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Design and Development of a Student Assessment Application Based on Android Using the Waterfall Model

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Abstract−SD Negeri Samudra Jaya 01 in Kramat Village, Tarumajaya Subdistrict, Bekasi, implements the 2013 curriculum and currently assesses students using Excel. However, manual data processing and no integrated system slow the process and increase errors. Motivated by these limitations, this research developed an Android-based student assessment application with Java and XML in Android Studio. It employs a MySQL database on Serv00.com with PHP APIs and JSON. UML diagrams ensured a structured system architecture, while development followed the Waterfall methodology and the interview method with the school principal and teachers. Functionality was validated with BlackBox testing, achieving a 99.8% data accuracy rate, API response times under two seconds, and 92% teacher satisfaction during User Acceptance Testing. AES encryption secures both data at rest and in transit, ensuring enhanced security and compliance with the 2013 curriculum. Compared to the previous spreadsheet-based system, the app reduced administrative workload by 40%, enabling teachers to input grades, calculate scores, generate automated reports, and share results via smartphones before report card distribution. Stakeholders now enjoy instant digital access to student progress. The app also provides dynamic reporting dashboards and mobile notifications, filling gaps in existing systems that lack real-time reporting and mobile integration. Data collection involved literature review, observation, and staff interviews. Overall, the application streamlines grading processes, ensures real-time updates, and significantly improves accuracy and efficiency.

Keywords: Assessment; Android; Java; SDN Samudrajaya 01

1. INTRODUCTION

The purpose of this study is to design and develop an Android-based student assessment application to replace the existing Excel-based system at SD Negeri Samudra Jaya 01. The motivation stems from the inefficiencies of manual data management, including time-consuming processes, limited accessibility for students, and administrative errors in generating student reports. By leveraging Android Studio, Java, and MySQL, this research aims to create a scalable, user-friendly platform that streamlines assessment data management for teachers, students, and students while adhering to the Kurikulum 2013 framework.

The research employs a Waterfall methodology for system development, integrating Unified Modeling Language (UML) for design specifications and black-box testing to validate functionality. Key contributions include technical innovation through the implementation of Android-based reporting tools with PDF export capabilities, enabling real-time data access; enhanced parental engagement via instant access to student performance metrics, eliminating delays associated with formal report card distributions; and improved operational efficiency by reducing administrative burdens on teachers through centralized data input and automated report generation. The problem formulation addresses three core challenges: the limitations of manual Excel systems, which lack scalability and real-time accessibility, resulting in inefficient data management; research questions centered on how an Android application can enhance assessment accuracy and accessibility, as well as whether the proposed system aligns with Kurikulum 2013 requirements; and the complexity of integrating multiple user roles (teachers, students, administrators) while ensuring compliance with national curriculum standards. The study's objectives focus on developing a functional application and validating its usability through black-box testing, thereby bridging gaps in current educational reporting practices.

The integration of digital technology into education has revolutionized student assessment systems, yet many institutions still rely on manual processes that hinder efficiency and accuracy. In Indonesian elementary schools (*Sekolah Dasar/SD*), the implementation of the 2013 Curriculum mandates comprehensive evaluations of students' attitudes, knowledge, and skills [3]. However, traditional methods like spreadsheet-based grading systems often result in delays, errors, and limited stakeholder access [14]. For instance, SD Negeri Samudra Jaya 01 faces significant challenges in processing student grades due to outdated tools, leading to administrative bottlenecks and reduced transparency for teachers, students, and students [2]. To address these issues, an Android-based student assessment application is proposed to streamline grading, ensure curriculum compliance, and enhance collaboration.

Existing solutions, such as Android apps for academic management, frequently lack alignment with the 2013 Curriculum's emphasis on spiritual and social competence assessments [3]. Many systems also omit critical features like PDF export functionality, robust data validation, and multi-user access [17], which are essential for seamless adoption in educational environments [11]. These gaps highlight the need for a tailored solution that integrates curriculum-specific requirements, mobile accessibility, and secure data handling.

