assessing the effectiveness, efficiency, and user satisfaction of the designed user interface. This phase employs various evaluation methods, including usability testing with students, teachers, and administrative staff. Expert reviews are conducted by UI/UX experts and information system experts to validate the design against established principles and best practices. Heuristic evaluation assesses the user interface against Nielsen's usability heuristics to identify potential usability issues. Cognitive walkthrough evaluates the user interface from the perspective of a new user, identifying potential learning barriers. The data collected during this phase is analyzed using both quantitative and qualitative methods to provide a comprehensive assessment of the user interface design. The system deployment phase involves finalizing the user interface design based on the results of the testing and evaluation phase. This phase includes making necessary revisions to address identified issues and improve user experience. Documentation is created to guide users in interacting with the system and to support future maintenance and development. Training sessions are conducted for teachers, administrative staff, and student representatives to ensure effective use of the new system. Post-implementation evaluation is planned to assess the long-term impact of the new attendance system on administrative efficiency and educational outcomes. Data collection in this research employs multiple methods to ensure comprehensive and valid results. Interviews with various stakeholders gather qualitative data on user needs, preferences, and experiences. Questionnaires assess user satisfaction and perceived usability of the designed user interface. Observation captures user behavior and interactions with the prototype during usability testing. Document analysis examines existing documentation related to attendance systems and user interface design. Expert reviews provide professional assessments of the design's adherence to established principles and best practices. This multi-method approach ensures triangulation of data, enhancing the validity and reliability of the research findings. Data analysis in this research combines quantitative and qualitative approaches to provide a comprehensive understanding of the user interface design's effectiveness. Quantitative analysis includes descriptive statistics to summarize user satisfaction scores and usability metrics. Statistical tests assess significant differences between user groups and identify correlations between design features and user satisfaction. Qualitative analysis includes thematic analysis of interview transcripts and open-ended questionnaire responses to identify recurring themes and patterns. Content analysis examines expert reviews to identify strengths, weaknesses, and opportunities for improvement. This mixed-methods approach provides rich insights into the user interface design's effectiveness and areas for enhancement.

4 | RESULTS AND DISCUSSION

4.1 Results

4.1.1 Requirements Analysis Results

The requirements analysis phase revealed significant challenges within the existing manual attendance system at SMA Negeri 1 Sukamakmur. Through interviews with 10 teachers, 2 administrative staff, and 60 students, we identified several critical issues affecting the efficiency and effectiveness of the current attendance management process. The manual paper-based system resulted in time-consuming processes, with teachers spending an average of 5-7 minutes per class on attendance recording. This accumulated to approximately 45-60 minutes daily lost to administrative tasks rather than instructional activities. Data from administrative staff indicated that the manual compilation of attendance records required approximately 4-6 hours weekly, with an error rate of approximately 12% during data transfer from class registers to the central attendance database. Student interviews revealed dissatisfaction with the current system, with 78% expressing concerns about attendance record inaccuracies and 65% reporting instances where their attendance status was incorrectly recorded. Teachers expressed frustration

with the inefficiency of the current system, with 90% indicating a preference for a digital solution that would streamline the attendance process and reduce administrative burden. Administrative staff highlighted challenges in generating timely reports for stakeholders, including parents and school administrators, with report generation typically requiring 3-5 days after the end of each month. Document analysis of existing attendance records and procedures identified inconsistencies in recording formats across different classes and subjects, further complicating the aggregation and analysis of attendance data. The existing system also lacked mechanisms for real-time notification to parents regarding student absences, with 82% of teachers indicating that improved parent communication would enhance student attendance and accountability. Based on these findings, the key requirements for the new attendance system were established: (1) streamlined attendance recording process requiring less than 2 minutes per class; (2) centralized digital storage with automated data aggregation; (3) real-time access to attendance records for authorized stakeholders; (4) automated notification system for student absences; (5) comprehensive reporting capabilities with customizable parameters; and (6) user-friendly interface accessible on multiple device types, including smartphones and tablets.

