

Assessment Cover Sheet

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Name of lecturer/tutor				
Assignment title				Faculty or school date stamp

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Project Proposal

An IoT-based table and order tracking system for open area shop utilizing smart card scanning and object detection for preventing unauthorized customers to use the facilities of the shop.

Unit Code: [REDACTED]

Unit Name: [REDACTED]

Tutor: [REDACTED]

Team: [REDACTED]

Members:

1. [REDACTED]
2. [REDACTED]
3. [REDACTED]

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1. Background / Problem Description

Neko Neko Nya is a hobby shop that sells card games and entertains board games with other players. Currently had facing few issues about the customers. Any customer can directly access the shop and sit down to play cards with friends, but employees can only recognize the customers in the traditional way which is manually knowing them. Security is one of the issues. Customers can come in and sit at the table to play cards, but employees will not awareness due to the lack of facilities that can track which table is currently being used. They can access the shop and get drinks by themselves and start playing card games. In this project, Team Serial will build a system that can track which table is currently being used. Several issues and pain points that needed to be noted down regarding project can be defined as below.

Issues:

- There is no assistance button to call the employees when the customer sitting on the table.
- Any customer can use the table without purchasing any item at the shop
- Table can be used by any customer without any booking.
- None of the facilities can drive away other customer that had not do any reservation or outsider (non-member)

Pain Points:

- Employee has to manually remember every customer's demand and facilities that being used
- Lack of awareness in customer who access into the shop
- Employees can only notice customer by moving to the front of the counter.
- It is hard to know whether the table is being used by any customer or not while the customer is away for a moment.

1.1. Problem Statement

Employees do not know who is using the table or whether the customer is away from the table for a moment. It is true that there is no system that can keep track of who is using the table or whether the table is temporarily unoccupied. The employees have to manually remember which customer is using the table and what card they play. Therefore, the team is thinking about building a system that can keep track which table is being used and who use the table.

By considering the background of the project along with the list of issues and pain points that need to be solved, the team propose a rough solution of an IoT system that monitor the table for customer who had done the payment or online booking to use the table and keep track which table is currently being used by which customer in order to solve the emerged problem.

2. Scope

In order to ensure that the project can be done smooth with high quality deliverables to be produced at the end of the project, project scope will be needed to be defined thus the project can have certain limitation on the things that must be covered and things that can be ignored at the moment. There will be several things to be defined on project scope itself, starting from defining about the aim and the goals of the project, how the solution can solve the issues, what features that will be developed on the project itself, even things that must be noted to be assumed as further development thus might not be covered in this project.

The main issue that the project wants to solve is about customers who come and use the facilities of the store without either making any prior booking, registered as member, or buying anything from the store. In order to ensure all the customers of the store will get the same feeling of comforts when playing games at the store, a table tracking system is needed to detect people who use the table in the unwanted way.

2.1. Goals/Aims

According to the problem domain that the project has, the goals or the aims of the project have been defined as below to ensure that the project has a clear path on what to develop.

Goals/Aims: This IoT system will help the shop to keep track the people who use the facilities of the store, especially for identifying those who are not purchasing anything from the shop.

This IoT system will keep track of members who use the shop's facilities, in addition to resolving the problem of non-members using the shop's facilities without making a purchase. Members of the shop will have a membership card that can be used to activate the table by scanning it with an RFID card scanner. Therefore, members are not needed to make a purchase in order to utilize the shop's facilities. However, non-members can only utilize the facilities after purchasing something from the store. To ensure that non-members have purchased something prior to utilizing the table, the admin dashboard will have a feature that allows the administrator to manually activate the table for non-members once they have made a purchase. With this feature, it is expected that the system can prevent strangers from using the shop's facilities freely and only allow authorized people to use the shop's facilities.

2.2. Objectives

Having the idea of what things to develop and the issues that wanted to be solved is not sufficient to ensure that the project will be developed smoothly. A project needs more details regarding the solution, especially about the features or attributes of the solution hence the project can ensure that the main deliverable of the project can really solve all the issues inside of the problem domain (Tsun 2021). By that, below are the objectives that this project needs to fulfill hence the project can be defined as fully finished after completing all these objectives.

Objectives:

- Customers who use the table without scanning the membership card (non-member) nor getting allowed to use the table by admin after purchasing something from the store shall be able to be detected by the system in under 1 minute.
- The system can change the table usage status from available to occupied within the range of 10 card scanning.
- The lighting system implemented in the system can change its colour according to the status of the table.
- Customers who have been allowed to use the table can press the assistance button to call the admin by giving notification to the admin.
- Admin can register someone as a new member along with having track of the members.
- Admin can track the usage status of each table by using the admin dashboard along with changing the status of each table as needed.
- Admin can see the business performance of the store by using the visualizations of the data that has been collected by the system with at least 3 visualizations being reported.
- Members can book a table from the customer dashboard then changing the status of available tables into booked when the time comes.
- Members can order something from the store online by using the customer dashboard with complete functionalities.

In order to ensure that the system will really make the situation better, there must be some distinctions between the manual system that the store is currently adapting and the IoT system that will be developed for the stakeholders to see and use. By that, below listed some discrepancies between the manual system and the IoT system with all the listed objectives.

Table 1: Distinctions Between the Current System and the Proposed Idea.

Current System (Manual)	IoT System
Manually remembering the regulars of the store.	Has a membership system that will keep track on the growth of the community.
Has a possibility for the admin to lose track of the tables usage thus some facilities might be illegally used by strangers without giving any benefits for the business.	Each table will have LEDs that will notify the status of the table along with camera that will know whether the table is being illegally used or not after cross-checking the information with the other components.
Customers need to pick up the snack by themselves while in game.	Customers can order the snacks online through customer dashboards.
Storekeeper will need to look around to store to find out the table that might have issue with the games.	Customers can press the call for assistance button to ask for the help from the admin.
Members will need to chat or tell the storekeeper to	Members can do the table booking process by

arrange a booking for the table	themselves through the customer dashboard.
Owner does not really keep track on the performance of the business	Some visualizations will show the data that might be useful for the owner to see how the business goes.

