0Q (Zero Queue)

Virtual Queue Management System for Banking Sector

by

Iman Munirah Binti Irwan

17002505

Dissertation submitted in partial fulfilment of

the requirements for the

Bachelor of Information Systems (Hons)

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Universiti Teknologi PETRONAS

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Perak Darul Ridzuan

CERTIFICATION

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A project dissertation submitted to the
Information Systems Programme
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Approved by,

(Ts. Nazleeni Samiha Binti Haron @ Baharon)

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR, PERAK
September 2021

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Munirah

IMAN MUNIRAH BINTI IRWAN

ABSTRACT

This project, 0Q (Zero Queue), A System Application for the Banking Sector's Queue Management, attempts to assist banks in adapting to the present Covid-19 scenario by minimizing face-to-face interaction and thereby preventing virus propagation. This initiative addresses the situation that, despite current law, certain services remain unavailable online or require particular face-to-face interaction. Queuing is unavoidable because banking facilities can only accommodate a certain number of customers, causing consumers to spend time waiting in lines and potentially creating unneeded crowds.

This proposal proposes a web-based queue management system that will benefit both customers and the bank. Customers can book services online or on-premises via an in-house device that interfaces with a web-based API that handles booking requests and distributes bookings to assigned services. It will benefit clients in terms of the flexibility of virtual queuing which can help them save energy and time through reduced waiting times, since customers will have the opportunity to join a queue digitally prior to physically arriving at the bank. For the bank, they will benefit from more efficient queue management, which will result in increased productivity and, indirectly, more customers.

The improved waterfall technique will be employed for this project due to its qualities that match the nature of the project. Angular Framework and a few more associated tools will be utilized for the software development. There are a few existing systems that are comparable to this one; however, they focus on distinct areas with distinct characteristics. The purpose of this project is to determine the needs for a virtual queuing application tailored exclusively for the banking industry. It is anticipated that the system's design and functions would suit the expectations of both types of users: customers and bank.

ACKNOWLEDGMENT

First and foremost, upon completion of this Dissertation Report that is required for all Universiti Teknologi PETRONAS's final year students. I would like to express my gratitude to the Almighty upon his blessings and chances that has been blessed upon me throughout completing my Final Year Project.

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ABBREVIATIONS AND NOMENCLATURES

UI	User Interface
SDLC	System Development Lifecycle
0Q	ZeroQueue

CHAPTER 1
INTRODUCTION

1.1 Background of Study

We are currently living in the world of pandemic, every move, strategy, plans are calculated crucially. Because Covid-19 spreads rapidly, it is vital for the government to develop a strategy for halting and healing the spreading of the disease. This tragic situation has persisted for over a year, with numerous businesses collapsing as a result of the country's mandatory lockdown. In response to the endemic, the government provided solutions for businesses to resume operations, but only if individuals and organizations adhere to current Standard Operating Procedures (SOP) legislation.

Financial and banking activities are a key component of people's daily life. That has been the primary motivation for this project. Research was undertaken on the SOP for the banking sector. Additionally, the administration has undertaken numerous other steps to adjust to the current situation. This rule is composed of three major points. To begin, all financial sector locations are urged to reduce their in-premise visitors. Following that, all doors must be guarded to verify that the first guideline is followed. Finally, the financial establishment's hygiene must be maintained at all times; they are also obligated to stock the establishment with sanitizers. Additionally, all employees are expected to maintain a one-meter separation from consumers during the banking process.

On average, people spend 52 days of their lives waiting in lines, it is indeed time consuming and wasteful of time. the number limitation of customer to visit a premise is restricted to prevent the premises to be crowded, hence making it a long tiring queue and could get uncomfortable considering the many factors of

vulnerabilities. 73% people are willing to wait up 5 minutes, people tend to leave when they see a long queue and this could be a damage to the bank business.

1.2 Problem Statement

The majority of services are given and performed online in order to minimize face-to-face interaction and avoid the spread of infections. Similarly, with banking services, a variety of services are already available to be conducted online. However, certain services are not available online or need face-to-face interaction. As a result, queueing is unavoidable, as financial establishments only allow a limited number of individuals to enter. This compelled people to spend time in lines, potentially creating unneeded crowds. According to completed research, numerous systems and applications have been developed to address these issues; however, they do not address the suggested characteristics of this project, which include presenting an estimated wait time before being served.

