

Barcode-Based Student Memorization Monitoring System Using Extreme Programming

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ABSTRACT

Luqman Al Hakim Islamic Boarding School in Surabaya faces inefficiency in recording halaqoh attendance and monitoring students' memorization progress due to reliance on manual paper-based methods and Mutaba'ah Yaumiyyah books. This reliance leads to a high risk of data loss, slow recapitulation, and a lack of real-time transparency for parents. This study aims to develop a mobile-based information system using the Flutter framework to address these issues. The Extreme Programming (XP) method is applied, focusing on iterative system development through planning, designing, coding, and testing phases. The system utilizes barcode scanning using the Student Identification Number (NIS) for accurate attendance tracking. Furthermore, the application integrates the Hive local database and Firebase Cloud Firestore to provide offline-first capabilities. This feature ensures teachers can input data without an internet connection, automatically synchronizing it once the network is available. Functional testing using the Black Box method demonstrates that all features for the Admin, Halaqoh Teacher, Parent, and Superadmin roles operate at 100% validity. In conclusion, this application successfully digitalizes boarding school administration, secures data records, and provides transparent memorization monitoring for parents.

Keyword: Attendance, Barcode, Extreme Programming, Flutter, Memorization Monitoring, Offline-first.

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1. INTRODUCTION

Islamic boarding schools (pesantren) play a vital role in Quranic education, yet many still rely on conventional administrative methods that are highly inefficient [1], [2]. Specifically, at the Luqman Al Hakim Islamic Boarding School in Surabaya, halaqoh (Quranic study circle) attendance and students' memorization progress are recorded manually using paper sheets and Mutaba'ah Yaumiyyah books. Based on interviews with the Head of the Dormitory, this manual approach causes several severe operational issues, including a high risk of data loss, human errors during manual entry into Microsoft Excel, and slow recapitulation processes. Furthermore, this conventional system creates a significant information gap, making it difficult for parents to receive real-time updates regarding their children's memorization achievements [3].

Digital solutions have been explored in several previous studies to address similar administrative issues. The implementation of an Android-based QR code attendance system for hospital employees successfully improved data management efficiency and minimized physical contact [4]. Similarly, a QR code presence system for university students demonstrated 100% functional validity and a 91% usability score [5], while another Android-based QR presence application achieved excellent UEQ scores and 1.6-second startup efficiency [6]. In the context of Islamic education, web and mobile applications have been developed for monitoring general academic progress in a Tahfidz house, providing transparency for parents [7]. Another study developed a Progressive Web Application (PWA) specifically for monitoring the memorization of Juz 30 [8].

Despite these technological advancements, previous research primarily focused either on general attendance without integrating learning achievements or on partial memorization monitoring without robust offline support. There is a lack of a comprehensive system that seamlessly integrates barcode-based attendance with detailed Quranic memorization monitoring across all 30 Juz. Additionally, pesantren environments often experience unstable internet connectivity, a critical issue that previous online-only systems failed to address effectively.

To overcome these administrative challenges, this study proposes the development of a barcode-based mobile application for halaqoh attendance and memorization monitoring using the Flutter framework [9]. The system utilizes the existing Student Identification Number (NIS) on the student card as a barcode for rapid and accurate attendance tracking. The application is developed using the Extreme Programming (XP) methodology to accommodate iterative development and rapid feedback [10]. The primary novelty of this research lies in its offline-first architecture, integrating the local Hive database with Firebase Cloud Firestore. This capability ensures that teachers can seamlessly record attendance and memorization data without an internet connection, automatically synchronizing it to the cloud when connectivity is restored, thereby providing real-time transparency for boarding school management and parents.

2. METHODS

This study is an applied research study in software development aimed at designing and developing a barcode-based halaqoh attendance and memorization monitoring application. In its development process, this study utilizes the Extreme Programming (XP) method as part of the Agile Software Development framework, which significantly accelerates system creation through an iterative and highly adaptable approach tailored to user requirements [10]. The research phases are structured based on the XP approach, which includes four main phases: planning, interactive designing, coding, and final testing [11].

