

A Smart IoT-Enabled RFID Door Lock System for Securing Rental Homes

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Abstract

The use of Internet of Thing (IoT) in daily life is rapidly growing. Many developers develop something that makes daily life easy by using IoT. The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Today, all rented houses use an old design. The safety of the population is a priority. Therefore, RFID Door Lock has been developed for homeowners to use. When the occupants want to enter the house, they need to scan the card that has their data which are name, serial number, time, date and authorized and then the door will open. If the user uses a card with no data, the door will not open. Using the Particle photon, the Internet of Things is gaining in importance with ever-increasing access to the internet. The Photon allows you to connect the board to the Internet using a built-in Wi-Fi chip and this opens many possibilities with the Photon. The following example will show you how to control things over the Internet using Particle functions. Usually, programming devices that access the internet can be quite complex and time consuming. Luckily the Photon uses a very simple method of using Particle functions within the sketch that either push data to the Gmail, SMS, Google Drive and Slack application. This project was developed to reduce the risk of home breakage from occurring. In addition, this project will make the secure data. The data on a RFID card is only readable when you have special equipment, this feature keeps the data recorded on the chip secure.

Key Words: *IoT, RFID, Unique, Lock, Safety, Risk*

1.0 Introduction

Radio Frequency Identification (RFIDs) Door Lock and Internet of Things (IOT) where users are a very important system in controlling thefts from occurring. RFID, Radio Frequency Identification is an inexpensive technology, can be implemented for several applications such as security, asset tracking, people tracking, inventory detection, access control applications. The main objective of this paper is to design and implement a digital security system which can deploy in secured zone where only authentic person can be entered. They implemented a security system containing door locking system using RFID which can authorized access and access denied. The door locking project functions in real time as the door opens quickly when user put their tag in contact with the reader.

The project includes door locking which opens when the user puts their tag in contact with readers and the user information matches the information already stored in google drive and displays the notification in slack application, gmail and SMS. The RFID controls the opening, and the door will be closed when the card does not touch the reader. In this study, RFID technology provides solutions for secure access of a space while keeping record of the user. The RFID are battery-less and they obtain power to operate from readers. The major advantages of passive RFID are its cost effective and small. Due to the above advantages, it is widely used by inventory tracking technology.

As theft cases are increasingly widespread and alarming, users need to use the RFID door lock and IOT via access and cell phone cards. Other than that, RFID aimed at reducing the percentage of theft.

2.0 Materials and Methods

2.1 Literature Review

A case study of four existing systems has been conducted, and it was found that there are similarities and differences with the similarities function between RFID Door Lock and

existing system that use RFID card. Each system has similarities and differences. When they have some similarities, so can be improved to make users love to use it or be more user-friendly and attractive. Table 1 shows a comparison of four systems.

Table 1: Comparison of four systems.

No.	Aspect	Advantages	Disadvantages
1	System Barrier Gate Using Access Card	- Prevents outsiders from entering without an access card - Improves residents' safety - Guards can monitor vehicles going in and out	- High number of users may damage barrier gates - Weaker security among internal residents
2	RFID based Attendance System in School	- High storage capacity - Easy tracking - Effective attendance monitoring	- Expensive - Difficult to read tags on metal or liquid items
3	Touch 'n Go eWallet	- Battery-free - Faster and easier toll payments - Auto-reload via credit card; can check balance and transaction history	- Cannot disable if someone else uses it - Mixed RFID and TnG lanes can slow down traffic
4	Automatic Toll Collection System	- Precise vehicle detection - Reduces user workload - Saves time from queueing - Reduces manpower needs	- Tags can be moderately duplicated - Users may drive faster since no need to stop

2.1.1 System Barrier Gate Using Access Card

Barrier Gates are used to control access into a secured area such as apartment or condominium. The reason why we choose this system because this functions and the way of using access card are the same with our future system. But we develop this system for everyone that who prefer home security. The system is for everyone and especially for those who live in apartments or condominiums. Refer Figure 1.