1.3 Objectives

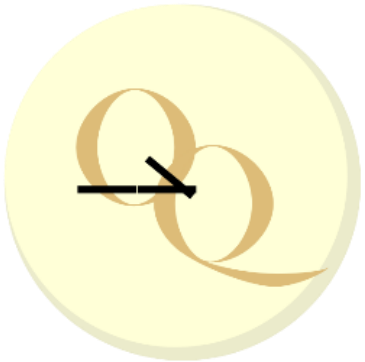


Figure 1 0Q (Zero Queue) Logo

The aim of this project is to develop a queue management system for banking sectors that allow users to see the estimated queueing time. This project caters to user's problems and bank's owner to run their business smoothly.

Therefore, the objectives applied for the project are:

i. To study the importance of knowing the estimated waiting time in lines and the impact of it to customers.

ii. To design and develop a virtual queueing web-based system incorporating Angular framework and Firebase.

iii. To evaluate user's acceptance on the virtual queueing system.

1.4 Scope of Study

To develop this queue management web-based system, various boundaries and limitations has been faced, this includes the user's level functions, project completion period, focus and software requirements for this system to run. This project uses CIMB's branches and banking services as the location and services parameters of this system prototype.

i. Focus

The focus of this project is to study the impact of good queue management by allowing users to know the estimated waiting time. The boundaries and limitations of the project is to develop an accurate waiting time queueing system and to improve user's queueing experience.

ii. Target User

The target users of this project are banking sector's premises and people who uses banking services.

iii. Time Limitation

The time limitation giving to complete this project are 8 months, which is 4 months for FYP1 and 4 months to FYP 2 in total 28 weeks.

iv. Queue Management System for Banking Sector

This project aims to develop a web-based queueing system using Visual Studio and Angular Framework as the main developing tools and incorporated with Firebase Database for customers and bank workers.

1.5 Significance of Study

The impact or importance of this project are:

i. To help financial sectors run their business smoothly while abiding current SOP
ii. To ease and save people time running their essential financial errand while staying as safe as possible
iii. To utilize technological advancement to ease queuing process

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction: Business in Pandemic

Covid-19 has been a massive disaster for the entire globe. It has had a disastrous effect on each country's social and economic factors. The outbreak resulted in serious health problems and fatalities (Tkach, D. V., and Kurpayanidi, K. I., 2020). While a few countries have begun to recover gradually, Malaysia is taking its time.

One of the government's initiatives to halt the spread of this disease was to halt all economic and social activity for a period of time, resulting in imposed lockdowns and movement restrictions. Regrettably, this has been going on intermittently for about two years. According to Kaushik, M., and Guleria, N. (2020), many industries such as airlines and hotels have been completely shut down, displacing a large number of people and producing economic disruptions that force enterprises to close permanently due to the financial strain.

To weather this economic storm, businesses are experimenting with new ways of working, such as working from home (WFH), which previously was only available in the information technology sector (George, G., et. Al., 2020). These modifications are necessary to rectify the situation. Despite the lockdown, critical and vital industries such as food, grocery, financial services, and many more are permitted to operate under rigorous controls and regulations.

2.1.1 Importance of Queuing Management System

According to Zhao, Z. (2016), there are numerous reasons why having an effective queue management system is critical. The four primary factors are as follows: first, **queueing is directly linked to consumer satisfaction**. It is considered that there is a correlation between queuing time and consumer satisfaction. The longer people wait, the lower their satisfaction level will be, even if the service or product is of excellent quality. If no obvious attempts are made to improve the customer queue management system, it will eventually have a negative impact on the firm.

The following critical component is that any **firm must require and cultivate a list of devoted clients to ensure the business's long-term viability**. Each consumer has their own psychological capacity for standing in a long line before opting to leave (Ramasamy, R. K., et. al., 2018). Apart from enhancing queue management, businesses can also give additional perks that make the queueing experience more bearable, such as free drinks, snacks, and internet.