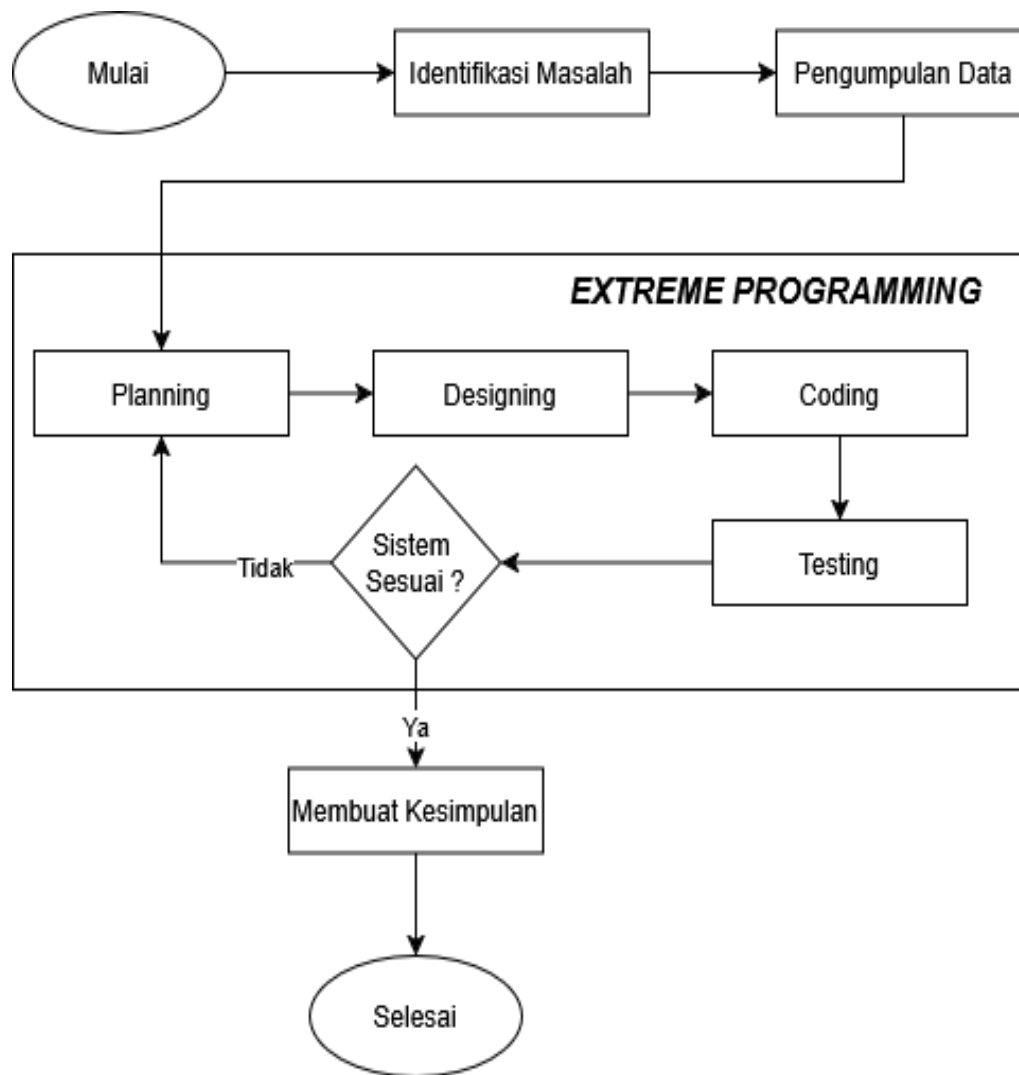


Figure 1. Research Flow Diagram

2.1 Data Collection

Data collection in this study was obtained from literature reviews and direct interviews conducted at the Luqman Al Hakim Islamic Boarding School in Surabaya. Information gathering was carried out through semi-structured interviews with the Head of the Dormitory to identify the core administrative problems, particularly regarding the inefficiency of manual attendance and the high risk of data loss associated with the *Mutaba'ah Yaumiyyah* books. These identification results were then analyzed in-depth as part of the requirements planning phase in the XP method to establish the functional and non-functional requirements.

2.2 System Design and UML

For crafting the software blueprint, this research uses the Unified Modeling Language (UML) to specify the structure and behavior of the object-oriented system [12]. The developed UML diagrams include a use case diagram to model interactions among four user roles (Superadmin, Admin, Teacher, and Parent) [13], an activity diagram to illustrate the barcode scanning and memorization input flows, and a class diagram to explain the static database structure mapping the relationships between students, teachers, and *halaqoh* groups. Furthermore, wireframing is utilized to construct a low-fidelity user interface design to facilitate early evaluation of the system's architecture before the coding phase [14].

2.3 Flutter Framework and Dart

The application is developed using the Flutter framework and the Dart programming language. Flutter serves as a cross-platform development tool that allows the system to be efficiently deployed on both Android and iOS devices using a single codebase [9]. It utilizes the Skia graphics engine to ensure high-performance rendering of the dashboard components and real-time memorization progress interfaces without compromising the device's computing resources [15].

