Development of a Cloud-Based School Management Information System Using Google Apps Script at SD Muhammadiyah Kadisoka

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Abstract*—Digital transformation in education remains unevenly distributed, with many Indonesian schools lacking the resources for conventional server-based systems. This study addresses this gap by designing and validating a cost-effective school management information system using a serverless Google Workspace stack for a resource-constrained religious elementary school, SD Muhammadiyah Kadisoka. The system was developed with Google Apps Script as the backend, Google Sheets as the primary datastore, and integrated with WhatsApp via the Wablas API to leverage ubiquitous communication channels. Following the Waterfall methodology, the implemented system provides modules for administrative data management, scheduling, academic grading, and automated notifications. Validation through black-box testing confirmed all functional requirements were met. A System Usability Scale (SUS) evaluation with 13 stakeholders yielded an average score of 74.77, indicating good acceptability. The findings demonstrate that a purpose-built system using widely available, low-cost cloud tools can effectively digitize core administrative workflows, offering a practical model for similar institutions facing infrastructure and budget limitations.

***Keywords*— school information management system, google apps script, cloud computing, serverless architecture, religious based school, whatsapp notifications, wablas api**

I. INTRODUCTION

The integration of information technology into educational management has become a critical standard for operational efficiency and transparency globally [1]. In Indonesia, this shift is driven by government mandates requiring schools to report data through centralized platforms such as Data Pokok Pendidikan (Dapodik) [2]. While these initiatives have successfully digitized national reporting, a significant digital divide remains at the institutional level [3]. A large segment of the educational landscape specifically small-to-medium schools faces substantial barriers to adopting internal digital management systems due to limited financial resources and a lack of technical expertise[4].

Unlike state-funded public schools that often benefit from direct infrastructure support, private religious schools like SD Muhammadiyah Kadisoka frequently operate under their own budget constraints. The existing administrative reliance on the national Dapodik platform presents a functional gap: Dapodik is designed for top-down reporting to the government, not for the bottom-up daily management of school operations [5]. Consequently, schools satisfy external reporting requirements digitally but revert to fragmented, manual paper-based workflows or offline spreadsheets for internal tasks such as grading, scheduling, and parent communication. This digitization leads to data redundancy, high administrative workload, and a lack of transparency for stakeholders, particularly parents who cannot access their children's academic records in real-time [6], [7].

The primary challenge for these institutions is not merely the absence of software, but the incompatibility of conventional enterprise solutions with their resources [8], [9]. Common Management Information Systems (MIS) often require on-premise servers, dedicated IT maintenance staff, or costly subscription fees requirements that are unsustainable for resource-constrained schools [10]. While cloud computing offers a pathway to reduce infrastructure costs, there is a scarcity of research on implementing serverless architectures specifically tailored for schools with zero IT budget and minimal technical literacy [11], [12].

To address this gap, this research proposes and validates a lightweight, serverless School Management Information System (MIS) built entirely within the Google Workspace ecosystem. Instead of a traditional cloud-native application requiring separate hosting and database management, this solution utilizes Google Apps Script as the backend runtime environment and Google Sheets as a structured datastore [13], [14]. This approach leverages the ubiquity of Google tools to minimize the learning curve for staff while eliminating server maintenance costs [15].

Using SD Muhammadiyah Kadisoka as a case study, this research aims to demonstrate that a Google-ecosystem-based architecture can provide a reliable, cost-effective alternative to conventional MIS for resource-constrained schools. The system integrates essential administrative functions including student data management, academic grading, and scheduling and employs the Wablas API to bridge the communication gap through automated WhatsApp notifications. This study contributes a practical technical framework for implementing zero-cost digital transformation in educational institutions that cannot support traditional IT infrastructure.

II. LITERATURE REVIEW

A. Digital Disparity and Administrative Management in Schools

The digital transformation of education in Indonesia is characterized by a significant disparity between centralized government reporting and local institutional management [16], [17]. While the Ministry of Education has successfully mandated the use of Data Pokok Pendidikan (Dapodik) for national data collection, this platform functions primarily as a top-down reporting tool rather than a bottom-up management solution for schools. Consequently, many resource-constrained institutions, particularly religious schools (Madrasah and Sekolah Islam), operate in a "dual-system" reality: they are digital in their reporting to the government but

remain manual and paper-based in their daily internal operations [18].