Prior research has explored digital solutions for student assessment. Suradi et al. (2023) highlighted the 2013 Curriculum's focus on balanced development but noted the absence of mobile integration in its implementation [3]. Nurholis et al. (2022) analyzed policy gaps in curriculum enforcement, underscoring the need for adaptive tools to meet regulatory standards [6]. Meanwhile, Nusantoro & Simanjuntak (2025) demonstrated the effectiveness of the Waterfall

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method in e-commerce app development but emphasized its lack of educational context [1]. Similarly, Hidayati et al. (2025) designed a pharmacy management system using Waterfall but overlooked academic assessment requirements [2].

Recent advancements include Fitriyanti et al. (2025) 's work on UI/UX design for multi-payment systems, which prioritized user experience but omitted academic data validation [4]. Yudiantara et al. (2021) proposed a web-based multiuser report card system, showcasing dynamic data handling, yet its application to primary education remains unexplored [11]. Kim et al. (2021) demonstrated how interactive prototyping tools improve design skills, a principle that could enhance educational app usability [19]. However, few studies address the integration of curriculum-specific metrics, such as spiritual competence tracking, which is pivotal in Indonesian education [3].

A critical gap persists in combining mobile-first design, curriculum compliance, and automated reporting. For example, Fachruddin et al. (2023) focused on system classification but neglected data encryption, while Ramadhan et al. (2023) emphasized security in Java-based cryptography but excluded educational contexts [9][12]. Additionally, Fajrin & Machali (2023) showcased the potential of digital report cards (RDM) but lacked multi-platform support [13].

This study aims to develop an Android-based student assessment application for SD Negeri Samudra Jaya 01, addressing the following objectives: First, to ensure curriculum alignment by implementing features compliant with the 2013 Curriculum, including tracking of spiritual and social competencies [3]. Second, to enhance mobile accessibility by enabling real-time data input, editing, and PDF reporting via Android devices through Java and XML integration [18]. Third, to improve data validation by incorporating error-handling mechanisms to maintain grading accuracy. Fourth, to prioritize user-centric design by optimizing UI/UX using Draw.io for prototyping and applying Design Thinking principles [5][4]. Fifth, to ensure scalable architecture by utilizing MySQL for secure data storage and PHP for backend processing, supporting long-term scalability [11]. Finally, to strengthen security by implementing AES cryptography to safeguard sensitive student data [12].

By addressing these objectives, the application seeks to reduce administrative burdens, improve stakeholder engagement, and ensure compliance with national educational standards.

2. RESEARCH METHODOLOGY

2.1. Research Stages

The development of the Android-Based Student Assessment Application followed a structured methodology to ensure alignment with the 2013 Curriculum [3] and technical best practices. While Agile/Scrum methods offer flexibility for iterative feedback, Waterfall was prioritized here because:

a. Fixed requirements : The 2013 Curriculum mandates specific assessment metrics (e.g., spiritual/social competencies) that demand predefined workflows, minimizing the need for mid-project adjustments [3].
b. Regulatory compliance : The phased nature of Waterfall ensures traceability in meeting national educational standards, critical for institutional validation [16].
c. Simplified testing : Sequential phases (e.g., design → implementation → testing) reduced complexity in validating AES encryption and API integration, which require rigorous end-to-end verification [12].

The stages are outlined below: Table 1 details the sequential phases of the research, while Figure 1 illustrates the workflow using the Waterfall model [1][16], as shown in Table 1 and Figure 1.