2.3. Constraints and Out of Scope Limitations

A project will have certain constraints and limitation of the things that will be worked on or the things that might need some attention during the development process. A system itself will always grow to solve the new issues that might come by time. By that, a project will need to have some limitations to make sure that the project can release a solution that will solve the specific issues that that project has targeted. These limitations will help to ensure that the project will be finished on time with the main deliverable covering all the specified requirements. The limitations themselves include constraints and out of scope contexts. Constraints will define mostly about the conditions that might limit the project in term of its implementation while out of scope contexts will list down the further improvements that might be able to be done in the future since those features will not be the focus of this project.

Constraints:

- Limitation of installation a sensor to the table. This is because the limitation of the table space would not allow a big device to be installed on the table which can be broken by someone if they accidentally knocked it and people will around the table which will affect the functionality of the sensor.

Out of Scope Features:

- Facial Recognition to detect members who come to the store.
- Inventory Tracking. This project will not cover the ability to track whether there is someone who takes something from the rack or not.

3. Stakeholders

A stakeholder is someone who has an interest in a business and can either have an effect on the business or be affected by it (Fernando 2022). In order to ensure that the project will have clear definition of people who will be involved in the project either directly or indirectly, below the table shows the stakeholders in this project and their interests.

Table 2: List of Stakeholders and Their Interests.

Stakeholder	Interests
Product Owner	Who will communicate with the client to translate the business requirement into features that need to be implemented on the system
Project Managers	Who is responsible to manage workloads of the project and ensuring that all the works can be completed on time as planned
Developers	Who is responsible to develop the features needed by the project on time and within the allocated budget
Customers/Users	Who will use the system directly
Client	Who has the issue that needed to be solved by the system.
Project Sponsor	Who will help the developers in sourcing or providing the required tools or technologies for the prototype of the project.

Some of the stakeholders that have been listed above will interact directly with the system as users, such as the customers and the client who will be mentioned as admin in this case. By matching the interests of the stakeholders with the objectives that this project wants to achieve, there will be some features that are accessible only for certain stakeholders thus below listed the features that will be used by stakeholders who will interact with the system.

Table 3: Stakeholders and Their Interactions with The System.

Stakeholders		Features
Customers/Users	Members	<ul style="list-style-type: none"> • Books a table via the Customer Dashboard • Scans membership card to check in and

		<ul style="list-style-type: none"> takes away the card to check out • Uses button to call for assistance
	Non-Members (<i>After a purchase has been made</i>)	<ul style="list-style-type: none"> • Uses button to call for assistance
Client/Admin		<ul style="list-style-type: none"> • Checks business performance via Admin Dashboard • Checks new order via Admin Dashboard • Checks and changes tables' status via Admin Dashboard • Registers a new member via Admin Dashboard

4. Possible Solutions Analysis

Solution is something that can be used to solve an issue. However, solution itself is not an absolute thing as there might be several different possible solutions that might also be able to solve the same issue. Things that make one solution to differ from the others are the compatibility of the solutions to several domains of the project such as the time, the cost, and the scope of the project itself. Having a list of possible solutions is an important thing that a project needs to have on its planning process as it shows that the solution was chosen out of several considerations thus declaring that the chosen solution is the best one to solve the issue hence achieving the goals and the objectives of the project.

In order to determine which solution will be the best one, some objective comparisons will be needed to ensure that all the solutions were considered at the same way of thinking. By that, several frameworks, such as Project Forces, SWOT, and KoST, were chosen by the team to be the guidance of the things that the team will need to consider while assessing the suitability of the solution to the problem domain of the project. Project Forces are talking about aspects that we need to consider whenever we have solution, starting from the time that we have, the cost that we might spend, even whether the solution is still inside of the scope of the project or not. Having a balance between these 3 aspects will help the project to deliver higher quality of deliverables.

SWOT will also help the decision-making process of choosing the best solution for the project. SWOT is the abbreviation for Strength, Weakness, Opportunities, and Threats. Other than just considering about the possibility of the solution to be developed in the project by looking at the Project Forces aspect, SWOT will also help us in identifying the business value of each possible solution thus it will also ensure that the chosen solution is also the best one in term of the values that the solution can give. The last framework to be used of consideration is the KoST Analysis which is an abbreviation for Knowledge, Skills, and Technology Gaps. A solution might be very possible to be done according to Project Forces and might be very valuable for the business according to the SWOT analysis. However, there might be some cases where the skills of the developers might not be sufficient to carry out the project well enough if that particular solution was chosen. So, KoST will put some extra gaps consideration to make sure that the chosen solution can be really carried out successfully by the developers later on (Tsun 2021).

The team has brainstormed some possible solutions that might be able to be worked on in order to solve the issue of people using the table without placing any order or also mentioned as table tracking in this document. Some analysis processes have been done for each solution thus the developer decided to take out the best solution out of the other ones to be implemented for this project. The analysis process of those possible solutions can be found on the table below.

Table 4: Possible Solution Analysis Process.

Problem Domain: People are using the facilities (table) of the store without making reservation or even placing an order				
Potential Solution	Project Forces	SWOT	KoST	Final Decision
QR Code Scanning System to Utilize the Table	Time: Plausible Cost: Might need to buy QR Code Reader for	Strength: Simple to be used Weakness: Untracked QR Code might be able to be	Knowledge Gap: Not Applicable Skill Gap: None of the team ever worked with	Plausible

	Arduino Scope: On scope	re-used Opportunities: QR Code Scanner can also be used by customers to directly purchase something by scanning the item and get the item listed on admin side Threats: Installation and maintenance of QR Code Scanner might cost a lot	QR Code Scanning system Technology Gap: Not Applicable	
Infrared or Distance Detection System to Detect Illegal Usage of Tables	Time: Plausible Cost: On budget as tools can be sourced from project sponsor Scope: Can detect whether there is someone using the table or not but missing the required ability to notify whether the person is a member or not	Strength: Simple implementation with affordable technologies Weakness: Infrared and distance sensor is sensitive thus it has higher chance to give false positive information Opportunities: Project can be delivered quicker Threats: The sensor will target a certain direction only so more than 1 sensors will be needed to cover the whole table	Knowledge Gap: Not sure whether the solution can really solve the issue or not Skill Gap: Not Applicable Technology Gap: Not sure whether the sensors can work well within a crowded area like how the store looks like.	Rejected
Sound Alarm System for Illegal Usage Notification Using Infrared No Touch Sensor	Time: Plausible Cost: On budget as tools can be sourced from project sponsor Scope: Can detect whether there is someone using the table or not but missing the ability to notice whether the customer is a member or not	Strength: Simple system with quick delivery time Weakness: The system is highly possible to be deceived Opportunities: Low-cost implementation Threats: The solution does not solve the problem	Knowledge Gap: Not sure whether the solution can really solve the issue or not Skill Gap: None of the member ever tried to use Infrared No Touch Sensor Technology Gap: Not sure how the Infrared No Touch Sensor will be able to detect whether	Rejected