B. Evolution of Low-Cost MIS Architectures

Previous research has proposed various Management Information Systems (MIS) to address school administration needs. The dominant approach in existing literature utilizes the LAMP stack (Linux, Apache, MySQL, PHP) or frameworks like Laravel to build web-based systems. For instance, Munawarah [19] and Somaida et al. [20] developed web-based solutions that successfully digitized administrative workflows. However, these solutions typically require rented hosting (VPS or Shared Hosting) and regular server maintenance.

As shown in Table I, while these methodologies are effective for institutions with IT budgets, they present a barrier for smaller schools. The primary gap identified is the lack of "maintenance-free" architectures. Most studies focus on feature completeness rather than operational sustainability for non-technical staff. This research differentiates itself by employing a serverless, zero-cost architecture that eliminates the need for hosting management.

TABLE I. COMPARISON OF RELATED WORKS AND RESEARCH POSITION

Author / Study	Methodology	Technology Stack	Key Limitations / Gap
Suwitno [21]	Implementation Study	Cloud Computing (General)	Focuses on the concept of cloud adoption rather than a specific low-code technical architecture.
Munawarah [19]	R&D (Research & Dev)	Web-based (CMS)	The complexity of CMS maintenance often exceeds the technical capacity of non-IT school staff.
Somaida et al. [20]	Waterfall	Web-based (PHP/MySQL)	Relies on traditional hosting which incurs recurring costs; limited scope (payment module only).
Nurdiana et al. [22]	Qualitative Case Study	Web-based + SMS/WA	Highlights communication importance but uses standard web hosting that requires IT maintenance.
This Study	Waterfall	Google Apps Script + Sheets (Serverless)	Eliminates hosting costs entirely; integrates WhatsApp automation; designed for zero-IT maintenance.

C. System Architectures

To address the financial and technical constraints of SD Muhammadiyah Kadisoka, this study shifts from traditional web development to a "Low-Code/No-Code" serverless approach using the Google Workspace ecosystem. Unlike standard cloud computing which often involves "Infrastructure as a Service" (IaaS) costs, Google Apps Script operates as a fully managed "Function as a Service" (FaaS) platform [23], [24].

Table II provides a comparative analysis between the traditional approach found in the literature and the proposed architecture. The choice of Google Sheets as a structured datastore rather than a traditional relational database, like MySQL is a strategic trade-off. While it sacrifices strict relational integrity, it offers superior accessibility for non-technical administrators who are already familiar with spreadsheet interfaces.

TABLE II. COMPARATIVE ANALYSIS OF SYSTEM ARCHITECTURES

Feature	Traditional Web-Based MIS (e.g., PHP/Laravel + MySQL)	Proposed Serverless MIS (Google Apps Script + Sheets)
Hosting Model	Requires Server (VPS/Shared Hosting)	Serverless (Fully Managed by Google)
Infrastructure Cost	Recurring (Monthly/Yearly fees)	Zero Cost (Standard Quota)
Database Structure	Relational Database (Strict Schema)	Structured Spreadsheet (Flexible Schema)
Maintenance	High (OS updates, Security patches)	Zero (Handled by Platform Provider)

D. Automated Communication Gateways

The effectiveness of an MIS is not solely defined by data storage, but by information dissemination [25], [26]. Traditional portals often suffer from low parent engagement. Recent studies by Nurdiana et al. [22] indicate that "push" notifications via instant messaging significantly outperform passive "pull" mechanisms (e.g., checking a website). This study incorporates this finding by integrating the Wablas API to automate WhatsApp notifications, ensuring that the system leverages the most ubiquitous communication channel in Indonesia.

