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Development of an IoT-Based Fingerprint Meal Distribution and Monitoring System for the Rancangan Makanan Tambahan (RMT) Program

Nurwaheeda Mohd Ali[1], Nayef Abdulwahab Mohammed Alduais[1]*

[1] *Fakulti Sains Komputer dan Teknologi Maklumat,*
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author: nayef@uthm.edu.my
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Abstract

Rancangan Makanan Tambahan (RMT) program at Sekolah Kebangsaan Othman Shawal (SKOS) previously relied on a manual, card-based meal distribution system, which led to inefficiencies, inaccuracies and delays in verifying student eligibility and managing meal records. This project aimed to modernize the process by developing an IoT-based fingerprint meal distribution and monitoring system integrated with an automated door lock mechanism. The system utilized fingerprint recognition technology for student verification, controlled access to the meal distribution via a smart lock and synchronized all data with Firebase for real-time storage and monitoring. The mobile interface was developed using Flutter, Firebase and Arduino IDE and the development lifecycle followed the waterfall model, covering requirement analysis, design, implementation and testing. Testing results and user acceptance testing (UAT) with school staff and students showed high accuracy in fingerprint identification, quicker verification times, and increased overall system reliability. It also showed significant improvements in accuracy and operational efficiency while also reducing administrative workload and human error. It is hoped that in the future, this system can be implemented in more schools and further enhanced with features such as wider hardware integration to better support school operations and resource management.

1. Introduction

RMT, also known as the Supplementary Food Program, is a Malaysian Ministry of Education initiative that began in RMT, also known as the Supplementary Food Program, is an initiative by the Malaysian Ministry of Education that started in 1979[1]. Its main goal is to provide nutritious meals to primary school students from low-income families, aiming to improve students' health, school attendance and academic performance [2].

At SKOS, the RMT program was originally managed through a manual, card-based system. However, this method often led to problems such as lost cards, delays in verifying student identity, and difficulties in tracking food distribution records. These challenges created administrative inefficiencies and increased the chances of human error. To address these issues, this report introduces an IoT-based fingerprint meal delivery and monitoring system integrated with a smart door lock. The system uses fingerprint scanning to verify a student's

identity. Once verified, the system automatically unlocks a food box, allowing the student to collect their meal safely and efficiently. It improves security and eliminates the need for physical identification cards.

The system is developed using the Flutter framework for cross-platform mobile application development and Firebase for real-time data management. It is primarily used by an admin and includes key modules such as student management, fingerprint verification, meal distribution tracking, and real-time reporting. This approach aims to improve the accuracy and speed of the RMT process, reduce manual work, and ensure that eligible students receive their meals in a more organized and secure manner.

2. Literature Review

Food distribution systems aim to guarantee that school meals are served fairly, safely and effectively. These solutions decrease food waste, increase safety and ensure that students get enough energy. Fingerprint technology improves security by eliminating conventional techniques such as PINs and cards which may be lost or misused. Meals may only be collected by approved students via fingerprint scanning. students can collect meals. Mobile applications support these systems by offering real-time data updates and a simple, user-friendly interface for administrators. Research indicates that combining fingerprint and mobile technology decreases human error and enhances traceability. This improves food delivery accuracy, security, and efficiency. Schools can better track who gets meals and when, which improves accountability and reduces laborious paperwork.

2.1 Study of Existing System

Several systems for food delivery and monitoring have evolved, using biometric and IoT technology to improve efficiency, security, and accountability. These systems aim to address key issues in meal allocation such as delays, data inaccuracy, and misuse of physical identification methods. The following analysis looks at three systems that use these technologies in different contexts from security to school canteen and illustrates their relevance, benefits, and limits when compared to the established RMT Fingerprint System.

MJSAT's IoT-Based Smart Lock System uses the NodeMCU ESP8266 microcontroller for fingerprint and RFID identification. When combined with the Virtuino IoT mobile app and HiveMQ MQTT broker, it enables wireless control and remote access. Although intended for building security, it illustrates how fingerprint recognition and IoT control may be used to safe, real-time school lunch collection. Its strength is in its emergency features and automation, although it may lack student-focused functionality [3].

The Poudre School District Biometric Meal Program replaces meal cards with fingerprint scanning that links directly to student databases. These decreases wait times and human error, resulting in better meal tracking accuracy. However, worries about biometric data privacy and the high cost of installation and maintenance make it unsuitable for low-budget institutions [4].

Genetec's Biometric Solution, created for the food industry, combines facial and fingerprint recognition for managing food access and storage. It supports high-level traceability and regulatory compliance but is resource-heavy and complex. Its sophistication and cost make it impractical for smaller school environments, despite its strong security features [5].

Table 1 compares existing system A, B and C to the created RMT Fingerprint System X based on essential properties. While the developed system includes mobile access, real-time tracking, student management, a simple interface, student-focused features, fingerprint authentication, and report generation, other systems lack some of these capabilities, emphasizing the RMT system's comprehensive and student-cantered design.

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Table 1: Comparison between existing systems and developed systems

Features \ System	A	B	C	X
Web-based platform	×	√	√	×
Mobile-based platform	√	×	√	√
Real-time data tracking	√	√	√	√
Student management	×	√	×	√
Simple interface	√	√	×	√
Student-focused features	×	√	×	√
Fingerprint system	√	√	×	√
Door lock system	√	×	×	√
Report generator	×	×	√	√

A: IoT-based smart lock system
B: Poudre School District Biometric Meal Program
C: Genetec Biometric Solution
X: Developed RMT Fingerprint System

3. Methodology

This project uses the Waterfall Model, a structured and linear approach to software development that ensures each step is completed before proceeding to the next. This technique is especially useful for projects with well-defined criteria and objectives since it gives a clear path from beginning to end. The Waterfall Model emphasizes thorough planning and documentation, making it easy to assess progress and ensure each step is in line with project objectives [6].

This model was chosen for several reasons. First, this project had clear objectives which are replacing the card-based system with a fingerprint-based solution, verifying eligibility, and enabling real-time reporting. These goals aligned well with the Waterfall Model's structured approach. Second, the model's linear progression ensured each phase was completed and reviewed before moving forward, minimizing errors that are crucial for a precise and reliable system involving biometric technology and meal distribution. Lastly, the emphasis on documentation provided detailed records of the system's design and implementation, supporting future maintenance and scalability.

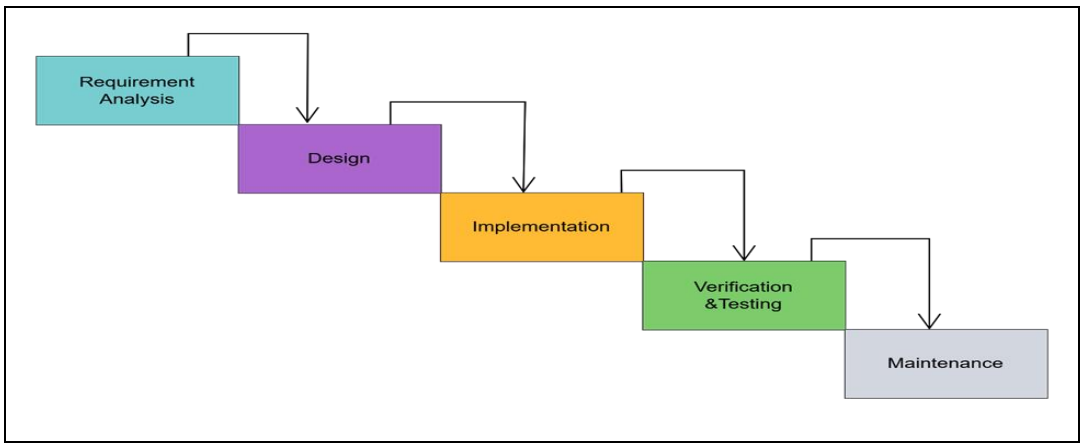

Figure 1: Waterfall Model

This figure illustrates the waterfall model methodology, a linear software development approach with five sequential phases, requirement analysis, design, implementation, verification and testing and maintenance. Each phase must be completed before progressing to the next, ensuring a structured and systematic development process. The Gantt Chart constructed for this project according to this waterfall model is shownin Appendix A.