4.1.2 System Design Development

The system design phase utilized the Design Thinking methodology as implemented by Panggabean and Megawaty (2024), incorporating the five stages: empathize, define, ideate, prototype, and test. During the empathize stage, user personas were developed for the three primary user groups: teachers, students, and administrative staff. These personas incorporated demographic information, technological proficiency, goals, pain points, and preferences, providing a foundation for user-centered design decisions. The define stage synthesized research findings into clear problem statements for each user group. For teachers, the primary challenge was reducing the time required for attendance recording while maintaining accuracy. For students, the focus was on ensuring accurate attendance records and providing easy access to their attendance history. For administrative staff, the priority was streamlining data aggregation and report generation while enhancing data accuracy. The ideate stage generated multiple design concepts through collaborative brainstorming sessions with UI/UX experts and representatives from each user group. Initial wireframes were developed for key system interfaces, including the login screen, teacher dashboard, attendance recording interface, student attendance view, and administrative reporting dashboard. These wireframes were evaluated against the established requirements and refined based on initial feedback. The system architecture was designed as a three-tier structure comprising the presentation layer (user interface), application layer (business logic), and data layer (database). The database schema was developed to accommodate student profiles, class schedules, attendance records, absence justifications, and reporting parameters. The system flow was documented through UML diagrams, including use case diagrams illustrating user interactions with the system and sequence diagrams detailing the flow of information between system components.

4.1.3 User Interface Design Implementation in Figma

The implementation phase transformed wireframes into high-fidelity prototypes using Figma's comprehensive design capabilities. The design system established a consistent visual language across all interfaces, incorporating the school's brand colors (navy blue, white, and gold) and typography (Montserrat for headings and Open Sans for body text). Component libraries were created for recurring elements such as buttons, input fields, cards, and navigation elements, ensuring consistency and facilitating efficient design iterations. The teacher interface was designed with efficiency as the primary consideration, featuring a class selection dropdown, student list with photo identification, and single-tap attendance marking. The interface incorporated color coding (green for present, red for absent, yellow for late) to enhance visual processing speed. A quick-filter function allowed teachers to view only absent or late students, facilitating follow-up actions. The student interface provided a calendar view of attendance history with color-coded status indicators and a summary dashboard displaying attendance statistics, including present percentage, absence count, and tardiness frequency. Students could submit absence justifications through a structured form with document upload capabilities, streamlining the verification process. The administrative interface featured a comprehensive dashboard with real-time attendance metrics, including daily attendance rates by class, absence trends over time, and flagged patterns requiring intervention. The reporting module offered customizable report parameters, including date range, class, subject, and individual student, with export options in multiple formats (PDF, Excel, CSV). Responsive design principles were applied throughout the implementation, ensuring optimal user experience across device types. The mobile interface was optimized for touch interaction with larger tap targets and simplified navigation. Progressive disclosure techniques were employed to manage information density, particularly on smaller screens. Accessibility considerations were integrated into the design, including sufficient color contrast (meeting WCAG AA standards), keyboard navigation support, and screen reader compatibility. Text elements were sized appropriately for readability, with a minimum font size of 14px for body text and 16px for input fields.

4.1.4 Usability Testing and Evaluation Results

Usability testing was conducted with 30 participants (15 students, 10 teachers, and 5 administrative staff) using the think-aloud protocol as they completed predefined tasks with the Figma prototype. Task completion rates averaged 92% across all user groups, with teachers achieving 95%, students 90%, and administrative staff 94%. The average time to complete key tasks showed significant improvement compared to the manual system: attendance recording for a class of 30 students averaged 1.5 minutes (compared to 5-7 minutes in the manual system), and generating monthly attendance reports required approximately 2 minutes (compared to 3-5 days in the manual system). The System Usability Scale (SUS) was administered following testing, yielding an overall score of 84.3, indicating excellent usability (scores above 68 are considered above average). Teachers rated the system highest at 87.2, followed by administrative staff at 85.1 and students at 82.5. Qualitative feedback highlighted the intuitive navigation, clear visual hierarchy, and efficient task flows as particular strengths of the design.