The third factor is **developing a competitive edge for the firm.** Nowadays, customers value their time and are more inclined to purchase from or receive service from businesses with the quickest wait times. People's daily pace has accelerated as the world has evolved into a modern culture. Time has always been a valuable commodity for everyone, which has resulted in individuals becoming more prudent and calculative about spending their valuable time in a queue.

Finally, a critical component in **optimizing queue management systems is increasing the economic efficiency of the business**. With an excellent business management team that is capable of resolving queueing issues, businesses may cut their costs indirectly by reducing their human resources and increasing their efficiency in the catering company.2.1.2 Bad Queueing Management Effects on Business

When people wanted to get a service or make a purchase, they would queue or "wait in line." Businesses must examine their customers' queueing theory. It focuses on how customers behave while waiting in line, the most efficient queueing system, and the number of customers in line over a specified time period (Shortle, J. F., et. al., 2018). However, it is equally critical to research queueing malfunctions because they might have a negative impact on business.

One of the detrimental repercussions of poor queue management is client cancellation, which compels organizations to investigate the cause. When consumers cancel, it can result in large costs due to the disruption of the business's routine operations (Xu, X., et. al., 2021). The study demonstrates that cancellations are influenced by the length of the waiting and how customers view them. When customers are aware of the anticipated wait time prior to queueing, their perception of waiting time changes.

According to Kyritsis, A. I., and Deriaz, M. (2019), queueing is indeed tiresome and stressful due to the indirect enforcement of client idle time. Thus, it is critical to understand each business's queuing pattern in order to control other variables that may add to wait time, such as staff schedule optimization. Inability to do so may result in decreased customer satisfaction.

There are numerous approaches to queue management that have been proposed by business owners, one of which is the queueing ticket. However, when customers use a queueing ticket, they frequently lose access to queueing information such as the queue length and expected time taken. The absence of a mechanism for customers to be aware of their wait time resulted in an overestimation of the wait time (Limlawan, V., and Anussornnitisarn, P., 2020, October). Overestimating waiting times has the effect of causing clients to abandon the queue. This has a detrimental effect on the usage of business resources and income.

2.2 Technology and Importance of Being Aware of Waiting Time

Business owners acknowledge the effect it could bring by having a bad queueing management. With the rapid technological advancement, technology has been aiding businesses to run easily. Ramasamy, R. K., et. al., (2018) said that long queues can be overcome by having an effective mobile based queueing mechanism, efficient machine learning method, AI advancement and more. However, there are yet to have a technological based queueing system that allows banking sector's customers to be aware of their awaiting time remotely from their own space which cater to the purpose of this project.

Queueing by utilizing queueing tickets has been improved customer's satisfaction as it gets rid of the physical line. However, the inefficiency of it also may cost business's revenues. One of the inefficiencies being, the lack of information on the queue. This causes customers to be unaware on their predicted waiting time causing them to just abandon the line instead.

Realistic customers have been studied and it shows that customers are capable of adapting their patience to the waiting context they use dynamic updating to improve forecasting and decision making over time (Kuzu, K., et. al., 2019). Therefore, it is important for customers to be aware of their queueing information. Xu, X., et. al., (2021) stated that by enhancing information transparency between business and customer's by letting customers aware with the predicted waiting time may reduce cancellation.

2.3 Existing System

2.3.1 Queue Management System to Optimize Table Seating' (QMS-OTS).

This project provides system solution for restaurants or dining sectors. By utilizing technology that people use in their daily life, which is mobile

phone. This project optimizes all required processes in preparing food by developing an effective mobile application queueing mechanism.

Ramasamy, R. K., et. al., (2018) shared that QMS-OTS allows customers to virtually queue before reaching their premises with the virtual queueing system. It also enables customers to book, view and manage queue without having to reach the premise. QMS-OTS also a cloud-based application, this allow the QMS-OTS to use as little resource as possible in the mobile devices.

Queue Management System for Casual Dining Restaurants to Optimize Table Seating (QMS-OTS) works by considering all related parameters to calculate estimated queueing time in optimizing table seating such as total capacity of available table, waiting time for serving food, total chef and available stoves, and total time taken waiting in line.