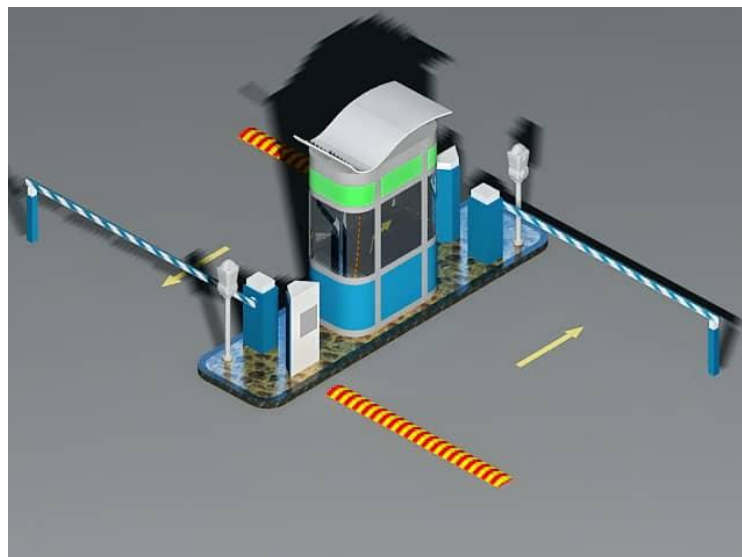


Figure 1: System Barrier Gate Using Access Card

2.1.2 RFID based Attendance System in School

RFID (Radio Frequency Identification) is a wireless technology using electromagnetic fields to transfer data between a reader and a tag containing a chip and antenna. It can

store up to 2k bytes of data and is used for tracking people, animals, or items. Most schools and colleges still use manual attendance systems, which are time-consuming and error-prone. The proposed system automates attendance using RFID tags assigned to each student. By scanning the tag near an RFID reader, attendance is recorded. The system includes a microcontroller, RFID reader, LCD display, oscillator, and preset circuit to efficiently manage student attendance records.

2.1.3 Touch 'n Go eWallet

RFID is an electronic payment system that uses a card to pass through toll. The RFID card, also called an RFID Touch 'n Go, is not only used for toll but also can be used for public transports which is Keretapi Tanah Melayu (KTM), Rapid Bus and others. The RFID card is linked to the Touch 'n GO eWallet from which the fare will be deducted. As the vehicle passes through toll, an overhead scanner reads the radio-frequency from the RFID card and charges the toll fare. The toll fare will then be deducted from the Touch 'n Go eWallet. Refer Figure 2.

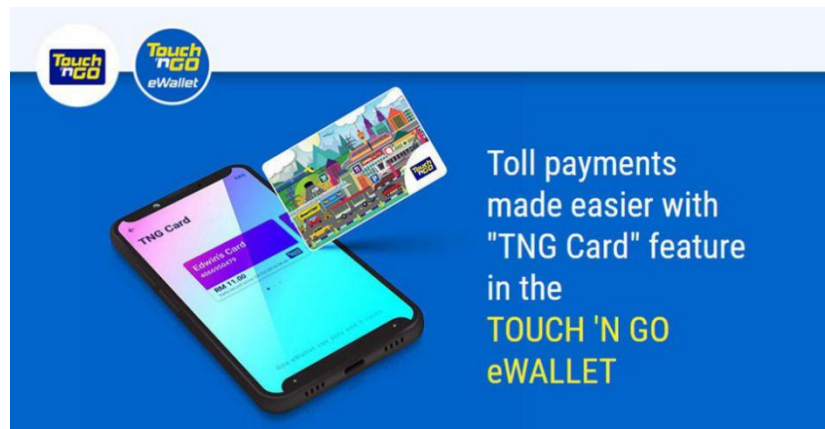


Figure 2: Touch 'n Go eWallet

2.1.4 Automatic Toll Collection System

The automated toll collection system using passing RFID tag emerges as a convincing solution to the manual toll collection method employed at tollgates. The tags have ID numbers with the recorded database. Example for Toll Collection System such as SMART TAG System. This system is also called as NO QUEUE TOLL TAX COLLECTION SYSTEM because users do not need to queue at the toll to scan the card.