			someone is illegally using the table or not	
Object Detection and RFID Card Scanning System with the Integration of Admin Dashboard	Time: Plausible Cost: On budget as tools can be sourced from project sponsor Scope: On Scope	Strength: Using more advance and newer technologies Weakness: The system is more complex thus needs more time to be delivered well with better management of project Opportunities: The usage of camera and RFID Card can be easily expanded to other usages Threats: Higher implementation cost	Knowledge Gap: Not Applicable Skill Gap: None of the team ever worked with RFID card or tried to do real-time object detection using camera. Technology Gap: Not applicable	Accepted

According to several considerations from different perspectives on each solution, by looking at the Project Forces, SWOT, and KoST analysis, the solution of Object Detection and RFID Card Scanning System with the Integration of Admin Dashboard seems to be more possible to solve the problem. Sound Alarm and Distance Detection solutions do not really solve the issue that this project want to work on. The QR Code solution is still doable and highly possible to also solve the problem but in term of cost and skills gap, the chosen solution of Object Detection and RFID Card Scanning System seems to be a better to work with. By that, the proposed solution that this project will work on to solve the illegal usage of table issue is the Object Detection and RFID Card Scanning System with the Integration of Admin Dashboard. More details regarding the chosen solution will be shown on the other sections especially to explain about the implementation of the solution.

5. Deliverables and Schedule

5.1. Deliverables of the Project

Deliverables are things that will be given or targeted to be completed by the end of the project (Bloomenthal 2022). Thus, the main deliverable of this project will be an IoT system consisting of several nodes with some sensors and actuators that are integrated with an online system to communicate with the users through interface using the dashboard. The main deliverable of the system will be in the form of prototype to show the most basic functionality of the system or also known as the Most Viable Product (MVP). The main deliverable itself of the project can be broken down into several components including:

1. Hardware
 - 1.1. RFID Card Scanner (including RFID Card or RFID Tag)
 - 1.2. Pi Camera
 - 1.3. Button
 - 1.4. LEDs
 - 1.5. Arduino
 - 1.6. Raspberry Pi 4 8GB
 - 1.7. XBee
2. Software
 - 2.1. Admin Dashboard
 - 2.2. Customer Dashboard

The hardware listed will form an IoT node that can be duplicated and used according to the needs of the project. Meanwhile the software listed will basically be the interface that can be easily used by the targeted users of the project. To make sure that the system can work well wirelessly through the internet, Amazon Web Services (AWS) will be used to help the system on the cloud side starting from hosting the dashboard, storing the data on the online database, even helping the IoT nodes to communicate through internet by using certain communication protocol.

Other deliverables that will be completed by the end of the project will be the project documentations that will show the concept of the system and its development process including the management plan of the project. The deliverables that fall inside of the project documentations category will also include the presentation slides of the project that can be used to present the system to stakeholders.

5.2. Initial Release Schedule

5.2.1. Product Backlogs

To make sure that the main deliverables of this project can have complete functionalities by the end of the project, product backlogs have been listed below to show the features or functionalities that will be developed for the prototype to be said as a complete system. Each item in the product backlogs is important for the project in ensuring that the developed system will solve the issues that have been defined along with achieving the goals of the project.

Product backlogs will provide some information regarding the features or functionalities that the project shall have, including the functionality of each item that will justify why that item is important for the project, the dependencies of each item that will show whether a certain item will depend on the other items to be finished first before it can be developed, the business values that will indicate how valuable the feature for the business is, and lastly the release schedule that will show when shall the feature to be developed during the development phase of the project. The first sprint of the project will focus on making the essential hardware parts work along with getting the membership system drafted while the second sprint will wrap up the project with more user interfaces that will be integrated with the system thus making the deliverables to be more solid. Below are the details of the product backlogs for this project.

Table 5: Product Backlogs

No.	Item	Functionality	Dependencies	Business Value (1 least – 20 most)	Release Schedule (Sprint #1 #2)
1	Membership Registration	To record the members' information thus registered customers can get the RFID card and turn on the lighting system of the table to use the table. Members will get the access to be able to book a table for competition or any other relevant purposes.	NA	20	Sprint #1
2	Object Detection using Pi Camera	To detect unwanted people (non-members) who want to use the table without purchasing anything from the store.	NA	20	Sprint #1
3	Check-in and Check-out system by using RFID Card for member	To allow members to turn on the lighting system of the table by placing their membership card (RFID Card) on top of scanner. Taking away the card from the sensor will automatically turn off the lighting system after some moments which reflects the check-out process of the system.	NA	20	Sprint #1
4	Table tracking system on Admin Dashboard	To allow admin to see the active table or the booked table along with some other information regarding the table usage.	1, 2, 3	15	Sprint #1
5	Integrated Smart	To give a proper lighting for the	3, 4	20	Sprint #1

	Light System for booked or allowed table usage	allowed and properly used table along with flagging the table as legally occupied. The lighting system will be integrated with the other feature to form a solidify system.			
6	Customer Dashboard	To allow members to book a table in advance thus flagging the table at the store as booked later hence preventing others from using it.	1, 4, 5	8	Sprint #2
7	Data visualization on Admin Dashboard	To allow admin in analysing the business performance of the store according to the tracked data about the tables or the other data generated by the system.	4	10	Sprint #2
8	Order making system through Customer Dashboard	To allow members who have booked and use a table to order things remotely from the table.	1, 4, 6	5	Sprint #2
9	Marking down active table from Admin dashboard	To give admin the ability to mark the table that can be used by non-members after they have ordered something from the store	4, 5	15	Sprint #2
10	Integrated assistance notification system using button on the table	To let members or allowed non-members to call the admin for assistance by simply pressing the button that has been implemented on the system. Pressing a physical button is considered to be easier and faster thus giving more convenience for the customers.	4	10	Sprint #2

5.2.2. Project Timeline

A project will have several phases in its process to allow several aspects of the project to be developed and delivered by the end of the project. Project timeline is important in helping the developers to keep track on the time hence ensuring that the project can be finished on time with all required modules are developed well. There are several project management frameworks related to defining how the project timeline of the project shall be. In this project, the developers decided to use the SCRUM methodology with Sprint approach to allow the development process to be more agile along the way.