4. System Analysis and Design

This section provides a thorough study and design for the proposed e-RMT fingerprint-based meal distribution and monitoring system. It starts with an overview of the system architecture and describes how the different

components interact to accomplish the system's objectives. The system specifications are outlined to define both the intended outcomes and the methods by which those outcomes are achieved. To enhance understanding of the design and workflow, diagrams such as activity, class, use case, and sequence diagrams are included to illustrate the overall system structure and interactions. Finally, this section explains how users such as administrators, canteen staff and students will interact with the system via the user interface and functional modules.

4.1 General System Architecture

System design and modelling entail the creation of visual representations and structural blueprints for a system to facilitate a thorough comprehension of its functionality and interactions among its components. System design encompasses the specification of architecture, components, modules, interfaces and data, whereas modelling allows stakeholders to visualize and enhance the system's structure and processes. This section provides an architectural overview of the Fingerprint-Based Meal Distribution and Monitoring System, accompanied by illustrative diagrams generated using diagrams.net (formerly known as draw.io). The system architecture defines the framework of the system, describing the interactions and collaboration of its components to fulfil the intended functions. It offers a framework for structuring and integrating various components of the system, including user interfaces, essential functionalities, and databases. This architecture is crucial for guaranteeing the system's scalability, efficiency, and maintainability.

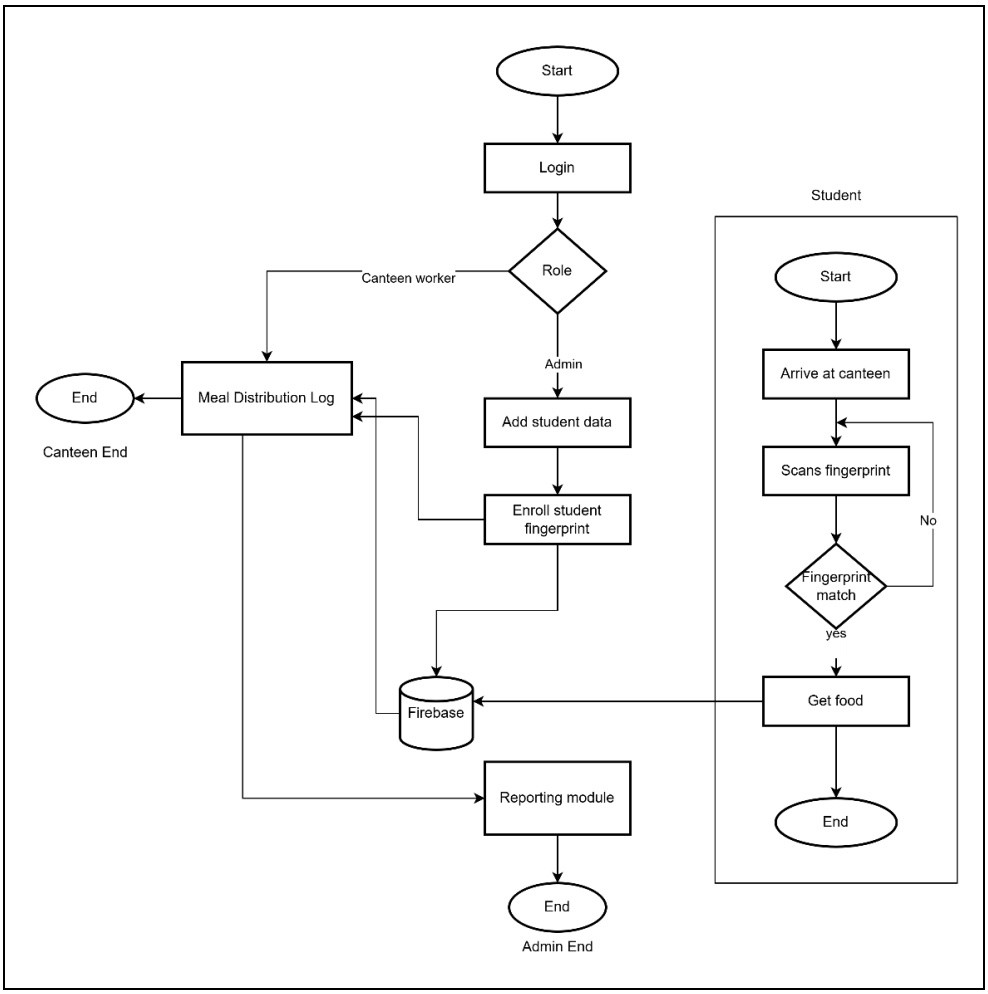

Figure 2: General system architecture of the developed system

4.2 Requirement Analysis

Requirement analysis is the process of systematically gathering, documenting and evaluating user needs and system specifications to ensure a comprehensive understanding of project objectives and constraints. The functionalities of the modules are explained in Table 2.

Functional requirements define the precise activities or operations that a system must execute to fulfil its objectives. These are fundamentally related to the system's operations and define the way the system engages

with users or other systems. Functional requirements provide specific information regarding the capabilities of a system, which considers its features, user interactions and the business processes that it supports [4]. The functional requirements for this system are outlined in Table 2, highlighting the modules, intended users and functionalities

Table 2: Functional Requirements Analysis

Modules	Users	Functionalities
Login and register module	Admin, canteen worker	• Secure login with role basis access • Allow users to register to the applications
Fingerprint module	Student	• Authenticate students using fingerprint scans to verify eligibility of the students
Reporting module	Admin	• Generate real-time report on meal distribution, attendance and trends for resource management
Student management module	Admin	• Update and manage student information
Meal distribution module	Admin, canteen worker	• Record meal status (Taken/ Not Taken) • Update real-time logs

Non-functional requirements emphasize the quality features of a system, including performance, dependability, usability and security. These requirements delineate the performance criteria of a system rather than its functional specifications. Non-functional requirements are crucial for guaranteeing a resilient user experience and the system's enduring success [7]. Table 3 outlines the key non-functional requirements for this project.

Table 3: Non- Functional Requirements Analysis

No	Users	Descriptions
1	Reliability	The system must operate without failure during school hours to ensure smooth meal distribution.
2	Performance	The system should authenticate a student's fingerprint within 15 seconds to avoid delays.
3	Scalability	The system should support an increasing number of students without compromising performance.
4	Security	All data, including student records and fingerprint data, must be securely encrypted and protected.
5	Usability	The interface must be user-friendly for all stakeholders, requiring minimal training for effective use.