Q = Queue number
To determine the waiting time,
Qt = Queue Time
t= average time used for per transaction.

$$Qt = Current\_Qt + t$$

Figure 2 Queue Time Formula

2.3.2 The Walk Away Queue Management System (The Walk Away QMS)

The second system that has been studied are called **"The Walk Away Queue Management System" (The Walk Away QMS)**. This system was based off MySQL as their central server that manages client's database and Web Application. This system allows customers to take their queueing ticket and to wherever they want (Aizan A. L., et. al., 2019), This system allows customers to be more flexible regarding their waiting location. Customers will

then receive an alert in form of Telegram text and SMS when their ticket turn is approaching. This system is the mobile based version of the traditional Queue Management System (QMS) which introduce more flexibility for their customers. The traditional QMS system works by wireless network as its way utilizing ticket dispenser that work as the control system and depended on the call pad terminal which restrict the movement of customers in queue.

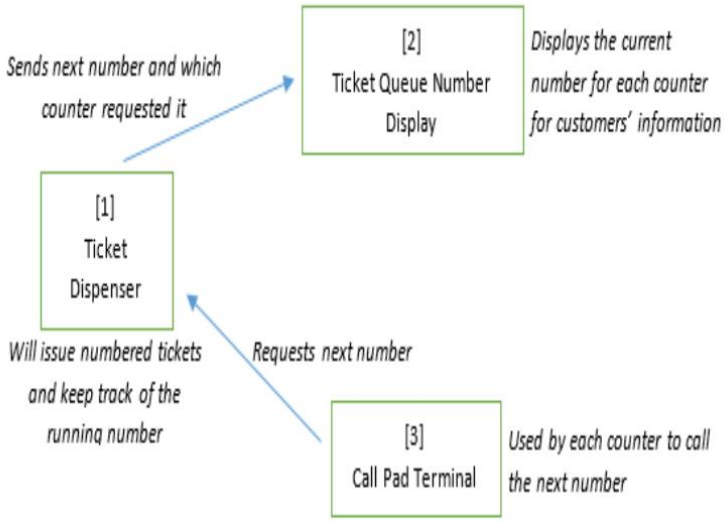


Figure 3 Traditional QMS Model

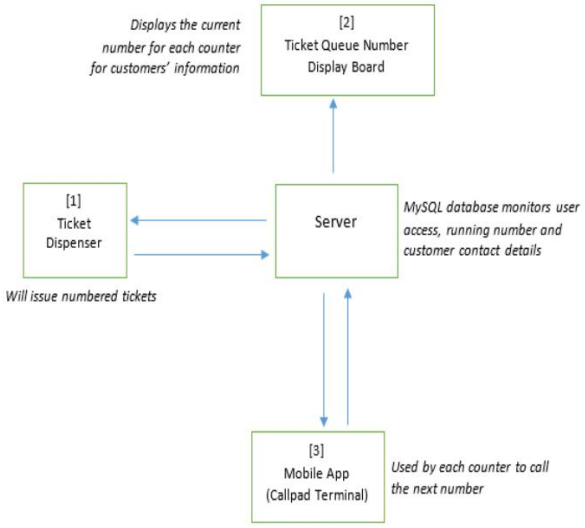


Figure 4 The Walk Away QMS model

As for The Walk Away QMS, it allows any other client to use this this service as it utilizes MySQL database that serve as a central server. Unlike the traditional QMS that restricting their customer's waiting location with call pad terminal, The Walk Away QMS replace is a mobile device that retrieve user's database by logging in to mobile app which then allowing users to see current queueing number and their queueing number.

2.3.3 QueueForMe

Kyritsis, A. I., and Deriaz, M. (2019) proposed a generic queuing system called QueueForMe which allow anyone to create a virtual queue based on a web application. this web application server two types of users, the virtual queue creator and the creator's clients.

This web application will prompt the queueing creator to input the queuing name and its description in order to start a virtual queue. Meanwhile, the creator's clients are not required to key in any information credential. The

creator's clients will then be able to access the queueing information such as, their current queuing position, estimated waiting time utilising past queue data with neural network training. The creator can operate the queue by asking for. Other than that, this system will propose an option to customise waiting time by defining a set of queue specific parameters.