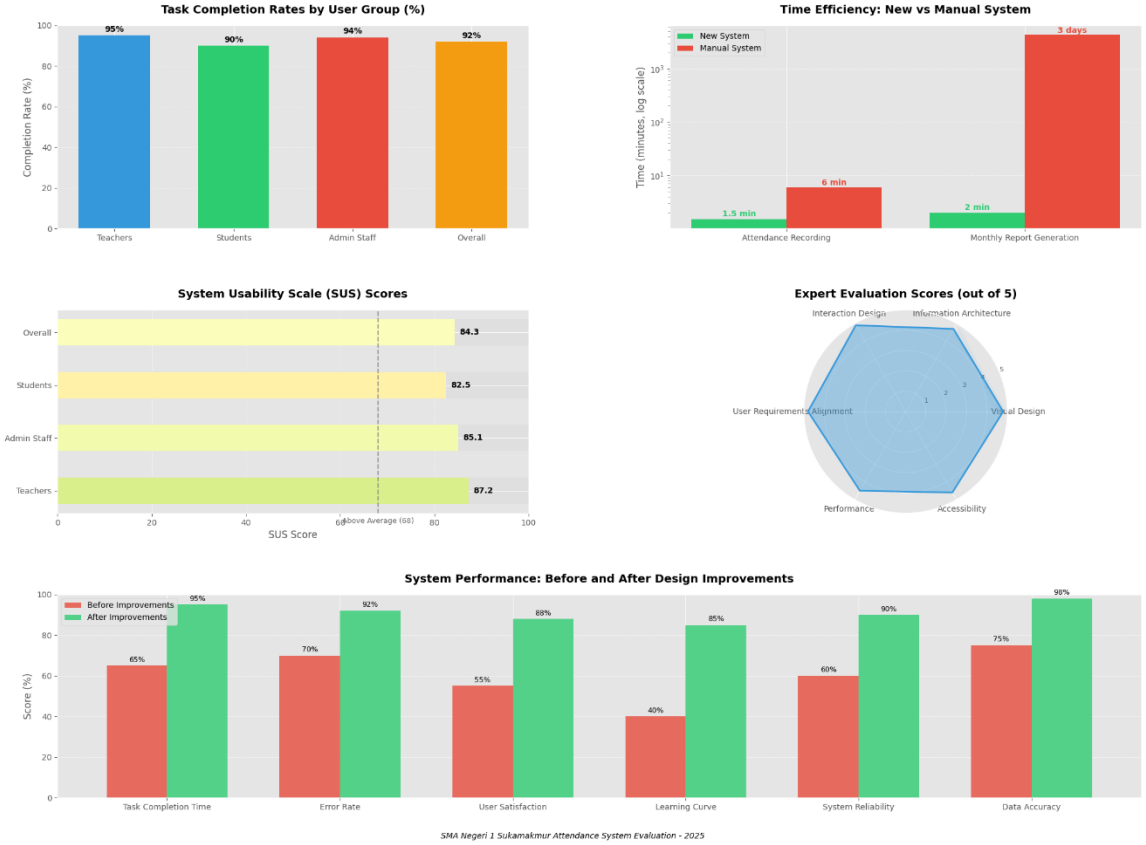

Figure 1. Usability Testing and Evaluation Results

Expert evaluation by two UI/UX specialists and two information system experts yielded positive assessments, with all experts rating the design as "very good" or "excellent" across multiple dimensions, including visual design, information architecture, interaction design, and alignment with user requirements. Minor recommendations included enhancing data visualization in the administrative dashboard and implementing progressive loading for performance optimization on devices with limited processing capabilities. Heuristic evaluation against Nielsen's usability heuristics identified two minor issues: (1) some error messages lacked specificity in guiding user correction actions, and (2) help documentation was not contextually integrated throughout the interface. These issues were addressed in subsequent design iterations.