III. RESEARCH METHOD

This study adopts the Waterfall Software Development Life Cycle (SDLC) model as the primary methodological framework. While iterative methods like Agile are popular for dynamic commercial products, the Waterfall model was selected for this research due to the static and well-defined nature of academic administrative rules [27]. The requirements at SD Muhammadiyah Kadisoka, such as grading formulas, class structures, and reporting formats, are governed by fixed institutional policies that do not require frequent changes during the development phase. As illustrated in Fig. 1, the research flow proceeds sequentially through Requirement Analysis, System Design, Implementation, and Testing.

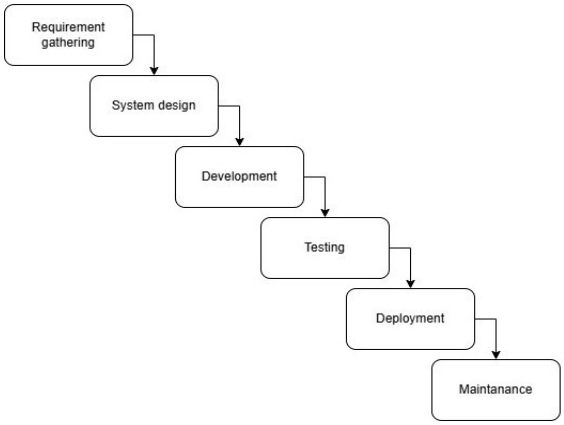

Fig. 1. The Research Workflow based on the Waterfall Model.

A. Requirement Analysis and Data Collection

To align the system design with the institution's specific operational constraints, primary data was gathered using a qualitative approach combining direct observation of existing manual workflows and semi-structured interviews with key stakeholders, including the School Principal, Head of Administration, and senior faculty. This requirements engineering process revealed three critical functional needs: a serverless backend to eliminate infrastructure maintenance, the capability for teachers to input grades remotely outside the local network, and an automated push notification mechanism to disseminate urgent announcements, such as early dismissals, directly to parents.

B. System Architecture and Design

Based on the requirement analysis, the system was designed using a Serverless Architecture, with the design phase utilizing Unified Modeling Language (UML) diagrams to blueprint system behavior before coding commenced. In terms of data modeling, Google Sheets was structured to act as a relational datastore, where separate sheets function as tables specifically for Students, Teachers, and Grades linked by unique identifiers (NISN/NIP). Complementing this structure, the process modeling employs a role-based access control (RBAC) strategy to define specific privileges: Administrators hold full access, Teachers are granted input access, and Students/Guardians are restricted to read-only capabilities. Fig. 2 depicts the System Use Case Diagram, illustrating how these actors interact with the core modules of the proposed system.

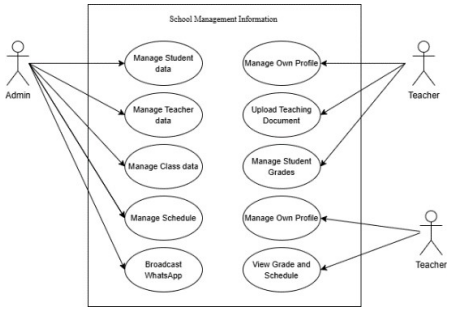

Fig. 2. System Use Case Diagram

C. Implementation and Testing Plan

The construction phase utilized the Google Apps Script environment (based on JavaScript) as the middleware connecting the User Interface (HTML5/CSS) with the Google Sheets database, integrated with the Wablas API for the message gateway.

To ensure scientific validity, the study employed a dual-testing strategy comprising Black-Box testing and usability evaluation. First, Black-Box testing was conducted to verify that every functional input produced the expected output without inspecting the internal code structure, with test cases derived directly from the requirement specifications. Subsequently, User Acceptance was measured using the System Usability Scale (SUS). To address sample size concerns, the study utilized purposive sampling to select a substantial respondent pool consisting of the School Principal, 35 teachers, and 60 student guardians. The instrument used for this evaluation is detailed in Table III.