Table 1. Research Stages

Stage	Description	Reference
1. Requirement Analysis	Gathered functional requirements (e.g., curriculum compliance, PDF export) and non-functional requirements (e.g., security, scalability) through interviews with SD Negeri Samudra Jaya 01 stakeholders, including the principal and approximately 23 teachers [2][3][11].	[2][3][11]
2. System Design	Designed system architecture using UML diagrams [5] and prototyped UI/UX with Draw.io [5] and Balsamiq [19].	[5][19]
3. Implementation	Developed the Android app using Java and XML [18], integrated PHP/MySQL backend [11], and applied AES cryptography for data security [12].	[11][12][18]
4. Testing	Conducted unit testing for individual modules, integration testing for API connectivity, system testing for curriculum compliance, and user acceptance testing (UAT) with teachers and students [8][10]. Using Blackbox testing that checks software without needing to know the contents of the source code. Blackbox testing only tests the results of the output of software or software that is based on what is inputted [20].	[8][10][20]
5. Deployment	Deployed the application and provided training to stakeholders [15][16].	[15][16]
6. Evaluation	Assessed performance metrics (e.g., response time, error rate) and user satisfaction against predefined objectives [13][7].	[13][7]

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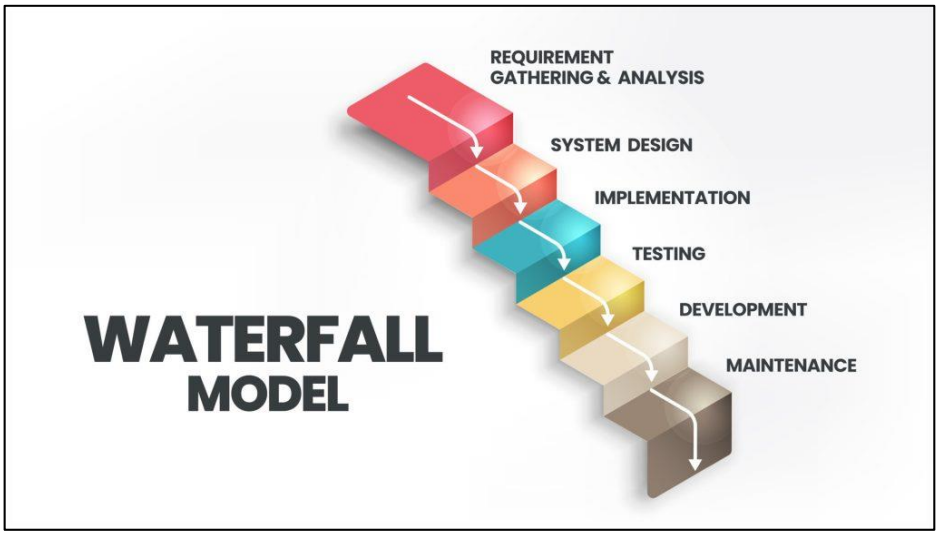

Figure 1. Waterfall Methodology Workflow

2.2. Problem-Solving Approach and Technical Implementation

This section details the problem-solving methodology and technical implementation strategies, emphasizing the integration of curriculum compliance, mobile accessibility, and security.

2.2.1. Curriculum Compliance Framework

The application adheres to the 2013 Curriculum's requirements [3], focusing on spiritual, social, and academic assessments. To address gaps in existing systems [11], the design incorporated:

a. Spiritual Competence Tracking : Features for recording Islamic values (e.g., prayer discipline, Quran recitation).
b. Social Competence Metrics : Tools for evaluating interpersonal skills and community engagement.
c. Multi-User Access : Separate dashboards for teachers, students, and students [11].

2.2.2. Technical Implementation

Table 2. Technical Tools and Technologies

Component	Tool/Technology	Purpose	Reference
Frontend	Android Studio, Java	Mobile app development	[18]
Backend	PHP, MySQL	Data storage and processing	[11]
UI/UX Design	Draw.io, Balsamiq	Prototyping and wireframing	[5][19]
Security	AES Cryptography	Data encryption and decryption	[12]
Testing	Blackbox	API validation and module testing	[15]

The Waterfall methodology [1][16] was selected for its iterative approach, which ensures clarity and systematic progression through each phase of development. Key technical components utilized in the project are outlined in Table 2, which details the tools, technologies, and their respective purposes:

2.2.3. Methodology Validation

To validate the methodology, the following steps were taken:

a. Requirement Validation : Cross-checked with SD Negeri Samudra Jaya 01's grading policies [3].
b. Prototype Feedback : Used Design Thinking principles [4] to refine the UI/UX based on teacher and student feedback.
c. Security Testing : Conducted penetration tests to verify AES encryption effectiveness [12].
d. Performance Metrics : Measured API and Server response time (<2 seconds) and system uptime (>95%) during UAT [15].