2.2 Methodology

The waterfall model was chosen for the development of this project. This waterfall model was initially described by Winston W. Royce in the System Development Life Cycle (SDLC) in 1970 (Kramer, 2018). The waterfall model is a sequential model, in which software development activities are divided into different phases consisting of a series of tasks with distinct objectives (Software Testing Help, 2023). This model defines several consecutive phases that must be completed one after another, and it proceeds to the next phase only when the previous phase has been fully completed (Arora, 2021). Referring to Figure 3, the phases of this waterfall model consist of planning, analysis, design, implementation, and testing.

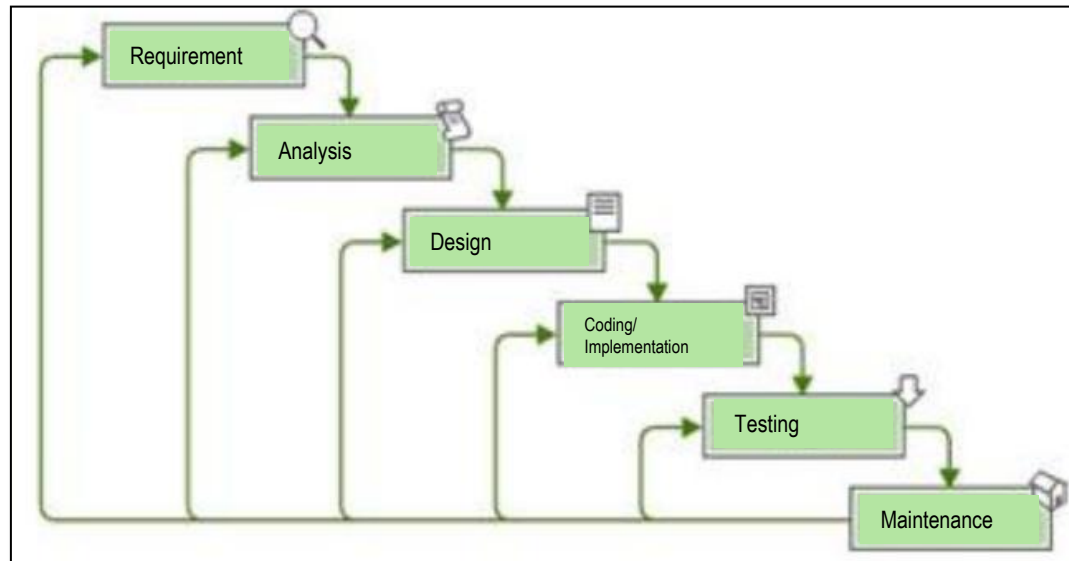


Figure 3: Waterfall Model (Originator: Winston W. Royce (Muhammad et al., 2021))

2.3 Requirements Analysis

All project requirements were analysed and documented in the form of a specification document, and a usability analysis was conducted to ensure the validity of the project requirements. At the beginning of this investigation phase, the problem statement, project scope, Gantt chart development, and planning strategies for system development were identified. All possible requirements for the system to be developed were identified during this phase and documented in the requirements specification document.

2.4 System Design

This system design helps to outline the hardware and system requirements and assists in identifying the overall architecture of the system. The system consists of two main modules, namely the administrator and user.

Administrators use the security door system. For example, admin will include data on each access card before it is given to the end user. The data will be sent to the SMS, gmail, google drive and slack application and will record the name, date, time, ic and authorized access for the user using the access card then admin can view the data by gmail, SMS and google drive. Additionally, if there are any problems associated with access cards, the admin will fix it to change to the new access card.

The user can view data by the slack application. For example, the user can see their data like name, serial number and authorized access who enter the house because the cards have their own serial number. Every card will have different serial number for different people. So, stranger or other people cannot use other data because the serial number in all cards are different.