The whole development process of the project will be divided into 2 different sprints whereby each sprint will take approximately 25 days of development with the extra of one day for Sprint Planning, one day for Sprint Review and Retrospective, and another day for Sprint Documentation. By that, the whole development process of the prototype will be expected to take around 56 days or 6 to 8 weeks in total starting from the proposal is confirmed to be accepted by the client or other stakeholders if applicable.

Before each sprint start, there will be a sprint planning session conducted to allow the developers to be able to review back on the things that the team needs to work on along with the deadline of each task. Some items in the product backlogs may also get broken down furthermore into list of actions with more details during the sprint planning session. After each sprint ended, there will also a day dedicated for the team to do review on the sprint that has been done along with reflecting on the things that have been done well and things that might need to be fixed. The following day will be used for writing the documentation about the sprint that has been conducted hence making the sprint to be more well-documented as future reference. It is expected that the team will be able to meet the client or the other stakeholders during the sprint review session or prior to that hence the team can show the current progress of the project and getting some feedbacks from the other stakeholders or client.

At the end of second sprint of the project or can be mentioned as the end of the development process, the prototype is expected to work well and complete thus the following week after the end of the second sprint can be utilized by the team to prepare the final documentation of the project. By that, at the end of the project duration, all the deliverables of the project shall have been ready along with each item on the product backlogs shall also have been implemented as the main deliverable. All the components needed for the project that were

not owned by the developers shall have been afforded prior to the end of the first sprint to ensure that the project can be conducted smooth.

Better visualization of the timeline is needed thus Jira is used to generate the Gantt Chart that can be referenced by the team to keep track on the time. All the description of the timeline for this project has been translated into a Gantt Chart that can be seen below. According to the Gantt Chart, there will be 2 sprints whereby the first sprint will start on September 30th, 2022, until October 24th, 2022, while the next sprint will start on October 28th, 2022, and ended on November 21st, 2022. Prior to the start date of each sprint, there will be a day for planning and two days after the end of the sprint will be used for review and documentation. The week after the second sprint is also annotated as the week for final documentation according to the custom Gantt Chart on Jira below. By that, the whole project will span from September 29th, 2022, until early of December 2022 that will be allocated as the pitching period. The timeline is subjective to change according to the needs and situations of the project thus further notification will be given to the other stakeholders if the timeline shifted for some adjustment.

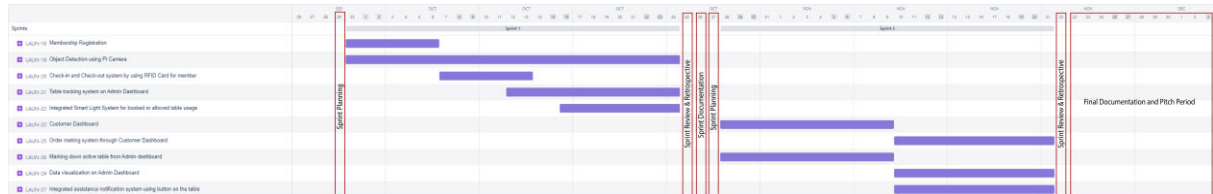


Figure 1: Jira Gantt Chart as Project Timeline.

6. Architectures of the Proposed Solution

In order to visualize how the proposed solution will work along with the components that might be needed in order to build the proposed IoT system, some diagrams of the architecture of the solution are needed. The proposed system will be described by using diagrams as it is easier to understand along with easier to be visualized compared to having to read several paragraphs in order to understand how the system works in detail. The diagrams that will be shown in this proposal are high-level diagrams which means that the diagrams will abstract most of the process and are not focusing on the technical implementation of the solution. There are several diagrams that will be shown this proposal including the Hardware Diagrams, Software Diagrams, Use Case Diagrams, and Activity Diagrams. All of these diagrams are presented in the proposal with the hope that all stakeholders will have better understanding of how the proposed solution will work in order to solve the emerged issues along with achieving the goals and objectives of the project.

6.1. Hardware Diagrams

The hardware diagram depicts the wiring of each piece of hardware and how it will look like when implement it on a table.

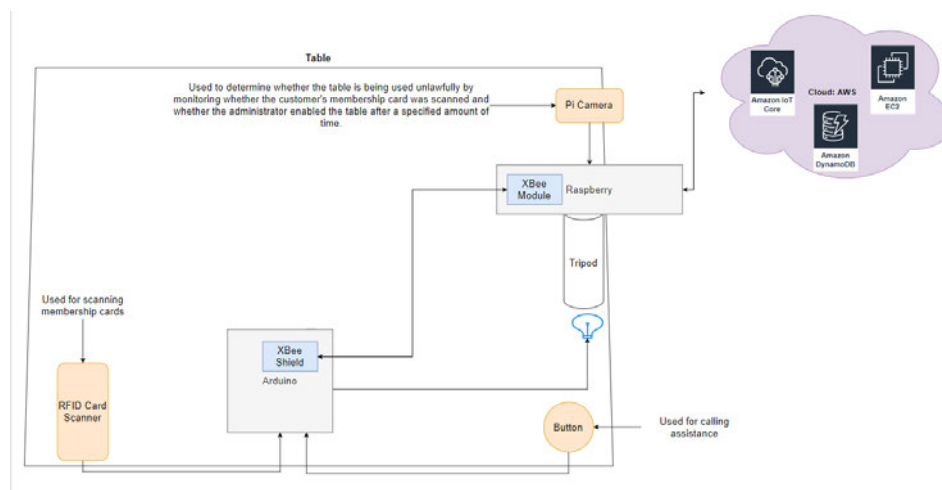


Figure 2: Hardware Diagram of the Proposed Solution.