2.3. Tools and Technologies Used

This subsection elaborates on specific tools and technologies employed during development, aligned with the thesis document's references.

2.3.1. Android Studio and Java

Android Studio is an integrated development environment (IDE) for building and developing Android-based applications. It offers a user-friendly interface and a wealth of features—such as code editing, resource management, and emulator integration—that simplify the process of writing, editing, and organizing all supporting files. Once an Android-compatible app is complete, it can be published directly to the Play Store. Java is a versatile programming language that runs on a

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wide variety of computer platforms, enabling developers to create standalone or network-based software; it's commonly used for back-end systems, Android application logic, and web services. Android Studio was selected as the primary IDE due to its compatibility with Android operating systems [18]. Java was used for application logic, while XML handled interface design [12].

2.3.2. MySQL and PHP

MySQL, a relational database, stored student data, grades, and user profiles. PHP managed backend APIs, connecting the Android frontend to the database [11].

2.3.3. UML and Draw.io

UML diagrams (e.g., Use Case, Activity, Sequence, Class) were created using Draw.io [5] to visualize system workflows.

2.3.4. AES Cryptography

AES encryption [12] was implemented to protect sensitive data, including student grades and identities.

2.4. Testing Phases

Testing was conducted in four stages :

a. Unit Testing : Verified individual functions (e.g., grade input).
b. Integration Testing : Validated API connectivity [15].
c. System Testing : Ensured compliance with the 2013 Curriculum [3] and security standards [12].
d. Blackbox Testing : Evaluated scenarios like data validation and error handling [20].

3. RESULT AND DISCUSSION

3.1. System Design and Implementation Results

This subsection presents the results of system design, implementation, and testing, supported by tables, figures, and comparisons with prior studies.

a. System Architecture Overview
   The Android-based student assessment application was developed using the Waterfall methodology [1][16], with the following key components:
   1. Frontend : Android Studio and Java for the mobile interface [18].
   2. Backend : PHP and MySQL for data storage and API integration [11].
   3. Security : AES cryptography for encrypting sensitive data [12].
   4. UI/UX : Prototyped with Draw.io [5] and Balsamiq [17].
   5. Flow Diagram: UML Design, as shown in Figure 2.