4.3 Use Case Diagram

Use case diagram is a Unified Modeling Language (UML) tool that illustrates how users or actors interact with a system, highlighting features and their usage. Key components include actors, use cases, relationships and system boundaries. These diagrams clarify requirements, roles, and interactions, guiding design, testing, and implementation while improving communication. A use case diagram is valuable for identifying system features and user needs during the early design phase [8].

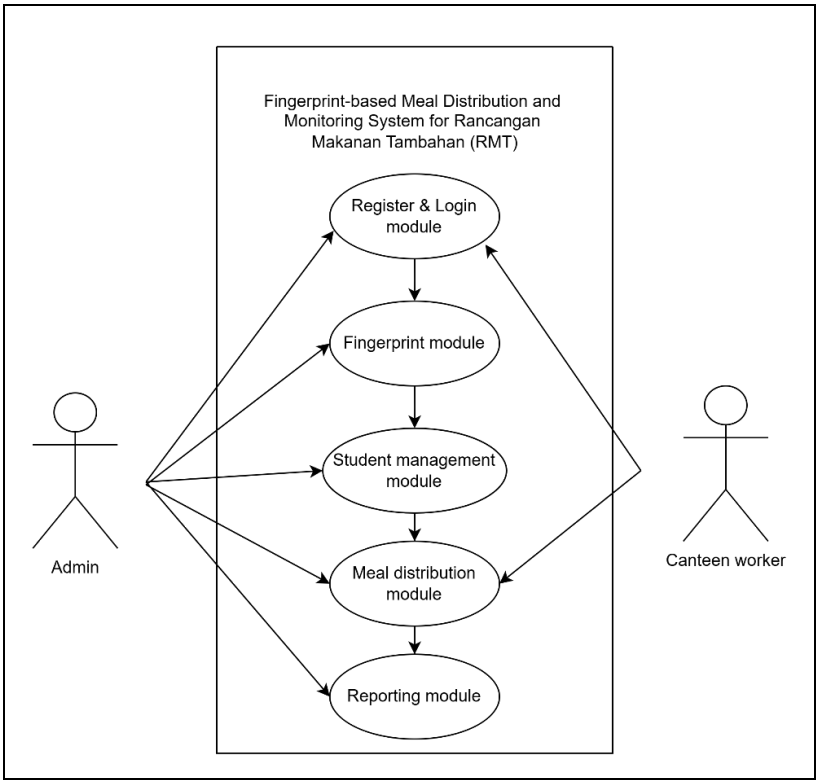

Figure 3: Use case diagram for the developed system

Figure 3 shows the use case diagram for the fingerprint-based meal distribution system, highlighting the roles of admin, canteen worker and student. The admin manages all modules, including login, fingerprint setup, student records, meal tracking and reporting. The canteen worker handles login and meal distribution. Students use the fingerprint module to verify their identity during meal collection. The diagram clearly outlines how each user interacts with the system.

4.4 Sequence Diagram

A sequence diagram is a UML tool that illustrates how items in a system interact with one another in a certain sequence across time. It shows the flow of messages between objects and the sequence in which activities must be performed to complete a process. This helps developers, designers, and stakeholders understand the system's behavior, timing and logic better. Sequence diagrams are particularly effective for determining how components interact, what prompts each phase and how data flows across different system pieces in real-world scenarios.

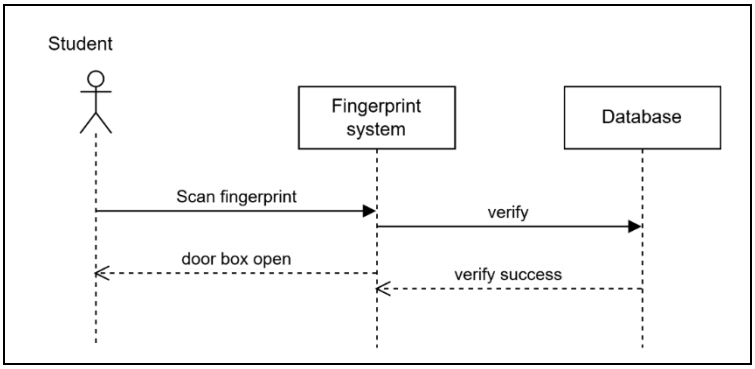

Figure 4: Sequence diagram for fingerprint process

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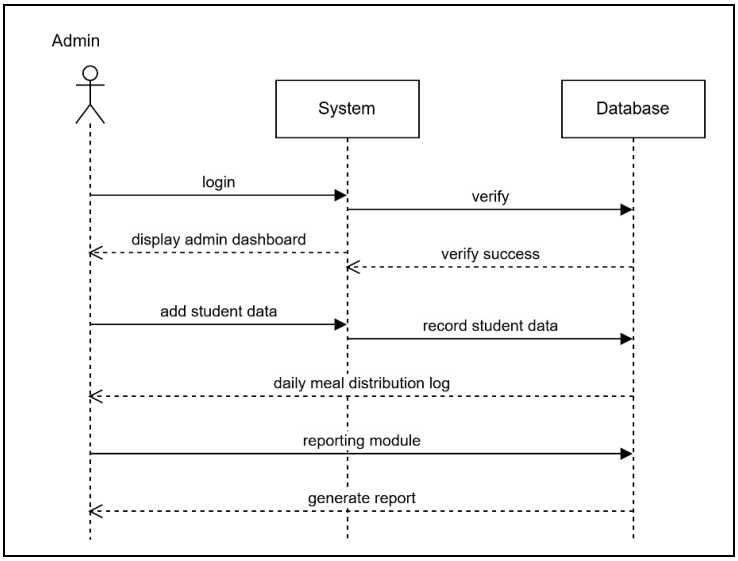

Figure 5: Sequence diagram for admin module

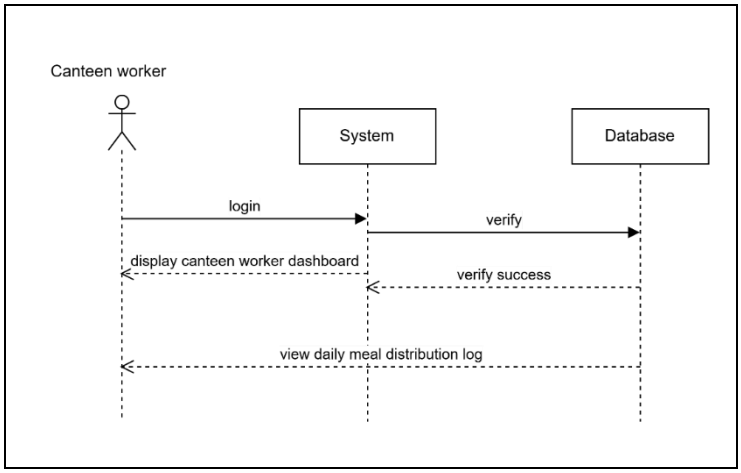

Figure 6: Sequence diagram for canteen workers module

Figure 4, 5 and 6 shows the sequence diagram of the developed system. The sequence diagram shows the interaction flow among system components, starting with the fingerprint process. When a student places their finger on the fingerprint scanner, the system immediately compares the fingerprint with the stored records in the Firebase database. If the match is successful, the system records the meal as "Taken" in real-time and triggers the smart door lock to open, allowing the student to collect their meal. If verification fails, the student is asked to retry scanning. The admin module involves logging in through a secure authentication process. Once verified, the admin accesses a dashboard that provides multiple functions such as adding or editing student data, viewing the daily meal distribution log, accessing the report module and generating summary reports. The canteen worker module follows a similar login process, verifying credentials via Firebase. Upon successful login, the worker sees a simplified dashboard focused on monitoring the current day's meal record and checking student meal status.