On the hardware diagram above, we can see that there will be 3 different sensors being used on the system, which are the RFID Card Scanner, Button, and Pi Camera. The button and the RFID Card Scanner will be connected with the Arduino that will later control the LED on the system which act as an actuator. Pi Camera itself is connected to Raspberry Pi that will communicate with Arduino through XBee along with the cloud services such as AWS IoT Core, AWS DynamoDB, and AWS EC2. Since object detection will hardly depend on the view or perspective that is captured by the system, the Raspberry Pi that is connected with the Pi Camera will be mounted on a tripod to give more flexibility for the setup. The Raspberry Pi can also be placed on a high shelf if there exists.

6.2. Software Diagrams

The software diagram shows the edge device (Raspberry Pi) manages to communicate between the cloud server (AWS) and edge node. The edge device manages the serial communications between the edge nodes in Arduino. The messages will be able to store the data in the database (DynamoDB) via MQTT communication protocol. Raspberry Pi and Arduino will be powered up separately as the Pi Camera will need to get better view for the object detection thus there must be no limitation on its placement because of the connection with the other nodes. By that, the communication between nodes will be managed by using Zigbee through XBee modules to enable wireless serial communication.

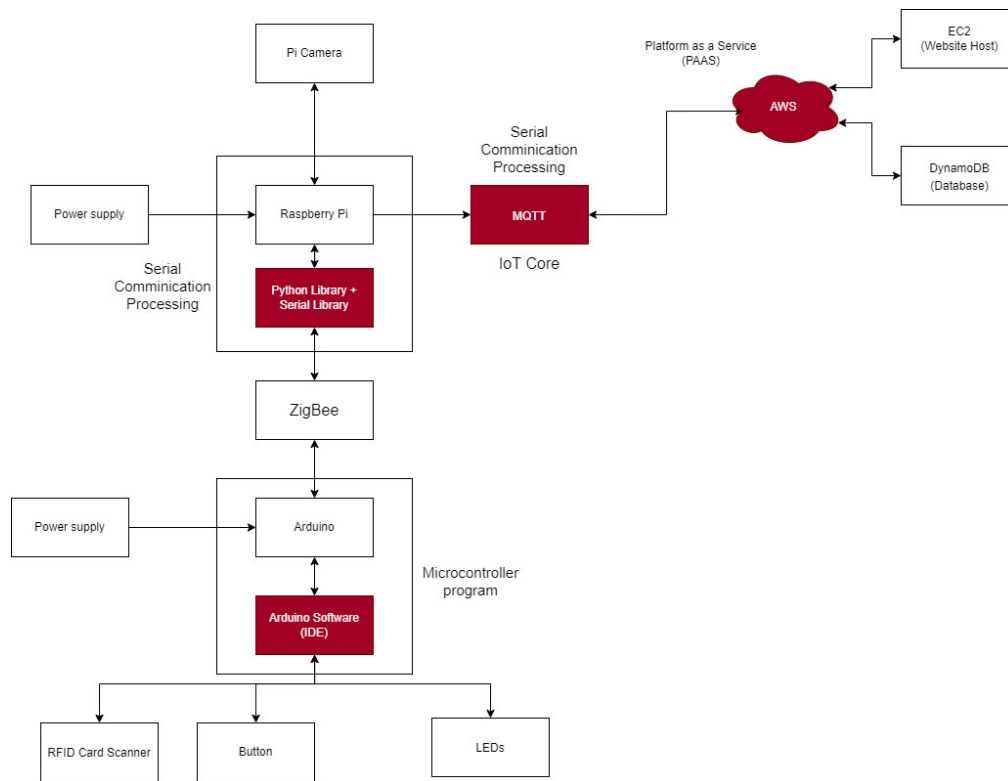


Figure 3: Software Diagram of the Proposed Solution.

6.3. Use Case Diagrams

A project will have several features to be implemented on the system but not all features will be accessible for all users especially when the users themselves were split into some access limitation categories. In the proposed that the team decided to develop to solve the issues that the clients have, the users of the system will be split into the categories of Member, Non-Member, and Admin. Each user category will have different use cases or features to be utilized yet some features might also be used by more than one user category. Use Case Diagram will present all of these concerns in a simpler form thus helping the stakeholders to better understand what are the things that each user category can do on the system.