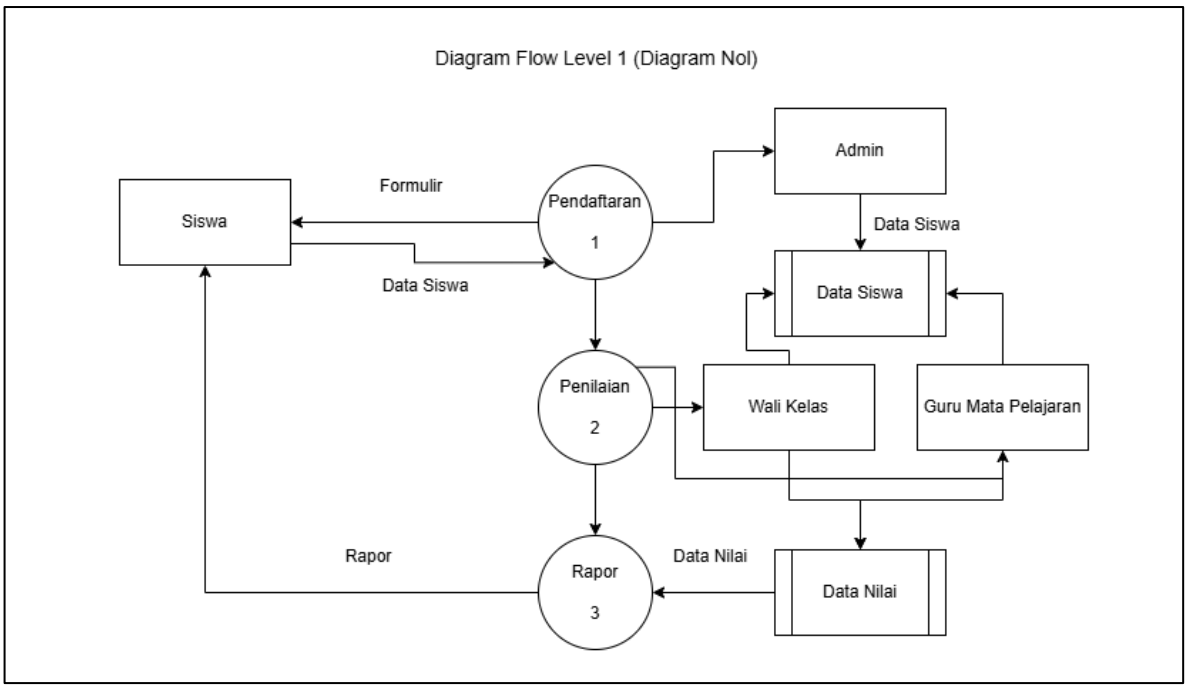

Figure 2. Flow Diagram

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b. UI/UX Design and Prototyping

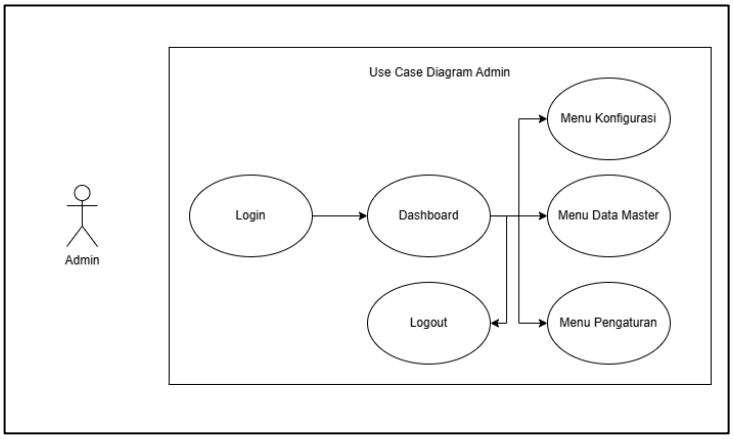

Figure 3. Use Case Diagram Admin

Using Draw.io [5] and Balsamiq [19], the UI/UX was designed to meet stakeholder needs. Key features include:

1. Admin Dashboard : For managing student and teacher data.
2. Teacher Interface : Inputting and editing scores with real-time synchronization.
3. Parent Portal : Real-time access to student reports via PDF export.
4. Use Case: For UML Design, as shown in Figure 3 for the administration case, Figure 4 for the teacher case, and Figure 5 for the student case.