2.4.1 Logical Design

A context diagram is a high-level view of a system; it is a basic sketch intended to define the entities based on the scope, boundaries, and their relationships with external components such as stakeholders (Pedriqueq, 2022). Figure 4 shows the Context Diagram for RFID Door Lock.

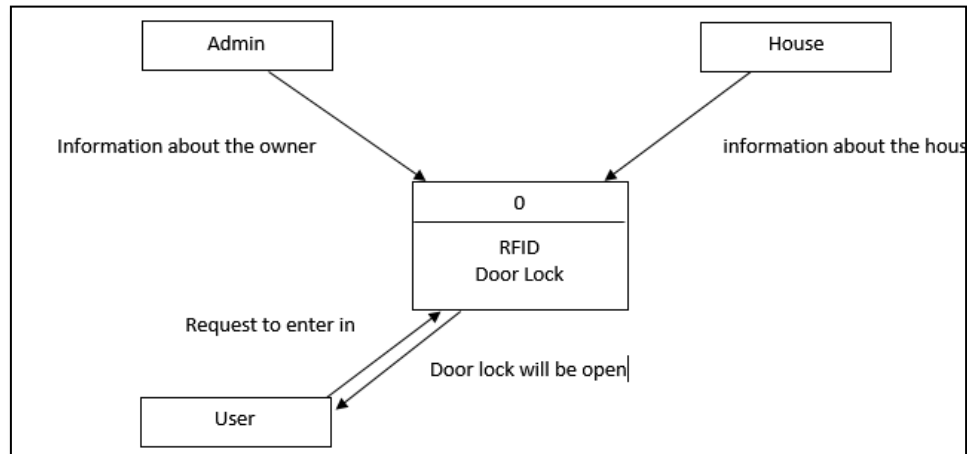


Figure 4: Context Diagram for RFID Door Lock.

2.5 Implementation

The implementation of the RFID Door Lock system, including its hardware and software components. It uses Slack for software and hardware such as Particle Photon, relay shield, jumper wires, solenoid door, RFID RC522, and batteries.

2.5.1 Instrument

The tools and technologies required to develop the RFID Door Lock are shown in Table 2.

Table 2 : List of instruments.

Parts	Main Function
Particle Photon 	Connect the board to the Internet
Relay Shield 	Controlling high current devices and voltage limit
Jumper Wires (male-female) 	Connector or pin
Solenoid Door 	Locking and unlocking
RFID RC522 	Scanner

Parts	Main Function
<i>Door Hinges</i> 	Mechanical bearing that connects two solid objects
<i>Batteries 1.5V</i> 	Source of energy
<i>Buzzer</i> 	audio signalling device
<i>Plastic Battery Storage Case Box Holder 8 x 18650</i> 	Hold batteries
<i>Waterproof plastic electric box</i> 	Place to save device
<i>Cardboard</i> 	Roof design
<i>Blackboard</i> 	Residential area
<i>Hot glue gun</i> 	Glue
<i>Stick hot glue</i> 	As detainee
<i>Ice cream wood</i>	As house gate

Parts	Main Function
	
<i>Wooden house model</i>	Prototype
	
<i>Wood paint</i>	Paint
	
<i>Brush paint</i>	Brush
	

2.5.2 Operation of Circuit

The block diagram shows the flows of RFID Door Lock for operation of circuit or control system. First, Particle photon is providing everything that need to build a connected product. It provides access to a free cloud service of the particle cloud. The particle cloud has some great features for building connected projects, including over-the-air firmware updates, and an easy-to-use. The Relay Shield is providing a solution for controlling high current devices that cannot be controlled by Arduino.s Digital I/O pins due to current and voltage limits. The Relay Shield features four high quality relays and provides NO/NC interfaces, four dynamic LED indicators to show the on / off state of relay and the standardized shield form factor to provide a smooth connection to the board. Then, Zapier is an online automation tool that connects application. Admins need to sign in the google account because to use for google sheet and google drive. After that, the data from user will be store in google drive and it will view it to admin. Meanwhile, Losant is an easy-to-use and powerful enterprise IOT platform designed. Losant provides powerful data collection, aggregation and visualization features to help understand and quantify vast amounts of sensor data. Losant's drag and drop workflow editor allows to trigger actions, notifications and machine to machine communication without programming. When use Losant, the data will send to SMS, Email and Slack application when we drag the flows. Figure 5 shows the Operation of Circuit for RFID Door Lock.