TABLE III. SYSTEM USABILITY SCALE (SUS) INSTRUMENT

Code	Questionnaire Item	Scale
Q1	I think I will use this system regularly to manage or check school needs.	1-5
Q2	This system feels rigid and less practical when used for school purposes.	1-5
Q3	I found this system easy to use.	1-5
Q4	I felt I needed help from another person, staff, or IT specialist to use it.	1-5
Q5	The menus (grades, schedules, data) are well-organized and interconnected.	1-5
Q6	The system's appearance and functionality are variable and inconsistent.	1-5
Q7	I'm confident most people can learn to use this system quickly.	1-5
Q8	I think the system is too complicated, even though it could be simpler.	1-5
Q9	I feel very confident using this system.	1-5
Q10	I need to learn a lot before I can start using this system smoothly.	1-5

This comprehensive evaluation approach guarantees the system meets both technical requirements and user experience standards, with SUS scores above 68 indicating acceptable usability [28] before deployment at SD Muhammadiyah Kadisoka.

IV. SYSTEM IMPLEMENTATION AND TESTING

This chapter details the technical realization and evaluation of the cloud-based School Management Information System (MIS) developed for SD Muhammadiyah Kadisoka. Following the design and requirements analysis phases outlined in Chapter 3, the system was built to address the specific operational constraints identified during the preliminary research. The implementation focuses on three primary objectives derived from interviews with the school principal and staff: providing a digital platform for teacher document submissions (such as lesson plans), eliminating reliance on expensive local servers, and extending data accessibility to parents who previously had no direct access to the government-centralized Dapodik platform.

A. Database Construction and Interface Implementation

The system backend utilizes Google Sheets as a structured data store. Unlike a standard SQL database, the schema was designed horizontally, with separate sheets acting as entities for Students, Teachers, and Grades. The User Interface (UI) was built using HTML5 within the Google Apps Script container, serving a single-page application that adapts dynamically based on the user's role.

The Administrator Module functions as the central control hub for school operations. Fig. 3 displays the Administrator Dashboard, which provides visualization of school metrics and full Create, Read, Update, and Delete (CRUD) capabilities. Furthermore, Fig. 4 illustrates the Student Data Management Interface, where administrators can input and manage student registries.

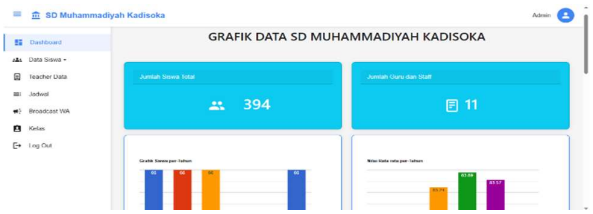

Fig. 3. Administrator dashboard interface.

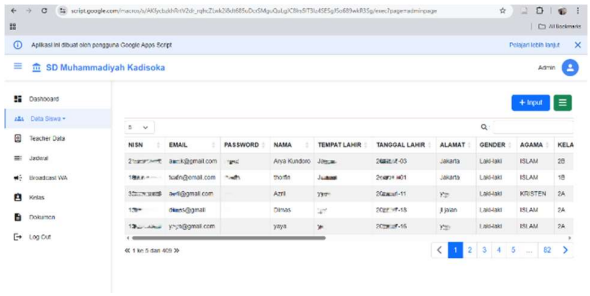

Fig. 4. Student Data Management Interface.

The Teacher Profile was developed to address the specific need for digital document submission. The interface allows for the upload of lesson plans directly to a designated Google Drive folder. Additionally, the grade input form, depicted in Fig. 5, fetches student lists dynamically based on the class assigned to the teacher's NIP, allowing for efficient data entry.

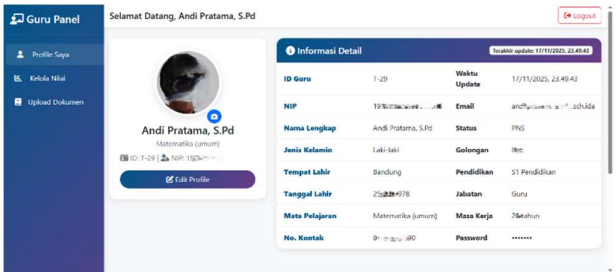

Fig. 5. Teacher Profile interface.