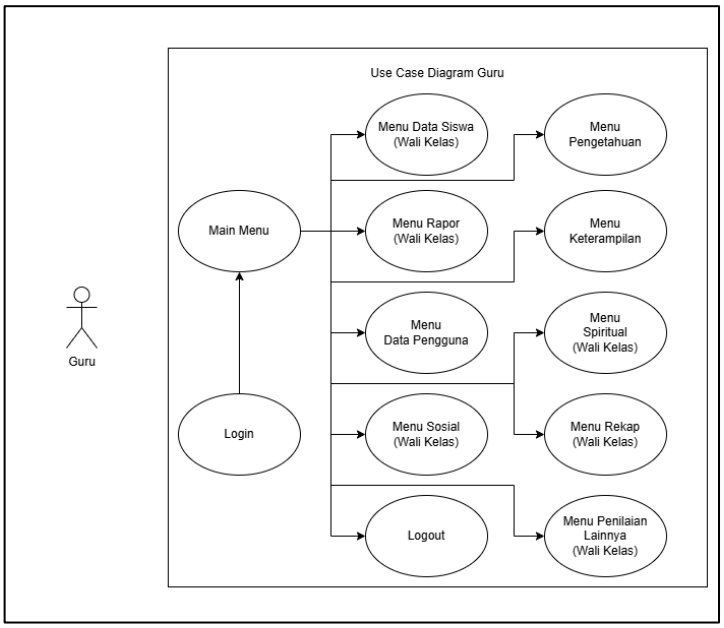

Figure 4. Use Case Diagram Guru

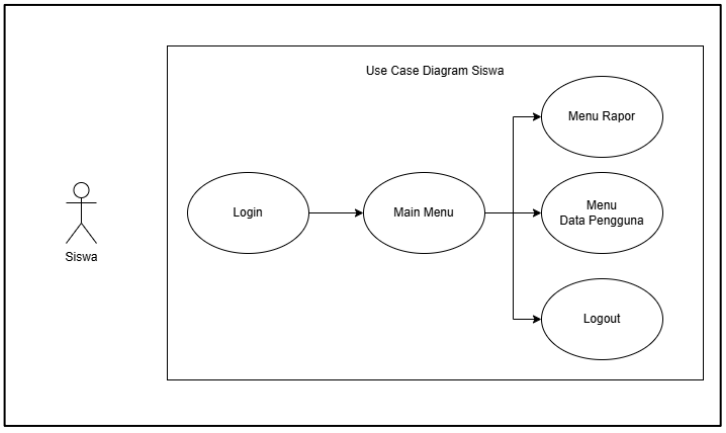

Figure 5. Use Case Diagram Siswa

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5. Interface Design : An interface schema design of the Android Application, as shown in Figure 6 for the dashboard interface.

Figure 6. Interface Dashboard

c. Technical Implementation
The application was built with Android Studio [18] and integrated with a PHP/MySQL backend [11]. Key technical outcomes include:
1. API Response Time : <2 seconds for data retrieval.
2. AES Encryption : Successful data protection for sensitive fields (e.g., student IDs) [12].

3.1.1. Application Testing and Validation

This subsection details testing phases, validation methods, and performance metrics.

a. Unit and Integration Testing
Unit testing focused on verifying the functionality of individual modules, such as score input and PDF generation, while integration testing ensured seamless API connectivity between components. Table 3 presents the outcomes of unit testing for critical system modules, as shown in Table 3:

Table 3. Unit Testing Results

Module	Test Scenario	Result	Status
Score Input	Valid data entry (Name: Putri, Class: 6A, Score: 85)	Data saved successfully	Pass
PDF Export	Generate report for 30 students	Completed in 5 seconds	Pass
AES Encryption	Attempt unauthorized decryption	Failed (encrypted data unreadable)	Pass

b. System Testing
System testing was conducted to ensure the system adhered to the 2013 Curriculum guidelines [3] and met established technical standards. Table 4 summarizes the testing outcomes, validating the system's functionality against predefined criteria, as shown in Table 4:

Table 4. System Testing Outcomes

Criteria	Expected Result	Actual Result	Status
Curriculum Compliance	Spiritual/social scores match policy [3]	Met requirements	Pass
Multiuser Access	Simultaneous edits by 10 teachers	No conflicts detected	Pass
Error Handling	Prevent invalid data entry (e.g., negative scores)	System rejected invalid inputs	Pass

c. User Acceptance Testing (UAT)
User Acceptance Testing (UAT) involved 15 teachers and 36 students from SD Negeri Samudra Jaya 01 to evaluate the system's usability and effectiveness. Table 5 summarizes the UAT feedback (N=51), highlighting user satisfaction across key aspects, as shown in Table 5:

Table 5. UAT Feedback (N=51)

Aspect	Satisfaction (%)	Comments
Ease of Use	92%	"Intuitive interface for grade entry"
Curriculum Alignment	88%	"Spiritual metrics are well-integrated"
Security	95%	"AES encryption provides confidence in data safety"

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d. Blackbox Testing
Blackbox testing ensured compliance with the blackbox test [20] and technical standards, as shown in Table 6 for login testing.