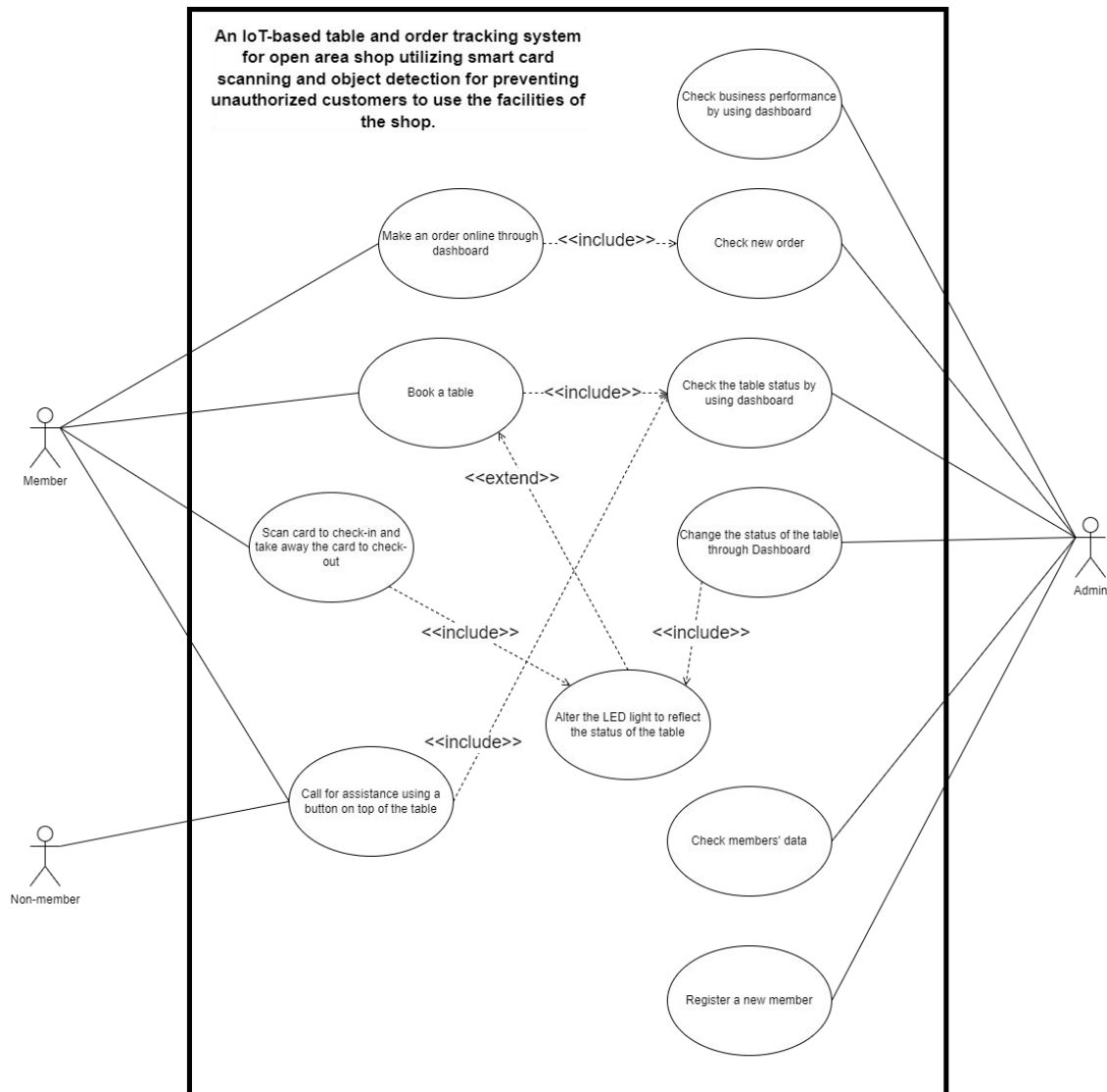


Figure 4: Use Case Diagram of the Proposed Solution.

6.4. Activity Diagrams

In the working process of the system, there will be several actions that will trigger several other actions according to certain conditions. An action that has been triggered by a certain user will need to be integrated with the other features that might be handled by the system or managed by the admin. In order to visualize about all of these actions and their conditions to form a certain flow, an activity diagram was created. Activity Diagram will try to show all the things that might happen on the system along with what things that trigger a certain action along with the possible conditions.

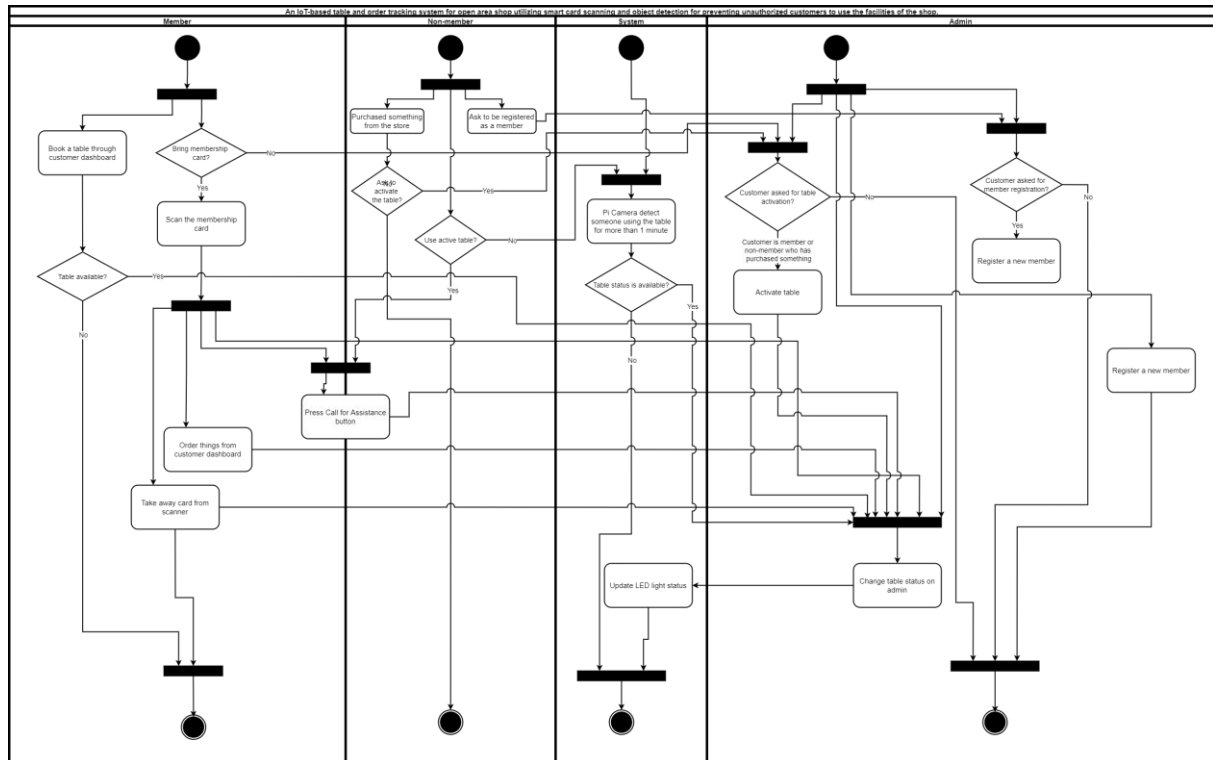


Figure 5: Activity Diagram of the Proposed Solution.

7. Quality Management

Completing all the deliverables is an essential thing to be done in a project. However, it is possible for the project to have poor quality of deliverables if there is no specific standards or measurement that need to be fulfilled by the developers. Thus, to make sure that all the features or functionalities in the project can pass a certain quality standard, Definition of Done and Quality Attributes were made to assess whether the developed features have worked as it is expected or not.

Definition of Done itself in short defines the conditions that a certain feature needs to fulfill or pass before the feature can be released. Definition of Done talks more about the business process or the intended behaviours that a certain feature needs to have to fulfill the defined requirements (Madan 2019). The requirements in this case itself is talking about the attributes that a certain feature needs to have hence the feature can be said as well-developed and releasable. The attributes that the features need to have to be declared as well-developed according to the expected behaviour itself is known as Quality Attributes.