2.4 Offline-First Database Architecture

To overcome the unstable internet connectivity often experienced in the boarding school environment, the system implements a robust offline-first database architecture. It utilizes Hive, a lightweight and blazing-fast key-value local database written in pure Dart, to store attendance and memorization data temporarily during offline states without requiring native dependencies [16]. Once the network is available, the system automatically synchronizes the local data to Firebase Cloud Firestore. As a NoSQL document database, Firestore securely manages the hierarchical data structure and ensures real-time data integration, enabling parents to continuously monitor their children's progress [17].

2.5 Black Box Testing

For system functionality testing, this study applies the Black Box Testing method to ensure all features operate according to the boarding school's requirements without examining the internal code structure [18]. This testing validates the input, process, and output of each application module. The test scenarios encompass authentication modules, barcode scanning accuracy, local-to-cloud data synchronization, and PDF report generation across all user access rights to guarantee 100% functional validity.

3. RESULTS AND DISCUSSION

This section presents the research findings and the system development outcomes of the MyHalaqoh application, structured into several sub-sections. The discussion covers problem analysis, system architecture, offline-first implementation, user interface, and functional testing results.

3.1 Problem and System Requirements Analysis

Based on interviews with the Head of the Dormitory of PP Luqman Al Hakim Surabaya, the manual administration of halaqoh attendance and memorization relies heavily on paper sheets and Mutaba'ah Yaumiyyah books. This conventional approach causes missing records, data loss when physical books are damaged, and requires tedious manual recapitulation into Microsoft Excel. To mitigate these operational delays and provide transparency, a digital mobile-based application with barcode integration is developed.

The functional requirements include master data management by the Admin, rapid barcode scanning (NIS) for attendance, automated juz calculation for new memorization (ziyadah) and repetition (muraja'ah), PDF report generation, and a real-time dashboard for parents. Non-functional requirements emphasize an offline-first capability for unstable connections, cross-platform compatibility via Flutter, and robust data protection through role-based authentication.

3.2 Use Case Diagram

The system architecture maps interactions among four distinct user roles: Admin, Teacher, Parent, and Superadmin. The detailed use case design is presented in Figure 2.

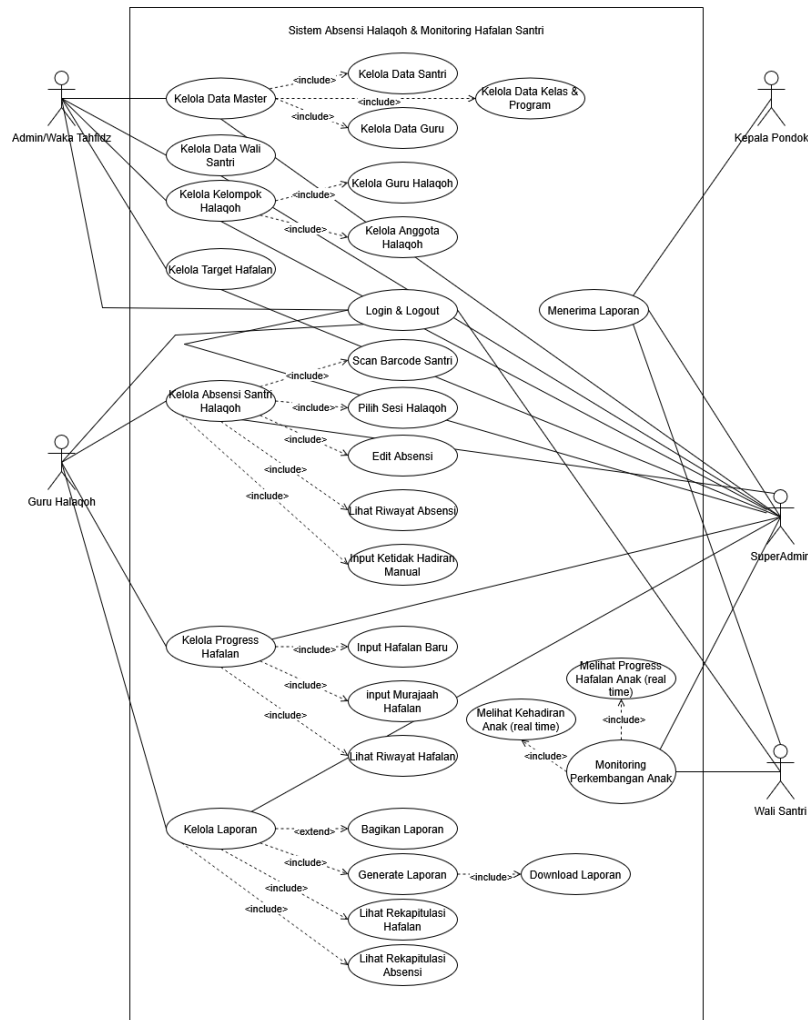


Figure 2. Use Case Diagram MyHalaqoh Application

Based on Figure 2, the Admin/Waka Tahfidz handles master data and halaqoh groupings. The Teacher executes daily transactions, including barcode scanning and memorization input. The Parent views real-time progress through a dedicated dashboard, while the Superadmin oversees the entire system using impersonation features.