4.5 Activity Diagram

An activity diagram shows the steps or events in a system in a logical order. It visually represents how processes flow and changes over time. Appendix B, Fig B1 illustrates the activity diagram for the fingerprint-based meal distribution system for RMT. The process starts when a user logs into the system. If they are already registered, they are directed to their dashboard. New users must first be authorized and assigned as role admin, canteen worker, or student. Students scan their fingerprints, which are verified against the database. If it matches, the system marks the meal as taken and opens the smart lock for meal collection. If it fails, the student must scan again. Admins can manage student data, track meal distributions, and generate reports. Canteen workers can view daily meal logs. Both log out after completing their tasks. The system ensures secure access and organized meal distribution based on user roles.

4.6 Class Diagram

In object-oriented computing, a class diagram shows how a system is structured visually. These diagrams are very important for design development and system modeling because they help workers understand how the system is put together and how it works. Not only are class diagrams used for design, but they are also a way for developers, stakeholders, and system designers to talk to each other. They make sure that everyone knows how the different parts of the system work together. Appendix B, Fig B2 shows the class diagram for the fingerprint-based meal distribution system. The system begins with users, such as students, administrator and canteen personnel. All users have basic information such as name, email, ID and role. They may sign in, log out and register. Students have additional information, such as their residence, income, IC number, number of dependents, fingerprint ID and course. To get a meal, they scan their fingerprints. The technology scans the fingerprint. If it matches, the system saves the meal and enables the student to retrieve it. The meal delivery records include the date, fingerprint ID, IC number and time. This information is saved in the database, which contains all information about users, students and meals. Admins can manage student information, check meal records, and create reports. Canteen workers can view the meal logs to see which students have received meals.

4.7 User Interface

A user interface (UI) is the visual design and arrangement of a system or program that facilitates successful user interaction. An effective user interface emphasizes simplicity, usefulness, and aesthetic design to enhance user experience and productivity. The user interface for this project was designed to support key features such as student registration, secure login with role-based access, a real-time monitoring dashboard, student and canteen worker management, fingerprint sensor integration, daily meal distribution tracking, and report creation. These capabilities let administrators, canteen workers, and students communicate with the system more quickly, resulting in seamless and transparent meal delivery under the RMT program. The interface also includes responsive layouts for different devices, intuitive icons for quick access, and visual indicators like color codes and status tags to guide users effectively and reduce errors during high-traffic times.

4.8 Hardware Installation

Figure 7 shows the hardware setup used in the fingerprint-based meal distribution system. The ESP32 acts as the central controller, connected to the relay module using yellow jumper wires. The relay functions as an electronic switch, allowing the ESP32 to control power to the solenoid lock. The solenoid lock (top right) unlocks when powered, enabling access to meals. The AS608 fingerprint sensor scans the student's fingerprint and sends data to the ESP32. The battery pack powers the entire system. When a student places their finger on the sensor, the ESP32 verifies the fingerprint. If matched, the relay is triggered to unlock the door, allowing the student to collect their meal. This setup ensures secure, real-time meal distribution based on fingerprint authentication.

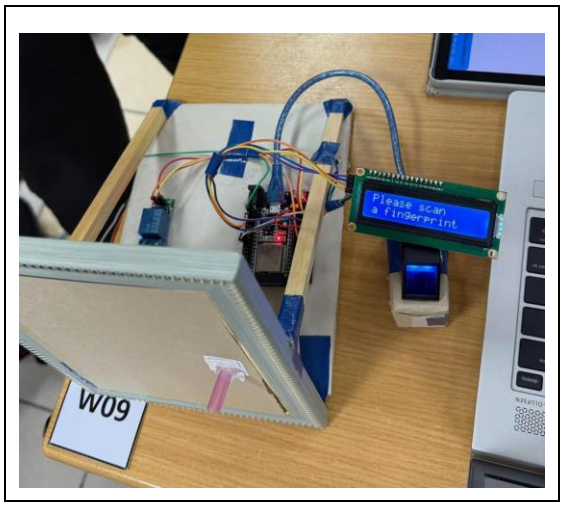

Figure 7: Prototype of Fingerprint based Meal Distribution and Monitoring System

5. Results and Discussion

A Fingerprint-Based Meal Distribution and Monitoring System was developed using Flutter for the mobile interface, Firebase for real-time authentication and storage, and an AS608 fingerprint sensor integrated with Arduino. It allows role-based access for admins and canteen workers, Admins can register students, manage data,

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view logs, and generate reports, while canteen workers scan student fingerprints and track meals daily. Students will use the system by simply scanning their fingerprints to the sensor to receive meals, ensuring fast, secure, and accurate attendance logging. This system removes manual tracking, reduces errors, and improves efficiency. Real-time updates in Firebase make the system reliable and transparent. With fingerprint scanning, student verification is fast, reducing the possibility of false records or meal duplications. The automated data logging ensures that every meal served is accurately recorded and can be accessed anytime. This improves monitoring for both daily operations and long-term program evaluation, making the system highly effective for school environments.

5.1 System Implementation

Figure 8 shows the e-RMT application's login and registration module, which is required for role-based user access management. When the app starts, users are greeted with a clean and professional splash screen that includes the e-RMT logo and branding. The login page allows existing users to securely sign in using their email and password. To support users who may have forgotten their credentials, a "Forgot Password?" option is provided. Additionally, there is a prompt for new users to create an account if they do not already have one. For registration, users are required to enter their full name, email, role and set a secure password with confirmation. This method guarantees that each user is accurately recognized and assigned to the appropriate position inside the system. Overall, this module offers users a simple and safe method to access the e-RMT platform.