According to Merriam-Webster (n.d.), Quality can be defined as a degree of excellence. Thus, Quality Attributes will list down the standards or the attributes that a feature needs to have to be said as 'excellent' according to the expectation of the stakeholders. By that, Quality Attributes can define something more than business processes, such as the usability aspect or the security aspect of a feature. In correlation with Definition of Done, Quality Attributes will define the aspects that the developers need to pay attention on while developing the feature and when the feature has fulfilled the defined Definition of Done for each attribute in the product backlog item, the feature then can be declared as ready to be released.

To define the Quality Attributes of each item in the product backlogs of this project, ISO/IEC 25010 Software Product Quality has been chosen as the measurement guide for defining the required quality attributes for each

feature. There are 8 major attributes assessed by ISO 25010 to ensure that the project can work well under different circumstance. Those 8 majors are (ISO 25000 n.d.):

1. Functional Suitability
2. Performance Efficiency
3. Compatibility
4. Usability
5. Reliability
6. Security
7. Maintainability
8. Portability

There are several attributes defined under each major and those attributes are the ones that will be used to assess the appropriateness of the feature to be released. More details regarding the things assessed by ISO 25010 will be defined in the table below. Each feature might have different Quality Attributes taken from ISO 25010 depending on the nature of the feature itself.

Table 6: Quality Attributes and Definition of Done of the project.

No	Product Backlog Item	Quality Attribute	Definition of Done	Justification	Sprint Goals
1.	Membership Registration	Availability	There is no failed membership creation process during the last 10 running tests of the project	Membership registration might be done in irregular timeframe thus having the system to be ready whenever it is needed even though it has not been used for quite a time is an important thing	<i>Sprint 1</i> <ul style="list-style-type: none"> Unwanted customers who use the table without membership or placing an order can be detected by the Pi Camera in real-time with the accuracy of more than 50% The system can detect the members information by scanning the RFID Card to the sensors and detecting log-out action after the members taking away the card The system can turn on the lighting under certain condition like when someone use the table inappropriately or after a member scanned his RFID card to the RFID sensor. Admin dashboard can show the list of tables with some categories of usage (available, occupied, improperly used, booked, or need assistance) The table status on the admin dashboard can change
		Capacity	There are at least 25 members data inserted into the database with no errors through the system	The number of members will grow by time thus the system must be ready to store more data in the future otherwise new membership might be neglected because of the full database	
2.	Object Detection using Pi Camera	Functional Correctness	The object detection accuracy must be more than 50%	Object detection is a process the requires Artificial Intelligence to work with thus it is important to ensure the system can detect the targeted object well with low error rate in its process	
		Time Behaviour	The system must be able to send alert notification under 1 minutes	People might try to deceive the object detection system thus it is	

			counted from the time when unallowed customer use the table	important for the feature to be responsive enough to ensure that unallowed usage of table can be detected fast	<p>according to the activity that has been done on the tracked table.</p> <ul style="list-style-type: none"> • Admin dashboard can be used to register a new member • Databases are ready to be used for testing with insertion and fetching action of at least 1 data per database. • Databases can be integrated with the User Interface on next sprint
3.	Check-in and Check-out system by using RFID Card for member	Functional Correctness	The system must be able to detect the data of the member and trigger something on the system by scanning the card with the success rate of more than 90%	The card scanning system will change the status of the table to active thus it is important to have the feature to be always able to fetch the data about members from the card correctly with low scanning error rate	
		Maturity	The scanner must be able to detect at least the last 15 check-in and check-out action with no scanning error	Members will expect the system to always be able to detect their card on the first scan thus it is important to have the system mature enough to always be able to scan the RFID card in normal condition	
4.	Table tracking system on Admin Dashboard	Functional Completeness	The dashboard must be able to detect the change of status of each table for at least 3 times consecutively per table with no error	The table tracking system will notify the admin about the usage status of each table, whether it is available, active, booked, or even illegally used. Hence, it is very important to ensure that the dashboard can show all those changes of status	
		Learnability	A user who has not seen the system must be able to understand about the status tracking system within 1 hour without any major support	An admin might be someone who is not tech-savvy thus it is important for the dashboard to be simple enough to be learnt thus admins without any advance tech knowledge will still be able to use the system comfortably	

5.	Integrated Smart Light System for booked or allowed table usage	Functional Appropriateness	The system must be able to change its lighting according to the changes of status for at least 10 consecutive changes	The lighting system will act to a lot of actions or triggers thus it is important to have the system to be able to accomplish its task even on rapid changes	
		Interoperability	The system must be able to adjust its lighting as response to the actions given on the system with no error for at least the last 7 actions	The lighting system will notify whether a table is available, occupied, booked, or even illegally used. All of those status will come from different sources starting from software side such as dashboard and hardware side such as card scanner and camera. It is important to ensure that the system can response to these different sources of data accordingly	
6.	Customer Dashboard	Functional Appropriateness	At least the last 7 booking of table made by the members must be able to be received by the system	The main purpose of having a customer dashboard is to allow members to book a table in advance thus it is important to ensure that the booking process will be done smoothly	Sprint 2 <ul style="list-style-type: none"> Admin dashboard can show at least 3 visualizations of some pre-processed data that has been stored on the database Members can use the customer dashboard to book a table in advance thus changing the table category on admin dashboard as booked Members who have checked-in to a table can order something from the store remotely using the customer dashboard then the admin can get the order notification when the order is confirmed Admin can allow non-members who
		Operability	A user who has not seen the system must be able to make a booking through the system within 20 minutes	A member might not be a tech-savvy person thus it is important to ensure that the interface is simpler enough to be operated by various backgrounds of users	
7.	Data visualization on Admin Dashboard	Appropriateness Recognizability	The admin can at least identify 1 business value that the admin can infer from the	The main purpose of having data to be visualized is to make the reading process of the data	