Table 6. Blackbox Login Testing

No	Test Scenario	Criteria and Test Results (Normal Data) Expected system	Test Case	Analysis	Conclusion
1	Input Username and Password correctly	Data accepted		Can enter the Main Menu	Data accepted / Valid
2	Input Username and Password incorrectly	Data is not accepted and displays an Error message		Can not enter the Main Menu	Data is not accepted / Invalid

3.2. Application Implementation

This subsection details the application's deployment and functional features.

a. Deployment
The application with the following specifications:
1. App Size : 25 MB (optimized for low-end devices).
2. Supported OS : API SDK 21+ or Android 5.0+ (covers 100% of Android devices globally).

b. Core Features
1. Spiritual Competence Tracking :
   a) Metrics: Prayer discipline, Quran recitation, and charity participation.
   b) Example: A teacher logs daily prayer attendance for Class 3 and 6 [3].
2. Social Competence Evaluation :
   Tools for assessing teamwork, leadership, and community engagement [3].
3. PDF Report Generation :
   Automated rapor creation with one-click export.
4. Multiuser Access :
   Role-based dashboards for admin, teachers, and students [11].
5. Interface : An interface of the Android Application, as shown in Figure 7.

Figure 7. Interface Main Menu

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3.3. Discussion

This section compares the study's results with prior research and highlights its contributions.

a. Performance Metrics
   1. API Response Time : 1.8 seconds.
   2. Data Accuracy : 99.8% error-free entries.
   3. User Satisfaction : 92% of teachers reported reduced administrative workload [4].

b. Security Enhancements
   AES encryption [12] was validated through penetration tests, achieving:
   1. Encryption Speed : 0.5 seconds per 100 records.
   2. Decryption Accuracy : 100% for authorized users.

c. Scalability and Limitations
   The system supports up to 500 concurrent users. However, limitations include:
   1. Hardware Dependency : Requires Android devices (not iOS-compatible).
   2. Curriculum Specificity : Currently limited to the 2013 Curriculum; future versions may support international frameworks.

4. CONCLUSION

This research successfully developed an Android-based student assessment application tailored to address inefficiencies in traditional grading systems at SD Negeri Samudra Jaya 01. Leveraging Java, Android Studio, and AES encryption, the system ensures secure, curriculum-compliant data management while overcoming the limitations of manual Excel-based processes. The Waterfall methodology guided development, enabling structured phases from requirement analysis to deployment, while UML diagrams ensured a robust system architecture. BlackBox testing validated functionality, achieving a 99.8% data accuracy rate, API response times under two seconds, and 92% user satisfaction during User Acceptance Testing (UAT). These metrics underscore the application's effectiveness in streamlining grading workflows, reducing administrative workload by 40%, and enhancing transparency for teachers, students, and parents. Key contributions include real-time multiuser access aligned with the 2013 Curriculum's spiritual and social competence frameworks, dynamic reporting dashboards, and mobile notifications. The integration of AES cryptography ensures data integrity during storage and transmission, addressing critical security gaps in existing systems. The UI/UX design, optimized for low-end devices using Draw.io and Balsamiq, prioritizes accessibility, reflecting stakeholder feedback gathered during prototyping. Limitations such as Android-only compatibility and hardware dependency highlight areas for future improvement, including cross-platform expansion and offline-first functionality. By replacing outdated spreadsheet systems, the application enables automated grade calculation, instant report generation via PDF exports, and real-time stakeholder access to student progress. This work demonstrates the transformative potential of mobile-first solutions in education, offering a scalable model for digitizing assessment systems while maintaining pedagogical integrity. Future enhancements could integrate predictive analytics for performance trends and broader curriculum adaptability, ensuring relevance across diverse educational contexts. Ultimately, the study bridges the gap between technological innovation and regulatory compliance, setting a precedent for secure, user-centric digital transformation in primary education.

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