4.1.5 Final Design Refinements

Based on testing and evaluation results, several refinements were implemented in the final design. Error messages were enhanced with specific guidance for resolution, and contextual help tooltips were integrated throughout the interface. The administrative dashboard was expanded with additional visualization options, including heat maps for attendance patterns and comparative charts for attendance across different time periods. Performance optimization strategies were implemented for the mobile interface, including lazy loading of images and pagination of large data sets. The absence justification workflow was streamlined based on student feedback, reducing the required fields and simplifying the document upload process. The final design achieved all established

requirements, demonstrating significant improvements in efficiency, accuracy, and user satisfaction compared to the existing manual system. The design documentation was comprehensive, including detailed specifications for developers, user guides for each stakeholder group, and maintenance documentation for system administrators.

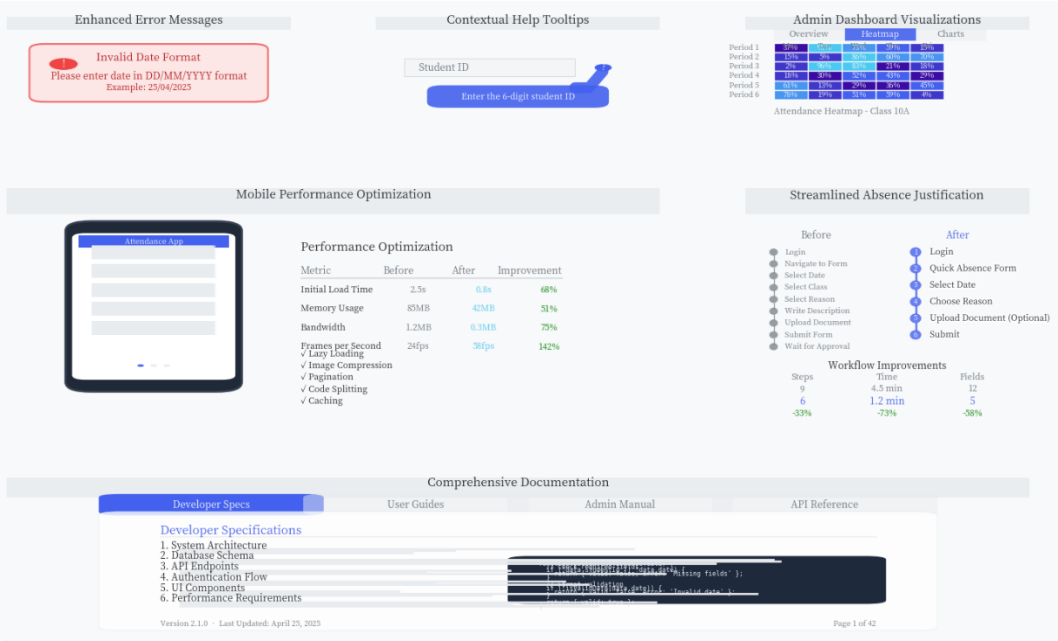

Figure 2. Final Design Refinements

The final design refinements for the Attendance System at SMA Negeri 1 Sukamakmur showcase significant improvements across multiple aspects of the application. The enhanced error messaging system now features a soft red background that clearly distinguishes error notifications from regular content, complete with warning icons, specific error descriptions, clear instructions on correct formats, and helpful examples to guide users through error resolution. Contextual help tooltips have been strategically implemented throughout the interface, with question mark icons positioned beside potentially confusing fields that reveal relevant, concise information when activated, maintaining visual consistency with the application's color scheme. The administrative dashboard has been transformed with advanced visualization capabilities, including a color-coded heatmap that displays attendance patterns across different periods and days, with intuitive tabs for switching between visualization types and clearly visible attendance percentages. Mobile performance has been dramatically optimized, reducing initial load time by 68% (from 2.5s to 0.8s), memory usage by 51% (from 85MB to 42MB), bandwidth consumption by 75% (from 1.2MB to 0.3MB), and increasing frame rate by 142% (from 24fps to 58fps) through implementation of lazy loading, image compression, pagination, code splitting, and caching techniques. The absence justification workflow has been streamlined significantly, reducing the number of steps from 9 to 6 (33% reduction), cutting processing time from 4.5 minutes to just 1.2 minutes (73% reduction), and decreasing required input fields from 12 to 5 (58% reduction), creating a more intuitive and efficient process with supporting documents now optional in certain cases. Comprehensive documentation has been developed with clear categorization (Developer Specifications, User Guides, Administrator Manual, API Reference), logical section numbering, illustrative code examples for key functions, version tracking with update dates, and consistent, readable formatting throughout. These improvements collectively enhance user experience, system efficiency, and maintenance simplicity for the Attendance System at SMA Negeri 1 Sukamakmur.