			data visualizations that have been shown on the dashboard	to be easier thus allowing the reader to infer more valuable information from the collected data. It is important to make sure that the admin who acts as the reader of the visualization will be able to know what things that have happened on the business from the given visualizations.	<p>have purchased something from the store to use a certain table by simply activate the table through the admin dashboard. The system will act accordingly to response the activation action done by the admin.</p> <ul style="list-style-type: none"> • The allowed users of the table can ask for assistance from the admin by pressing a button that has been implemented on the table hence flagging the table with the category of 'need assistance' on the admin dashboard
		Accessibility	At least 2 users who have not seen the visualization and come from different expertise are able to infer something from the data visualization	Reading data is not something that can be easily done by people in general since it needs basic knowledge of statistics. A data visualization must be that readable even for people with the most basic knowledge of statistic can read the data and infer something important about the business	
8.	Order making system through Customer Dashboard	Functional Completeness	At least 3 orders must be able to be placed successfully with several actions before confirming the order starting from adding items, changing quantity, removing items, and checking the total payment needed.	An online ordering system will expect the users to get more convenience by being able to order things from distance compared to standing in from of a counter. Thus, it is important to ensure that the system will covers all the things that usually being done when ordering things directly to the counter.	
		Operability	A user who has not seen the interface must be able to place an order with some additional actions such as adding items, changing	Ordering things online might be uncomfortable for some users as they are not getting used to do this kind of thing hence the system	

			quantity, deleting items, and checking total payment within 20 minutes	will need to ensure that the interface is simple enough for users with various background to operate and place an order	
9.	Marking down active table from Admin dashboard	Maturity	The admin must be able to activate or de-activate table for at least 5 times consecutively for each table without any error	Marking a table as an active table is an important part of the project as it will allow people to start using the table. It is important to ensure that the admin can always activate the table for non-members to allow them to use the table otherwise the non-members might not be able to use the table at all	
		Interoperability	The admin must be able to trigger the lighting system and set the lighting system as occupied for at least 3 times consecutively by simply changing the status of the table as active from the dashboard.	The activation action that been done on the admin dashboard will send an information to the system thus triggering the lighting system to also response to the given data. It is important to ensure that this process will run smoothly otherwise the non-members might not be able to use the table	
10.	Integrated assistance notification system using button on the table	Availability	At least the last 12 presses of the button were successfully sent an assistance notification to the admin	The assistance button will be used mostly on undesired condition thus it is important to always have the button ready whenever it is needed	
		Interoperability	The admin must be able to get the assistance notification from each table for at least twice that	Pressing the button will send a notification to the admin thus the admin know that a certain table needs	

			were done consecutively	an assistance. Since assistance data can be considered as urgent and important, the system must ensure that all the assistance data sent by different table can be received well by the admin	
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8. Resources

This section outlines the materials, manpower, and equipment used to complete this project. It is separated into Human Resources and Non-Human Resources. Human resources are intangible resources that originate within and consist of personal qualities or characteristics. Our team members hold the following human resources to complete this project:

- **Knowledge**
 - Have a basic understanding on IoT industry
 - Knows how to build a simple IoT system
- **Abilities and Skills**
 - Knows how to code the system using Python
 - Knows how to integrate the devices with Arduino
 - Can fix bugs
 - Know how to improve the system
- **Attitudes**
 - Polite
 - Willing to help each other
 - Always shows positive attitude
- **Energy**
 - Able to work at least 4 hours a week

Non-Human Resource is known as material resource. Listed below are the non-human resources for this project:

- **Time**
 - Two weeks to complete the project proposal and seven weeks to complete the proposed IoT system.
- **Money**
 - This project does not appear to use any funds as all the goods can be borrowed from the project sponsor and services that will be used are free.
- **IoT Technologies**
 - Arduino
 - Raspberry Pi 4 8GB
 - Pi Camera
 - LED light
 - RFID Card Reader
 - Button
 - XBee
- **Services**
 - AWS

Other than that, this section will also define about the roles of each member to ensure that all the division of responsibilities will be done appropriately as approved by all team members. The roles defined will mark down the person that will be the lead of that certain field of works. Regardless the roles that have been defined above, all members are expected to be able to participate equally and fair in the development process of the project thus

all members are also expected to be able to develop the IoT solution, communicate with the client, and managing the sprint.

Table 7: List of Members and Their Roles.

No.	Name	Expertise	Roles
1.	Alesandro Michael Ferdinand	Project Management	Project Manager
2.	Chua Jia Zheng	Communication	Liaison Person
3.	Hsu Wei Ying	IoT Development	Developer

Regardless the fact that the prototype of the proposed solution will need to funding support, the system will still cost money when the system will be implemented in the real environment since the components themselves will need to be purchased by the clients themselves. Thus, below is stated the approximated cost that an IoT Node of the system will cost if there is no funding support provided.

Table 8: Cost Analysis of the Product Implementation.

No.	Hardware Components	Price (RM)	Quantity	Total (RM)	References
1.	Arduino Uno (Rev3)	109.00	1	109.00	Click to see
2.	Raspberry Pi 4 8GB	369.00	1	369.00	Click to see
3.	Pi Camera	125.00	1	125.00	Click to see
4.	LED Light	0.10	3	0.30	Click to see
5.	RFID Card Reader + RFID Card	9.00	1	9.00	Click to see
6.	Button	0.50	1	0.50	Click to see
7.	XBee	111.00	2	222.00	Click to see
8.	Electrical wire (1m)	0.80	1	0.80	Click to see
9.	Arduino power cost (Annually)	2.15	1	2.15	Click to see
10.	Raspberry Pi power cost (Annually)	40.00	1	40.00	Click to see
11.	Banquet Table (long table)	65.00	1	65.00	Click to see
12.	Jumper wire (male to male) (40 pcs)	4.00	1	4.00	Click to see
Sub Total				946.75	-
No.	Services	Detail		Price (RM) / Year	References
1.	AWS EC2 (web hosting)	t4g.nano		219.00	Click to see
2.	AWS DynamoDB (database)	100 writes and 100 reads per day		0.29	Click to see
3.	AWS IoT Core (MQTT broker)	20,000,000 messages		111.20	Click to see
Sub Total				330.49	-
Grand Total				1,277.24	-

9. Approval Signatures

Project Team

Table 9: Project Team List.

No.	Name of student	Student ID	Signature
1.	██████████	██████	██████
2.	██████████	██████	██████
3.	██████████	██████	██████

Project Sponsor

Table 10: Signature of Project Sponsor

Tutor's name (on behalf of the client)	Signature
██████████	

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