The Student profile focuses primarily on data retrieval. This interface allows guardians to view real-time schedules and academic reports without requiring intervention from school staff. Fig. 6 presents the Student Dashboard and Schedule View available to guardians upon login.

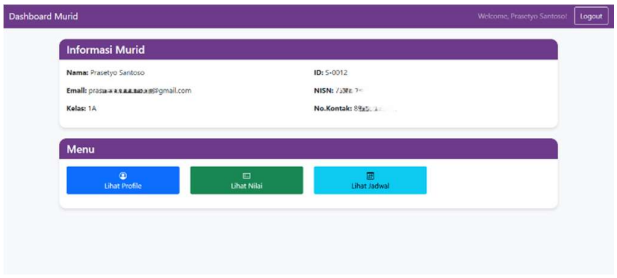

Fig. 6. (a) Student profile interface.

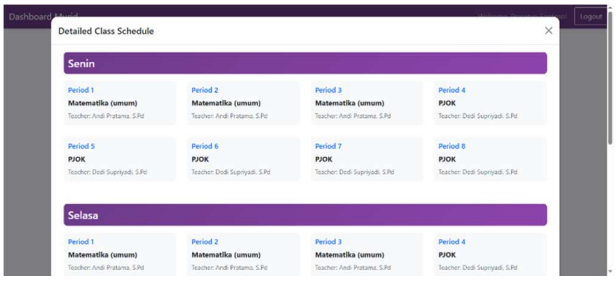

Fig. 7. (b) Schedule interface

B. *Notification System Integration*

A critical feature implemented in this system is the automated notification gateway using the Wablas API. This was developed to enhance the speed of communication, replacing manual SMS or paper notices. The backend logic was programmed to trigger WhatsApp messages during specific events. For instance, upon the successful registration of a new student or when a broadcast message is initiated by the administrator, as shown in Fig. 14, the system constructs a JSON payload containing the recipient's phone number and the message content. This payload is transmitted via an HTTP POST request to the Wablas server, ensuring immediate delivery to parents' WhatsApp accounts.

Fig. 8. WhatsApp messages

C. *Functional Testing*

Functional validation was conducted to ensure the system met the requirements defined in the methodology. This phase followed an iterative process where initial bugs were identified and resolved. Early testing cycles revealed a session management issue where users could navigate back to the account page after logging out, and a data redundancy bug where editing a grade resulted in double entry. These critical issues were patched prior to the final deployment.

Current testing results, summarized in Table IV, reveal that while core functions operate correctly, specific constraints remain regarding the API latency and UI defaults. Notably, the WhatsApp broadcast feature functions successfully but exhibits a throttling delay of 20–30 seconds per message to comply with the Wablas API transmission limits.

TABLE IV. FUNCTIONAL (BLACK-BOX) TESTING RESULTS.

User Role	Test Case Scenario	Expected Outcome	Actual Result	Status
Admin	Session Logout	User cannot return to dashboard after clicking logout.	Initial: User could navigate back. Final: Session acts as terminated; back	Pass (Fixed)

User Role	Test Case Scenario	Expected Outcome	Actual Result	Status
			button redirects to login.	
Teacher	Edit Grades	Updating a grade overwrites the existing value.	Initial: New row created (Double Data). Final: Existing row updated correctly.	Pass (Fixed)
Notification	WhatsApp Broadcast	Message sent to target parents immediately.	Messages delivered successfully, but with a 20–30 second delay between messages due to API throttling.	Pass (with Latency)
Admin	Column Visibility	Admin hides a column (e.g., "Date of Birth") in Google Sheets.	System adapts or ignores hidden columns. The web UI fails to render the table correctly. The script relies on fixed column indexing.	Fail (Bug).
Student	View Grades (Default)	System displays the latest semester grades automatically.	Partial Pass. The table appears empty upon loading. The user must manually select the Class/Semester to trigger the fetch.	