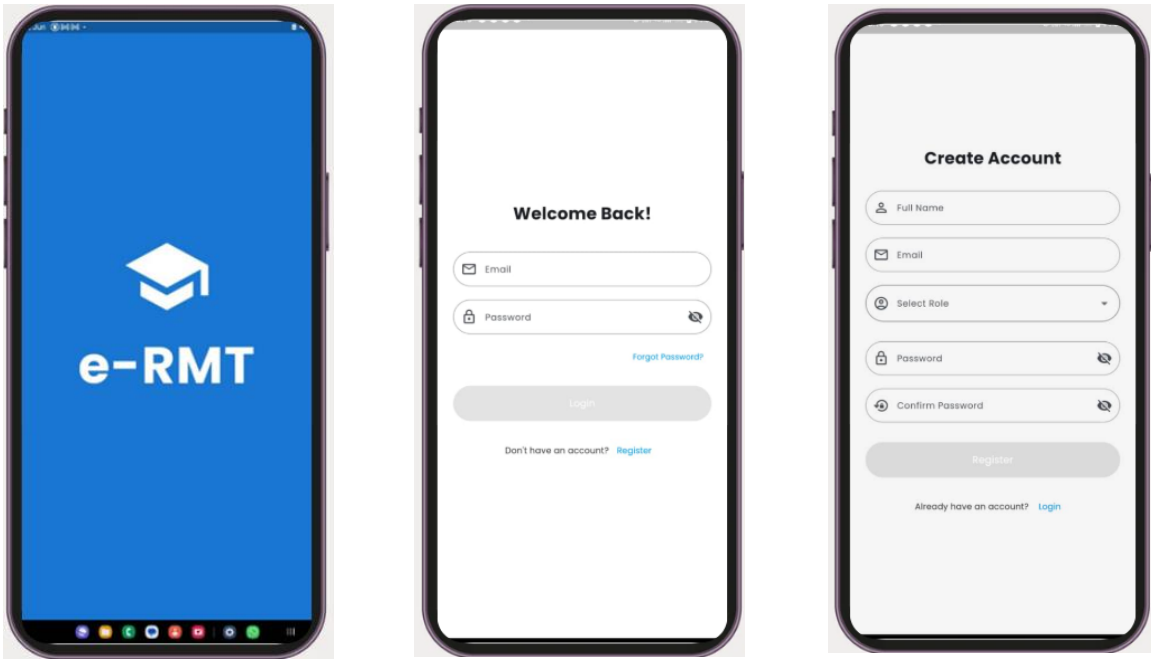

Figure 8: Login and registration module

Figure 9 shows the Admin Dashboard page of the e-RMT app. This page gives a quick summary for the admin to manage the system. At the top, there is a logout button for the admin to exit the app safely. The dashboard displays the total number of students in the system as well as how many did not take the RMT meal today which is marked in red for easy identification. It also shows today's menu which in this case includes "Mi Goreng" and "Sirap Ais." At the bottom, there is a navigation bar that allows the administrator to move between sites such as Dashboard, Students, Reports, and Meals. This helps the admin manage everything easily in one place.

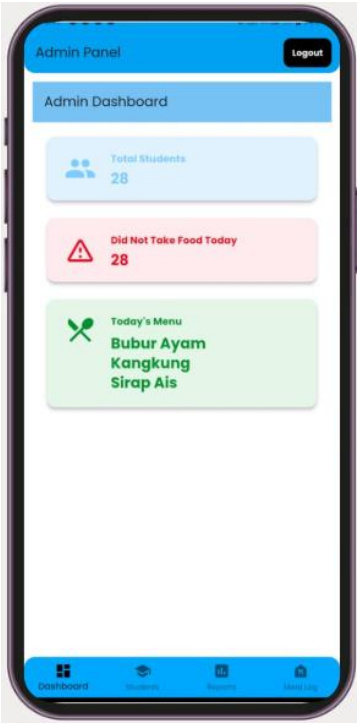

Figure 9: Admin dashboard page

Figure 10 shows the Student Management page, where the admin can view, add, and edit student details easily. Students are grouped by class, and there's a search bar to quickly find a student by name or IC. To add a student, the admin fills out a form with details like name, address, class, income and type of help received. The admin can also scan and save the student's fingerprint. If changes are needed, the admin can edit the student's info or delete the record. This page makes it simple to manage all student data in one place.

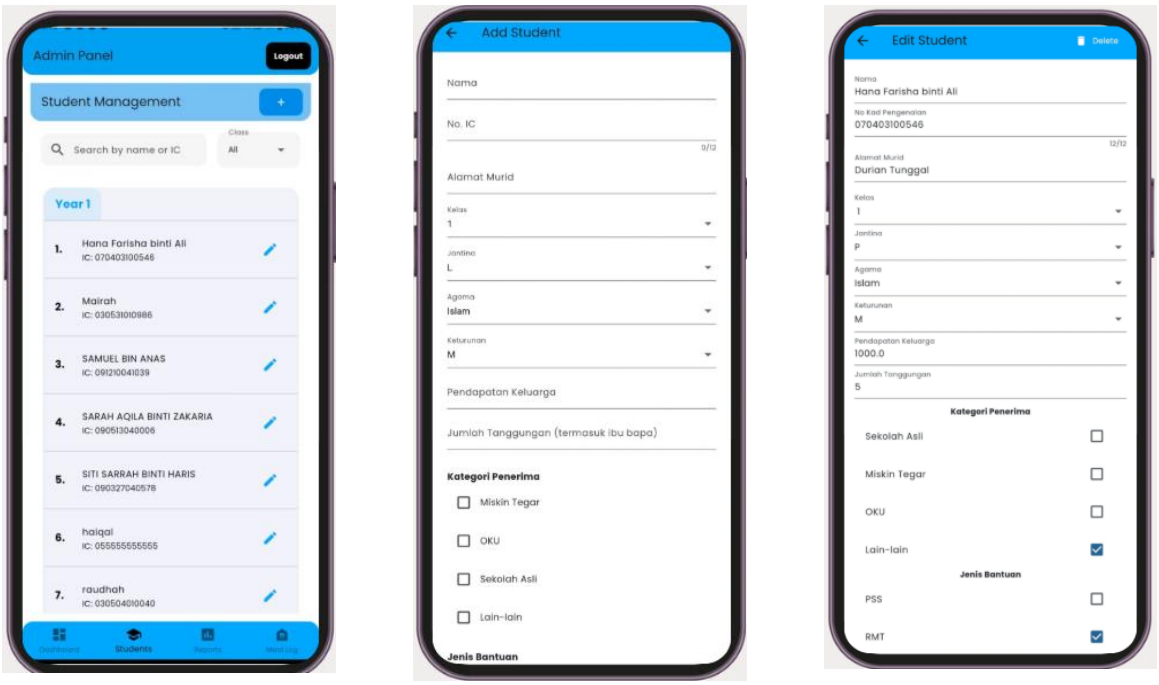

Figure 10: Student management page

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Figure 11 shows the reporting page. It enables administrators to examine, filter and manage meal log records. It allows you to search by student name and filter by date range to get more detailed results. The administrator may update data and make reports by exporting them to PDF or CSV format. Summary cards provide total logs, meals eaten, and meals missed, offering a rapid summary. This page helps the admin generate and access accurate reports efficiently.

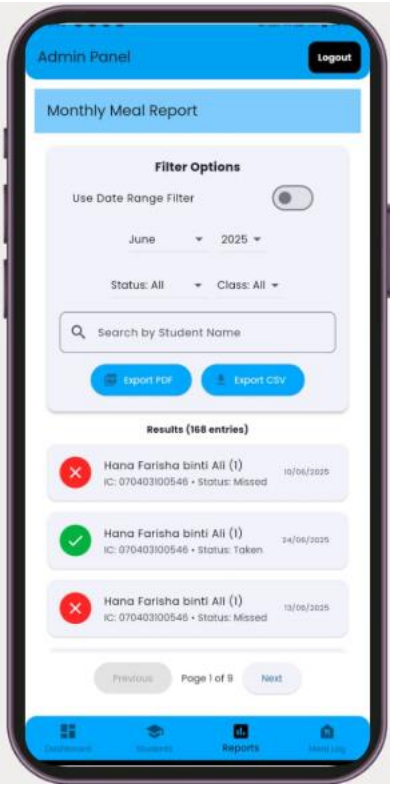

Figure 11: Reporting module page

Figure 12 shows the daily meal distribution log page. This page allows the admin to track which students have received their meals for the day. Students are grouped by year, and each name is listed with a status label showing if the meal was "Taken" or "Not Taken." A search bar helps quickly find specific students. The admin can update each student's meal status as meals are given. This page helps ensure accurate and organized meal distribution tracking.