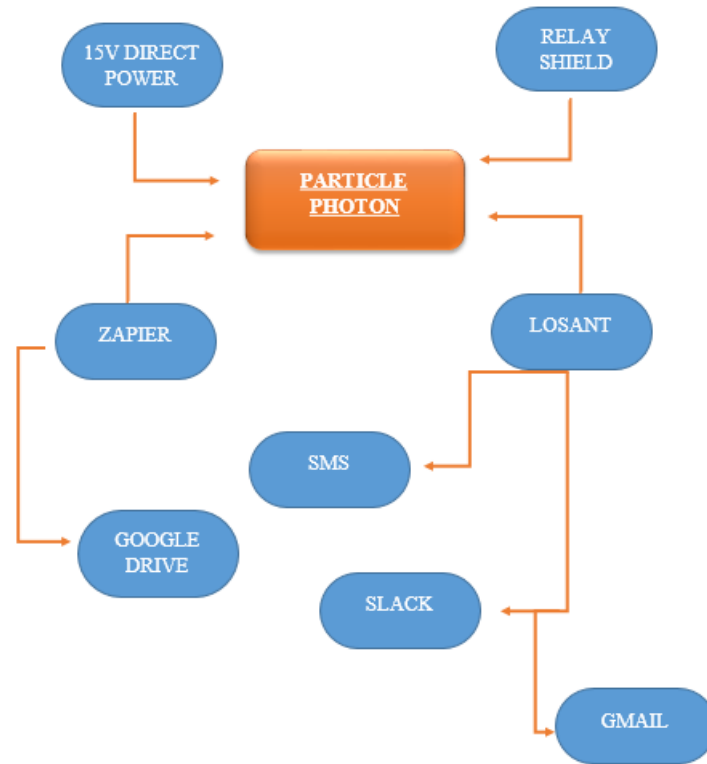


Figure 5: Operation Of Circuit in Particle Photon for RFID Door Lock.

2.5.3 Slack

RFID DOOR LOCK is using Slack application as user interface because it is easy for user use it. Users need to install the application and after that, they can just use it. The function of this application is the data of who scan the card to reader will view in Slack. So, users can know who are entering in their house. Actually, it will be more safety because they can know the time that who enter in the house. Slack will view the data of user such as time, names and serial numbers of RFID cards. Figure 6 shows the Slack application.