3.3 Offline-First System Implementation

Unlike conventional online applications, this system implements a robust offline-first architecture utilizing BLoC (Business Logic Component). When a teacher scans a barcode, the Flutter application directly stores the data into the Hive local database, ensuring zero latency even without an internet connection. Once a stable network is detected, a background service automatically triggers data synchronization to Firebase Cloud Firestore. Firestore securely maps the data into hierarchical NoSQL documents, utilizing a last-write-wins mechanism to resolve offline-to-online data conflicts, which guarantees real-time integration.

3.4 User Interface and Implementation

The primary feature for the teacher is the barcode-based attendance system. Instead of manual calling, the teacher scans the Student Identification Number (NIS) barcode on the student's ID card. The barcode scanning interface is presented in Figure 3.



Figure 3. Barcode Scanning Interface for Attendance

After recording attendance, the teacher evaluates the students' memorization. The teacher selects the memorization type (ziyadah or muraja'ah), specifies the Surah, inputs the verse range, and evaluates fluency and Tajweed on a scale of 1-100. The system employs an auto-calculation algorithm to determine the precise Juz. The implementation of the memorization input form is presented in Figure 4.

Input Hafalan

Abrisam Nabil Ulum Annafis
NIS: 554202507052

ZIYADAH **MURAJAAH**

Formulir Hafalan

Tanggal Setoran
Selasa, 7 Juli 2026

Tambah Surat
Pilih Daftar Surat

01 An-Nazi'at
Juz 30

☐ Semua Ayat

AYAT AWAL AYAT AKHIR

26 30

30

Penilaian

Kelancaran Skala 1-100

90 **Mumtaz**

Tajwid Skala 1-100

80 **Jayyid**

SIMPAN

BATAL

Figure 4. Memorization Input Form

To bridge the information gap, the system provides a real-time monitoring dashboard for parents. The dashboard visually highlights the total Juz completed against the targeted curriculum, alongside a monthly attendance recapitulation. The parent monitoring dashboard is presented in Figure 5.



Figure 5. Parent Monitoring Dashboard

3.5 Black Box Testing Results

To ensure that all functional requirements are met and the system operates without errors, a comprehensive Black Box Testing method was conducted. The testing focused on observing the input and output of the application without examining its internal code structure. The tests were performed on all user roles, including authentication modules, data management, offline-first synchronization, and PDF report generation. The summary of the Black Box Testing results is presented in Table 1.

Table 1. Summary of Black Box Testing Results

Module	Test Case Summary	Result
Authentication	Login validation, role-based redirection, password reset, and account blocking after 5 failed attempts.	Valid (100%)
Admin	Master data management (teachers, students), halaqoh group configuration, bulk data import via CSV, and target setting.	Valid (100%)
Teacher	Barcode scanning validation, manual attendance fallback, memorization input, and PDF report generation.	Valid (100%)
Parent	Real-time dashboard data retrieval, attendance history view, and memorization progress tracking.	Valid (100%)
Superadmin	Role impersonation (accessing as Admin, Teacher, or Parent) and real-time activity logging.	Valid (100%)

CONCLUSION

This study has successfully developed and implemented MyHalaqoh, a barcode-based mobile application for halaqoh attendance and memorization monitoring at the Luqman Al Hakim Islamic Boarding School, utilizing the Flutter framework and the Extreme Programming (XP) methodology. The system effectively addresses the inefficiencies of manual recording by providing a centralized, real-time digital solution that accommodates the specific operational needs of administrators, teachers, and parents. The integration of barcode scanning significantly accelerates the attendance process and minimizes human errors, while the implementation of an offline-first architecture using Hive local storage and Firebase Cloud Firestore ensures seamless data entry and synchronization despite unstable internet connectivity. Furthermore, functional validation through Black Box Testing confirmed that all system features operate accurately according to the specified requirements, proving the system's reliability. For future developments, it is recommended to conduct large-scale performance testing, integrate a WhatsApp Gateway for push notifications, incorporate a machine learning module to predict students' memorization success rates based on historical data, and expand the barcode utility to encompass a broader range of boarding school activities to create a fully integrated educational ecosystem.

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