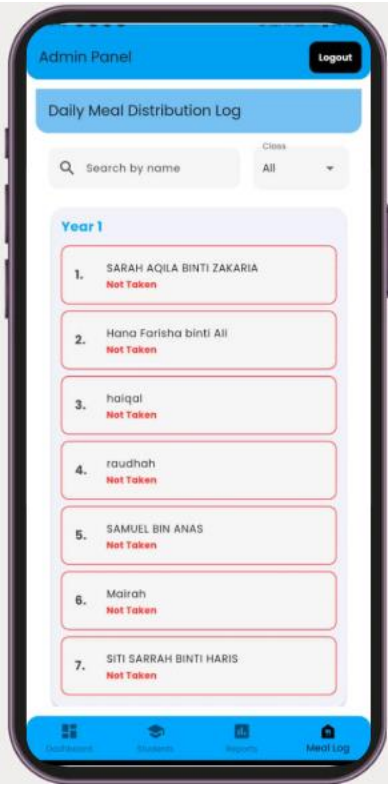

Figure 12: Daily meal distribution log page

5.2 System Testing

Before being released, the proposed system must be thoroughly tested to confirm that it satisfies all the stated criteria and is defect-free. This procedure is critical to ensure system performance, dependability and user satisfaction. To successfully analyze the system, a detailed test strategy and user acceptability testing (UAT) were implemented. These testing approaches help in identifying possible flaws, validating functionality and ensuring that the system functions properly in real-world scenarios. Ensuring thorough testing also increases stakeholder trust and lowers the likelihood of failure after deployment.

5.2.1 Test Plan

The purpose of this test plan is to validate that the fingerprint-based meal distribution and monitoring system operates correctly and meets all user and system requirements. Each module has been thoroughly tested to ensure proper functionality, performance, and data integrity. The testing process helps identify bugs or mismatches early, ensuring the system is reliable and ready for deployment.

Table 4: Student management module

Test	Expected Result	Actual Result
Add new student	Students are added and appear in the list	Pass
Edit student details	Updated details are saved and displayed	Pass
Delete student	Student record is removed from the database	Pass
Search and sorting student	Matching students appear instantly	Pass

Table 5: Fingerprint enrollment module

Test	Expected Result	Actual Result
Scan fingerprint	Fingerprint is read and ID is assigned	Pass
Save fingerprint ID to Firebase	ID is correctly stored in students' field	Pass
Find match fingerprint ID	ID match and food distributed	Pass

Table 6: Meal distribution module

Test	Expected Result	Actual Result
Update meal status	Meal status updates to "Taken" or "Missed"	Pass
Auto-refresh or manual refresh	Data updates without app restart	Pass
Display student list by class	Students are grouped by class correctly	Pass

Table 7: Admin dashboard module

Test	Expected Result	Actual Result
Show total student count	Accurate total is displayed	Pass
Show number of missed meals	Real-time missed meal count is shown	Pass
Display today's menu	Menu matches what is stored in Firestore	Pass

Table 8: Reporting module

Test	Expected Result	Actual Result
Filter reports by date range	Results match selected dates	Pass
Export to PDF/CSV	Files are generated with correct data	Pass
Summary cards display logs	Totals for "Taken" and "Missed" are accurate	Pass

5.2.2 User Acceptance Testing (UAT)

The purpose of User Acceptance Testing (UAT) was to verify that the developed system satisfied the functional and usability needs of its intended users especially in the school environment. Actual users, including administrators, canteen staff and test students, evaluated the system's primary capabilities, which included fingerprint scanning, student registration, meal distribution monitoring, and report generation. During testing, users evaluated the system's usability, accuracy and overall performance. The comments received revealed that the system was practical, efficient, and well aligned with the stated goals. The UAT findings are shown in Table 8 and Figure 9, indicating that the system fulfilled user expectations and was suitable for real-world deployment.

Table 8: Result of User Acceptance Testing for the developed system

No.	Acceptance Requirement	Actual Result				
		1	2	3	4	5
User Interface						
I	Easy to understand				√	
II	Easy to navigate				√	
III	Interface design (e.g., color, background, font)					√
System Function						
IV	Register function				√	
V	Login function				√	
VI	Admin dashboard function				√	
VII	Student management function				√	
VIII	Daily meal distribution log function				√	
IX	Reporting function				√	
X	Integration IoT with fingerprint function				√	

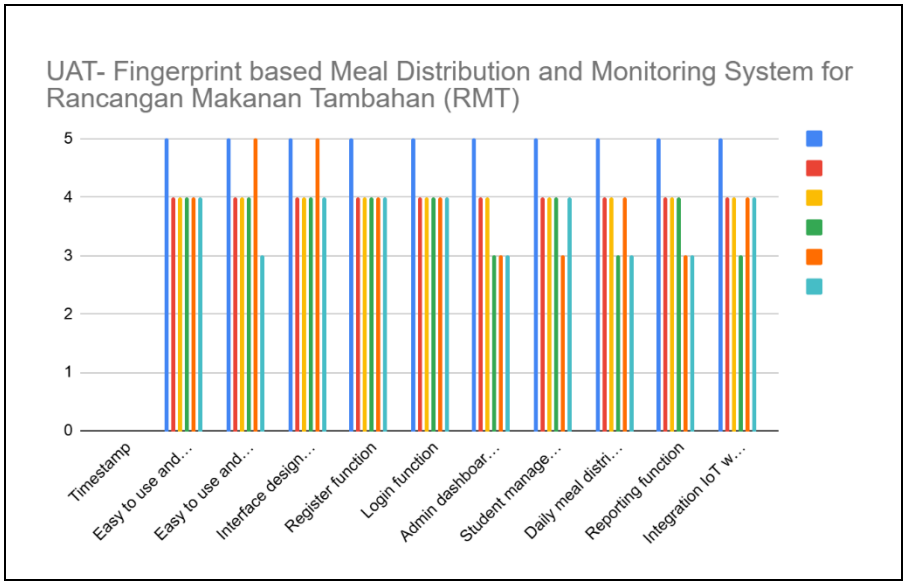

Figure 13: Graph result UAT for the developed system

From table 8 and figure 13, the user acceptance testing (UAT) results show that users are very satisfied with both the system's interface and core functionality. All mentioned acceptance standards were given the highest grade, indicating that users believed the system to be functional, intuitive and user-friendly. In terms of user interface, users agreed that the system was simple to comprehend and navigate, with an attractive design. The layout, color scheme, and fonts were seen as appropriate and visually consistent, supporting efficient user experience.

For system functions, all major features including registration, login, admin dashboard, student management, daily meal logging, and reporting were successfully tested and met user expectations. Notably, the integration of IoT with the fingerprint sensor was also marked as effective, confirming that the hardware-software interaction performed reliably. These results validate that the system fulfills its intended purpose: streamlining meal distribution, reducing manual errors, and enabling transparent tracking under the RMT program. The positive feedback also suggests the system can be adopted widely in schools, with minimal training required for users due to its accessible design and smooth functionality.

6. Conclusion

In conclusion**,** the proposed fingerprint-based meal distribution and monitoring system for the RMT program was developed to solve critical issues with present school food distribution systems. Traditional approaches are not only time-consuming, but also prone to human error, duplication and manipulation. These methods make it difficult for school administrators to monitor the distribution of meals in real time, often resulting in a lack of accountability and inefficiencies. The developed system aims to solve these problems by providing a more reliable, secure and automated approach that ensures only eligible students receive meals, while also providing accurate data for daily monitoring and reporting.