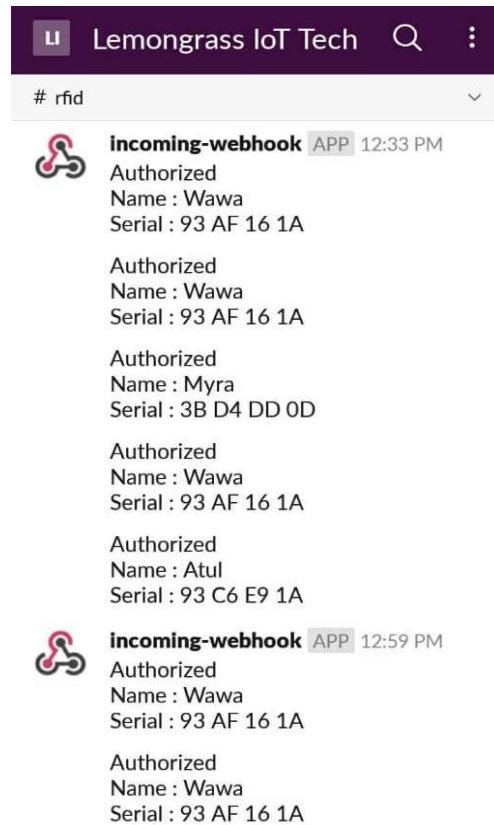


Figure 6: Slack application

2.5.4 Losant

The RFID Door Lock system uses Losant, an IoT platform, to send notifications via SMS, email, and the Slack application. By using Losant, user data can be configured to trigger notifications through these channels when specific conditions are met. The process of setting up the notification flow is simple, as Losant uses a drag-and-drop workflow interface that does not require any coding or programming knowledge, making it user-friendly for beginners. This allows easy integration of real-time alerts for access events. Figure 7 illustrates the interface of the Losant application used in this project.

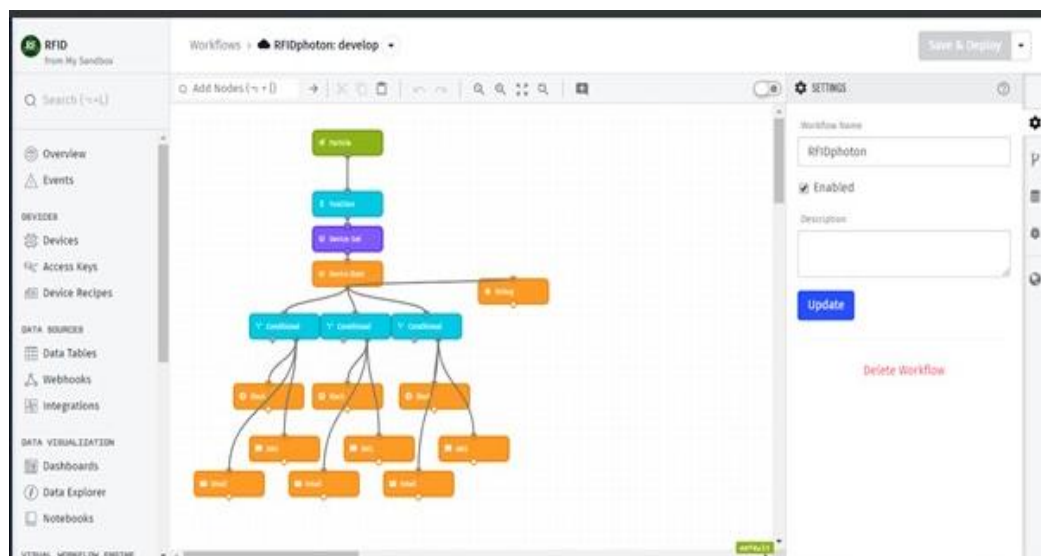
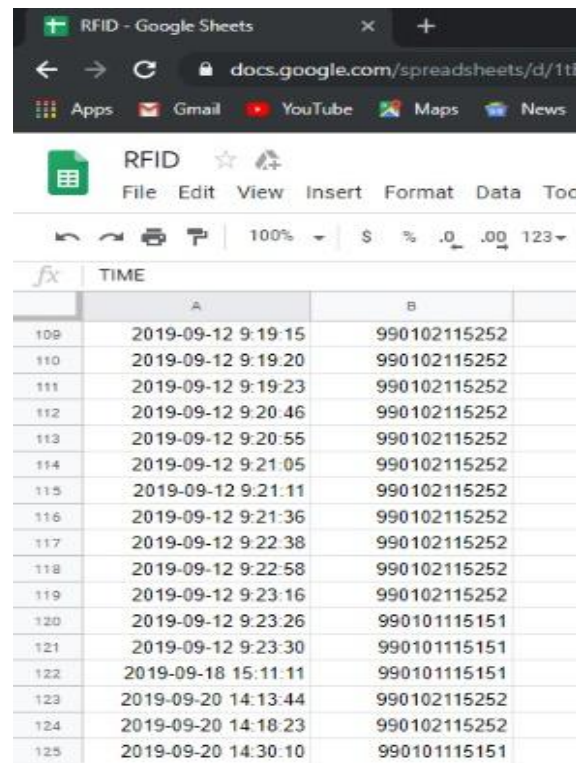


Figure 7: Losant application

2.5.5 Google Drive

Google Drive is used as a cloud storage platform to store user data securely. However, the data stored in Google Drive cannot be modified or manipulated by regular users. Only the admin has access to view and manage the stored user information, ensuring data privacy and security. This setup helps in maintaining proper records without the risk of unauthorized changes. Figure 8 displays the Google Drive interface used in this project.