D. Usability Testing (SUS) Analysis

To evaluate the user acceptance of the system, a System Usability Scale (SUS) assessment was conducted with a population of 96 respondents. For the purpose of analysis, the School Principal was grouped with the teaching staff as they share similar internal administrative privileges. Table V presents the statistical summary of these results.

TABLE V. SUS SCORES BY USER ROLE

Respondent Group	Sample Size	Mean Score	Min Score	Max Score	Interpretation
Teachers & Principal	36	88.43	75.00	100.00	Excellent
Student Guardians	60	78.15	60.00	100.00	Good / Excellent
OVERALL	96	82.01	60.00	100.00	Excellent

The overall average score of 81.67 significantly exceeds the benchmark of 68, placing the system in the "Excellent" category of usability. However, a divergence is observed between user groups. Teachers recorded the highest average (88.60), with many participants giving a perfect score of 100. This suggests that the system effectively resolves their previous administrative burdens (manual grading and paper filing), and the interface logic closely mimics their existing workflow, resulting in high intuitiveness.

In contrast, Guardians showed the widest variance (Min: 60.00), although the average remained in the "Good" range (78.15). A detailed review of the raw data indicates that guardians with lower scores (e.g., Respondent 'Rina' and 'Maya') struggled with Question 4 ("I felt I needed help...") and Question 10 ("I need to learn a lot before using..."). This correlates with the Black-Box finding regarding the "View Grades" feature, where the lack of a default view likely confused less tech-savvy parents, requiring them to perform extra clicks to see data.

V. CONCLUSION AND RECOMMENDATIONS

A. Conclusion

This research successfully validated the development of a serverless, zero-cost School Management Information System (MIS) designed specifically for resource-constrained institutions like SD Muhammadiyah Kadisoka. By shifting from traditional server-based architectures to the Google Workspace ecosystem (Apps Script and Sheets), the study demonstrates that digital transformation is achievable without the prerequisite of an IT budget or dedicated infrastructure.

The empirical results from the implementation highlight three key findings. First, regarding operational efficiency, the system effectively bridges the gap between external government reporting (Dapodik) and internal needs. For the school staff, the transition from manual filing to a digital dashboard resulted in a high System Usability Scale (SUS) score of 88.43, indicating that the logic of the application aligns well with existing administrative workflows. Second, regarding user accessibility, the "Dual-Interface" approach provided mixed but positive results. While the overall system usability was rated "Excellent" (82.01), the lower scores among student guardians (78.15) reveal that non-technical users struggle with data retrieval without intuitive defaults. Specifically, the requirement for parents to manually filter class semesters to view grades was identified as a barrier to usability. Third, regarding technical constraints, the serverless architecture eliminates maintenance costs but introduces performance trade-offs. The integration with the Wablas API successfully automated parent notifications but with a measured latency of 20–30 seconds per message due to API throttling. Additionally, the "Column Visibility" bug identified during Black-Box testing confirms that using a spreadsheet as a database creates a tight coupling between data structure and application logic, reducing flexibility compared to standard SQL databases.

B. Recommendations

Based on the identified limitations and user feedback, several strategic improvements are proposed to enhance system maturity. To address the lower confidence scores observed among student guardians, the user experience requires optimization through the implementation of "Smart Defaults" in the Student Module; specifically, the system should automatically render the current active semester's data upon login, thereby removing the cognitive load of manual filtering. Regarding technical performance, the current 20–30 second latency in WhatsApp broadcasts necessitates future optimization, such as implementing a queueing mechanism within the backend script or upgrading to a higher-tier API service to prevent bottlenecks as enrollment increases. Furthermore, to resolve the "Column Visibility" bug inherent to the spreadsheet database, the codebase requires refactoring to decouple the data retrieval logic; referencing headers dynamically rather than by fixed column indices will prevent frontend breakage when administrators modify the spreadsheet layout. Finally, considering the finite cell limit of Google Sheets, a long-term migration strategy to Google Cloud SQL or Firebase is advised once historical data accumulation exceeds the three-year mark, ensuring sustained stability without altering the user interface.

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