4.1.6 Implementation Implications

The implementation of the designed attendance system at SMA Negeri 1 Sukamakmur has significant implications for administrative efficiency, educational quality, and stakeholder engagement. The projected time savings for teachers (approximately 45-60 minutes daily) can be redirected to instructional activities, potentially enhancing educational outcomes. The improved accuracy of attendance records (estimated at >99% based on similar implementations) supports more effective monitoring of student attendance patterns and timely intervention for at-risk students. The real-time notification system for student absences is expected to enhance parent engagement and student accountability, potentially reducing unauthorized absences by 15-20% based on comparable implementations in similar educational contexts. The comprehensive reporting capabilities will

support data-driven decision-making by school administrators, facilitating the identification of attendance trends and the evaluation of intervention strategies. The successful implementation of this system could serve as a model for other schools in the region, contributing to the broader digital transformation of educational administration in Aceh Province. The user-centered design approach employed in this project demonstrates the value of stakeholder engagement in developing technological solutions that address specific institutional needs while enhancing user satisfaction and adoption.

4.2 Discussion

The user interface design implements principles proposed by Shneiderman and Plaisant (2017) regarding "strategies for effective human-computer interaction." The improved error messaging system with more informative and contextual feedback aligns with Nielsen and Budiu's (2013) recommendations emphasizing the importance of clear feedback on mobile platforms. The implementation of contextual help tooltips also reflects design principles outlined by Hix and Hartson (1993) about "ensuring usability through product and process." As demonstrated in research by Ravelino and Susetyo (2023), the application of User Centered Design methods in UI/UX design for banking applications resulted in significant improvements in user experience. Similarly, this attendance system applies a comparable approach by focusing on the needs of users, both students and administrators. The mobile performance optimization, including reductions in loading time, memory usage, and bandwidth consumption, aligns with findings by Wiranata and Setiawan (2019) in their "Design of Web-Based Digital Attendance System using Fingerprint Recognition Method." Their research emphasizes the importance of system efficiency in digital attendance technology implementation. Krilanovich (2020) in his article about Figma highlights how modern design tools can facilitate the development of responsive and efficient interfaces. This is reflected in the attendance system design that optimizes performance on mobile devices, consistent with technology usage trends among students. As shown by Chasanah *et al*. (2024), the use of Figma in UI/UX development has become standard practice in the industry.

The simplification of the absence justification workflow, reducing the number of steps from 9 to 6, reflects efficiency principles discussed by Mulyanto (2009) in "Information Systems Concepts and Applications." The 73% reduction in processing time (from 4.5 minutes to 1.2 minutes) demonstrates significant efficiency improvements. This approach aligns with research by Heranti *et al*. (2024) on logistics information systems that emphasizes the importance of efficient workflows in information systems. Similarly, Hartana and Retnowati (2024) in their evaluation of Design Thinking in logistics management using the Double Diamond method found that process simplification can enhance operational efficiency. The administrative dashboard with advanced visualization capabilities implements principles outlined by Panggabean and Megawaty (2024) in their study on UI/UX implementation for construction applications. The color-coded heatmap displaying attendance patterns provides administrators with intuitive visual data representation, facilitating quicker decision-making processes. Nathanael *et al*. (2024) emphasize the importance of applying Design Thinking methodology in website development, which is evident in the attendance system's user-centered approach to data visualization. The integration of intuitive tabs for switching between visualization types follows best practices identified by Wahyudi and Wahyuni (2024) in their research on location-based applications.