	A	B
109	2019-09-12 9:19:15	990102115252
110	2019-09-12 9:19:20	990102115252
111	2019-09-12 9:19:23	990102115252
112	2019-09-12 9:20:46	990102115252
113	2019-09-12 9:20:55	990102115252
114	2019-09-12 9:21:05	990102115252
115	2019-09-12 9:21:11	990102115252
116	2019-09-12 9:21:36	990102115252
117	2019-09-12 9:22:38	990102115252
118	2019-09-12 9:22:58	990102115252
119	2019-09-12 9:23:16	990102115252
120	2019-09-12 9:23:26	990101115151
121	2019-09-12 9:23:30	990101115151
122	2019-09-18 15:11:11	990101115151
123	2019-09-20 14:13:44	990102115252
124	2019-09-20 14:18:23	990102115252
125	2019-09-20 14:30:10	990101115151

Figure 8: Google Drive

3.0 Results And Discussions

3.1 Result

The testing phase was carried out to identify any errors or discrepancies in the project after the implementation phase had been completed. White-box testing or unit testing was conducted to determine the accuracy of the developed software processes and to verify that each unit in the software code operates according to the plan. The main purpose of unit testing is to ensure that each system user unit functions according to its specifications (Kristina et al., 2017). Table 3 shows the findings of the unit testing analysis that was conducted. In conclusion, based on the analysis results, the RFID Door Lock has passed the testing conducted.

Table 3. Analysis Based on Unit Testing.

No	Criteria (User)	Pass(%)	Fail(%)
1	Request to enter(User)	100	0
2	Record in Google Drive(User)	100	0
3	Notification to user by Slack Apps(User)	100	0
4	Authorized access(Admin)	100	0
5	Get notification from gmail & SMS(Admin)	100	0
6	Door will be open(all user)	100	0

3.2 Discussions

RFID DOOR LOCK is using Slack application as user interface because it is easy for user use it. Users need to install the application and after that, they can just use it. The function of this application is the data of who scan the card to reader will view in Slack. So, users can know who are entering in their house. It will be more safety because they can know the time that who enter in the house. Slack will view the data of user such as time, names and serial numbers of RFID cards.

RFID Door Lock is using Losant to get notifications from SMS, email and Slack application. When use Losant, data of user will be sent by SMS, email and Slack when we are setting it. Then, the flow to get notification will be drag and it is easy because Losant do not use coding or programming.

Google drives are used for storing the data but cannot manipulated it. Only admin can use google drive to view data of users.

Security door systems using RFIDs and Internet IOT where users are a very important system in controlling thefts from occurring. This product can be used through the access card and mobile phone users after the SLACK application is downloaded. User data will be included in the access card. In addition, the SLACK application will record user data and at the same time the user will get notification from email and users will know who are enter in their home. As theft case is increasingly widespread and alarming, users need to use the RFID Door Lock.

4.0 Conclusion

According to this research, in conclusion all the aims of this project have been achieved. This product will start with users scanning the access card on the scanner and the user's data will be recorded in Google drive. Other than that, users can get notifications for those who enter the house by email, Short Message Service (SMS) and SLACK application.

Next, SLACK application is just for users only for checking a name and serial number for who enters the house. Admin can get information about users whose name, IC number, serial number, date and time from Google drive, email and SMS. By using this feature, it will help to reduce cases and incidents about theft nowadays.

Lastly, this product work by internet. So, users can easily check the record about other user who enter in the house, on SLACK application everywhere. For the conclusion about this product, everybody knows that RFID Door Lock are for home safety. So, users can do their work as usual and will not be worried anymore.

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