By integrating Flutter for cross-platform development, Firebase for real-time cloud storage and authentication and the fingerprint sensor with a microcontroller, the system ensures fast, accurate and user-friendly meal distribution. When a student scans their fingerprint at the canteen, the system verifies their identity. Once verified, the door will unlock, and the meal will be distributed then updates their meal status instantly in Firebase. Admins and canteen workers can view this data in real time through role-based dashboards admins manage student records, generate reports and oversee daily logs, while canteen workers monitoring fingerprint scanning process and viewing meal distribution status.

The system was successfully developed using the waterfall method. Real users like students, teacher and canteen worker tested the system during User Acceptance Testing (UAT). Their feedback showed they were satisfied with how the system worked, how clear the interface was, and how easy it was to use. The testing results proved that the system helps reduce errors, improves the accuracy of meal tracking and saves time and effort compared to manual monitoring.

The system does have a few limitations. It needs a stable internet connection to update data in Firebase, so slow or no connection can delay syncing. Also, fingerprint scanning may fail if the finger is dirty or injured. In the future, the system can be improved by adding offline features, using stronger hardware, and including extras like alerts for parents. Overall, this fingerprint-based system helps the RMT program work better than manual methods. With more updates and feedback from users, it can be used in more schools to make meal distribution faster, fairer, and clearer, while helping schools and the government make smarter decisions.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nurwaheeda Mohd Ali, Nayef Abdulwahab Mohammed Alduais;* ***data collection:*** *Nayef Abdulwahab Mohammed Alduais;* ***analysis and interpretation of results:*** *Nurwaheeda binti Mohd Ali, Nayef Abdulwahab Mohammed Alduais;* ***draft manuscript preparation:*** *Nurwaheeda binti Mohd Ali, Nayef Abdulwahab Mohammed Alduais. All authors reviewed the results and approved the final version of the manuscript.*

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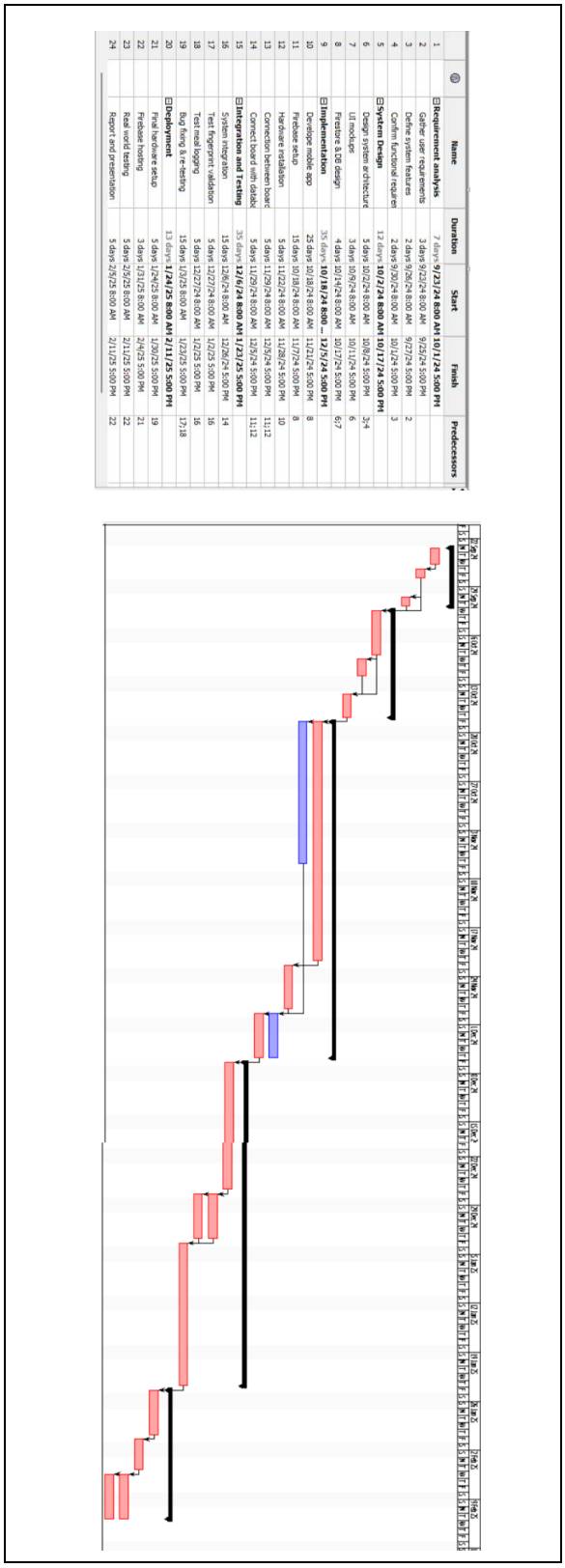
APPENDIX A: Gantt Chart

A.1 Gantt Chart Table



	Name	Duration	Start	Finish	Predecessors
1	**Requirement analysis**	17 days	**9/23/24 8:00 AM**	**10/14/24 5:00 PM**	
2	Gather user requirements	3 days	9/23/24 8:00 AM	9/25/24 5:00 PM	
3	Define system features	2 days	9/26/24 8:00 AM	9/27/24 5:00 PM	2
4	Confirm functional requiren	2 days	9/30/24 8:00 AM	10/1/24 5:00 PM	3
5	**System Design**	12 days	**10/2/24 8:00 AM**	**10/17/24 5:00 PM**	
6	Design system architecture	5 days	10/2/24 8:00 AM	10/8/24 5:00 PM	2FS
7	UI mockups	3 days	10/9/24 8:00 AM	10/11/24 5:00 PM	6
8	Firestore & DB design	4 days	10/14/24 8:00 AM	10/17/24 5:00 PM	6;7
9	**Implementation**	35 days	**10/18/24 8:00 ...**	**12/5/24 5:00 PM**	
10	Develope mobile app	25 days	10/18/24 8:00 AM	11/21/24 5:00 PM	8
11	Firebase setup	15 days	10/18/24 8:00 AM	11/7/24 5:00 PM	8
12	Hardware installation	5 days	11/22/24 8:00 AM	11/26/24 5:00 PM	10
13	Connection between board	5 days	11/29/24 8:00 AM	12/5/24 5:00 PM	11;12
14	Connect board with databa	5 days	11/29/24 8:00 AM	12/5/24 5:00 PM	11;12
15	**Integration and Testing**	35 days	**12/6/24 8:00 AM**	**1/23/25 5:00 PM**	
16	System integration	15 days	12/6/24 8:00 AM	12/26/24 5:00 PM	14
17	Test fingerprint validation	5 days	12/27/24 8:00 AM	1/2/25 5:00 PM	16
18	Test meal logging	5 days	12/27/24 8:00 AM	1/2/25 5:00 PM	16
19	Bug fixing & re-testing	15 days	1/2/25 8:00 AM	1/23/25 5:00 PM	17;18
20	**Deployment**	13 days	**1/24/25 8:00 AM**	**2/11/25 5:00 PM**	
21	Final hardware setup	5 days	1/24/25 8:00 AM	1/30/25 5:00 PM	19
22	Firebase hosting	3 days	1/31/25 8:00 AM	2/4/25 5:00 PM	21
23	Real world testing	5 days	2/5/25 8:00 AM	2/11/25 5:00 PM	22
24	Report and presentation	5 days	2/5/25 8:00 AM	2/11/25 5:00 PM	22