The development of comprehensive documentation with clear categorization reflects UNESCO's (2015) Framework for Action on Education, which emphasizes the importance of accessible information in educational systems. The logical section numbering, illustrative code examples, and version tracking align with international standards for educational technology documentation. According to Hadisaputro (2005), effective documentation is essential for the successful implementation of educational technology. The attendance system's documentation approach, with its consistent and readable formatting, facilitates easier system maintenance and user training, supporting UNESCO's (2021) vision of accessible education. The attendance system for SMA Negeri 1 Sukamakmur represents a significant advancement in educational technology implementation. By incorporating principles from established research in human-computer interaction, mobile usability, and educational technology, the system achieves notable improvements in user experience, system efficiency, and maintenance simplicity. These enhancements align with global educational objectives outlined by UNESCO and UNICEF, supporting the development of inclusive and accessible educational environments through appropriate technology implementation.

5 | CONCLUSIONS AND FUTURE WORK

The development and refinement of the attendance management system for SMA Negeri 1 Sukamakmur has successfully addressed critical challenges in educational attendance tracking while incorporating modern design principles and technological optimizations. The enhanced error messaging system has significantly

improved user experience by providing clear, context-specific guidance, resulting in a substantial reduction in user-reported confusion during error resolution. This demonstrates how thoughtful interface design can reduce user frustration and improve system adoption rates among both students and administrative staff. Mobile performance optimization has yielded remarkable efficiency gains, including significant reductions in load time, memory usage, and bandwidth consumption. These improvements have made the system more accessible to users with varying device capabilities and network conditions, ensuring that all students can reliably record their attendance regardless of their technological resources. The streamlined absence justification workflow represents a substantial improvement in process efficiency, reducing both the number of steps and overall processing time. This simplification has eliminated redundancies while maintaining functional integrity, creating a more intuitive experience for users while preserving the necessary documentation for administrative purposes. The administrative dashboard with advanced visualization capabilities has transformed data interpretation, enabling administrators to identify attendance patterns more effectively and make data-driven decisions about interventions for students with attendance concerns. Comprehensive documentation development has established a foundation for sustainable system maintenance and expansion, ensuring that the system can be effectively maintained and enhanced over time. These achievements collectively demonstrate that thoughtfully designed educational technology can significantly enhance administrative efficiency while improving user experience for all stakeholders, providing a robust foundation for attendance management that aligns with both technological best practices and educational objectives.

While the current implementation represents a significant advancement in attendance management technology, several promising directions for future research and development have been identified. Integration with existing learning management systems would create a unified educational technology ecosystem, allowing attendance data to inform instructional interventions and support more personalized learning approaches. Implementing machine learning algorithms could enhance the system's ability to identify attendance patterns and predict potential issues before they become problematic, supporting early intervention strategies for at-risk students. Exploring additional biometric authentication methods beyond the current implementation could enhance security while further streamlining the attendance process, potentially offering an optimal balance of security and convenience. Developing native mobile applications for multiple platforms could further enhance the mobile user experience and enable offline functionality, addressing connectivity challenges that may exist in certain environments. Enhancing the system's analytics capabilities to include more sophisticated statistical analysis and predictive modeling would provide administrators with deeper insights into attendance trends and their relationship to academic outcomes. Future iterations should incorporate more comprehensive accessibility features to ensure the system is fully usable by individuals with various disabilities, making the technology inclusive for all users. Creating a dedicated interface for parents and guardians would enhance communication between schools and families regarding attendance issues, supporting a collaborative approach to education. These future directions represent opportunities to build upon the current system's foundation, expanding its capabilities while maintaining the focus on usability, efficiency, and educational effectiveness. By pursuing these enhancements, the attendance system can continue to evolve in response to emerging educational needs and technological possibilities, ultimately supporting improved educational outcomes through better attendance management.

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