Fig A.1 Gantt Chart Diagram

APPENDIX B: Deliverables for Result and Discussion Section

B.1 Activity Diagram

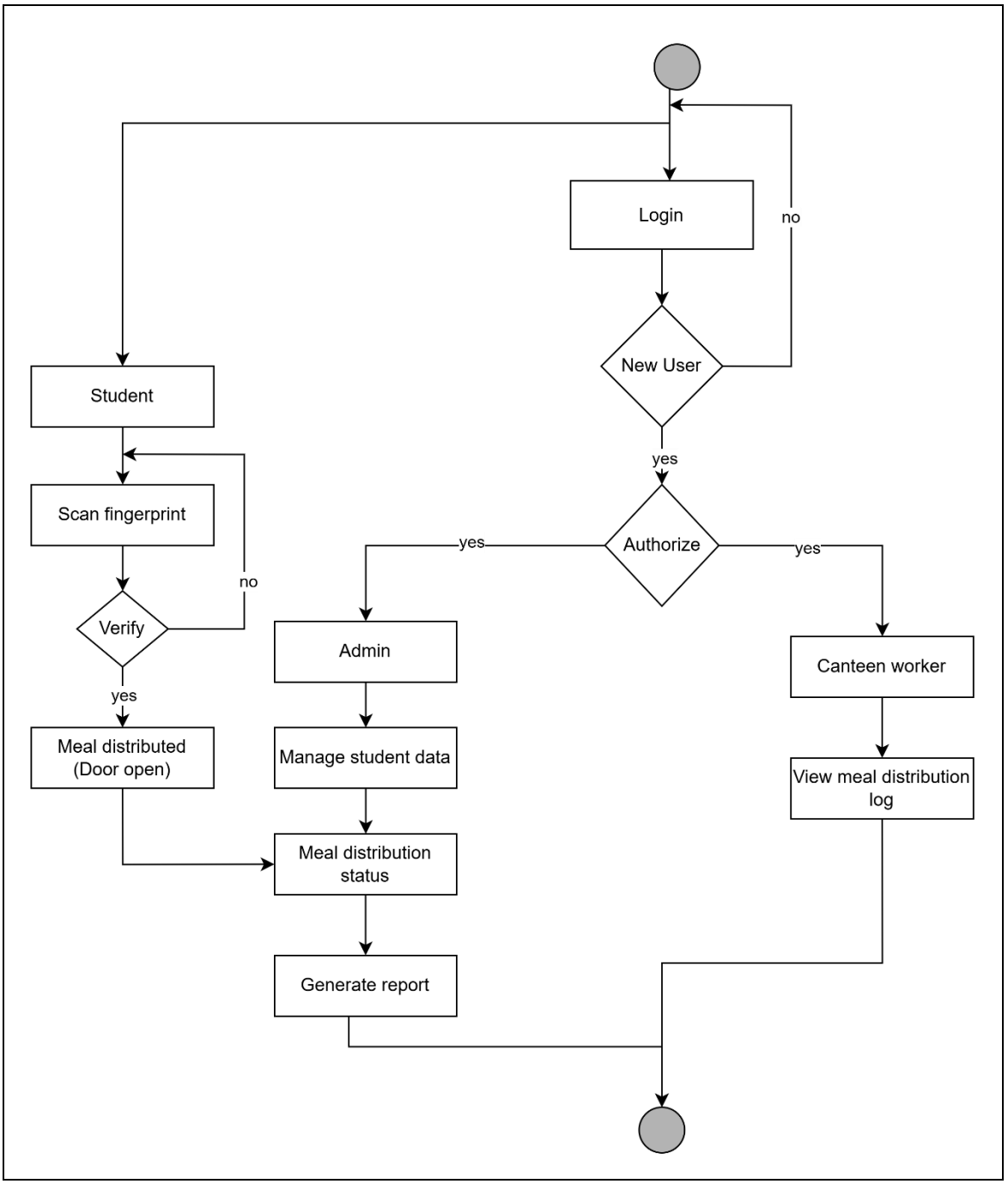


Fig B.1 Activity diagram for the developed system

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B.2 Class Diagram

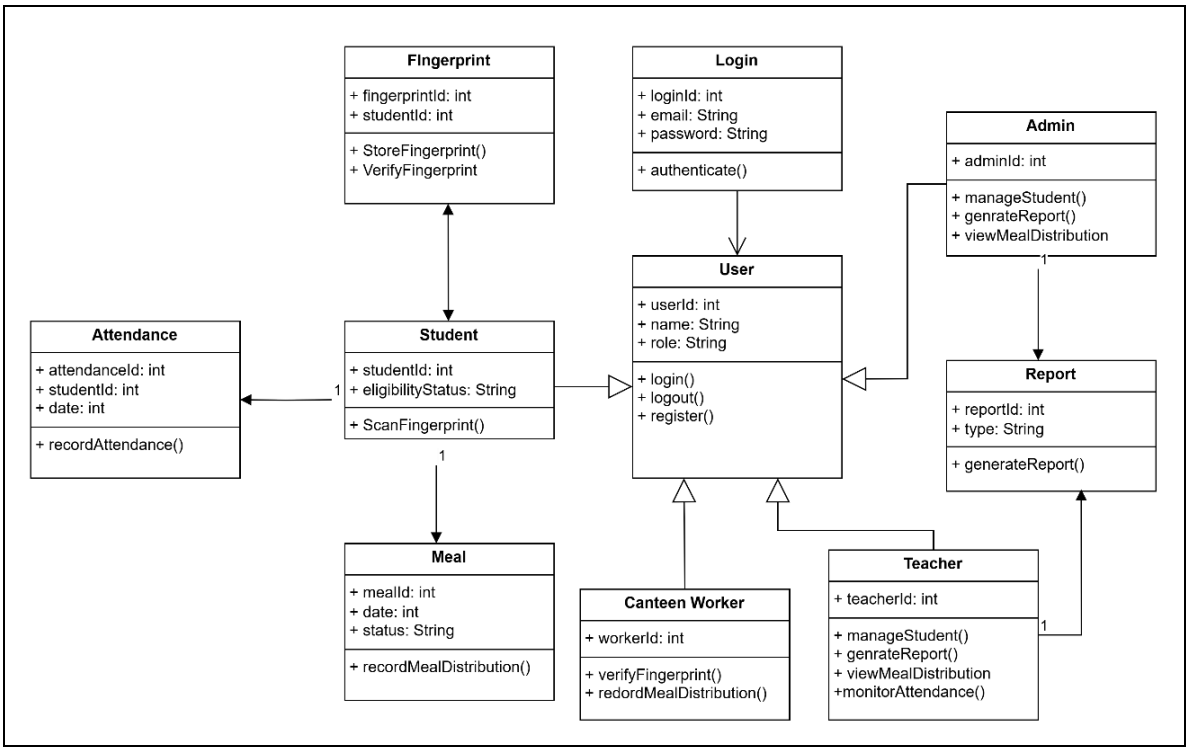

Fig B.2 Class diagram for the developed system