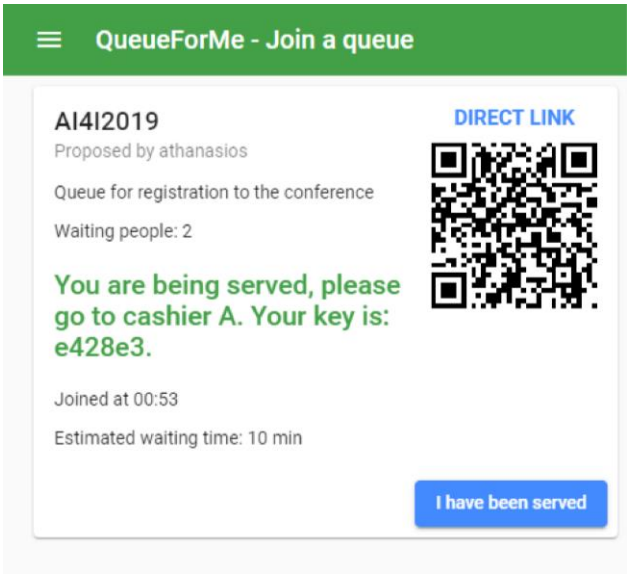


Figure 5 QueueforMe web application view

2.4 Required Features and Characteristics for Good Virtual Queueing Management

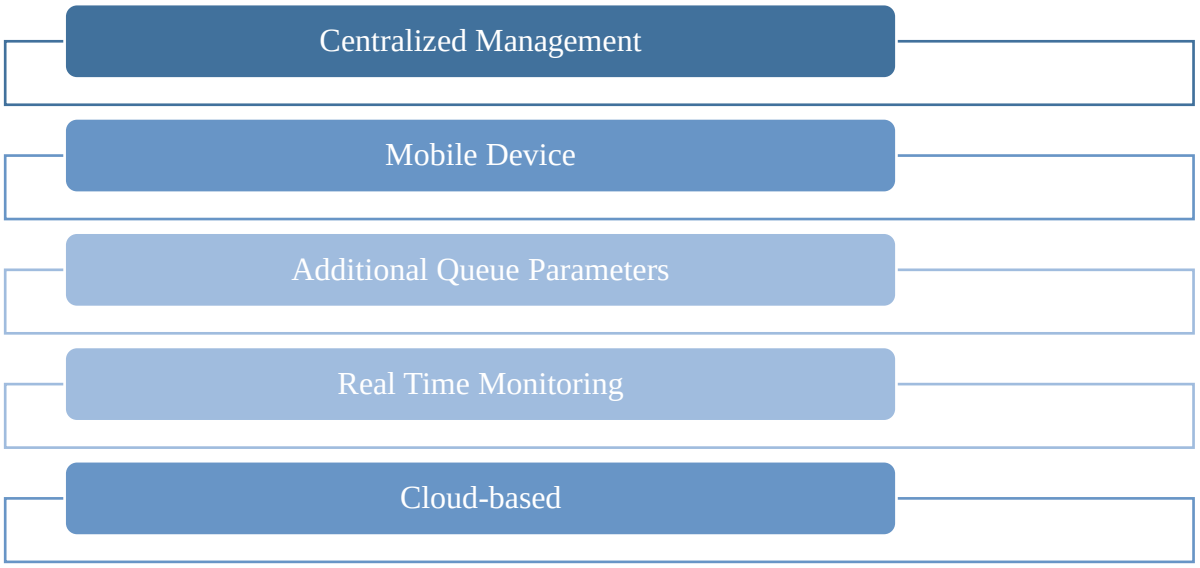


Figure 6 Virtual Queueing Management Required Features and Characteristics

There are various features that equipped each management system. This is the studied features that enable users to determine a good queuing management system. A centralized management allows business to access their customers' information. It also allows business to manage their customers such as, service provider allocation, enable to manually manage customer's waiting time and access the customers' demanded service (Abusair, M., et. al., 2021). The centralize management also allows customers to not be in the premises waiting area or queueing line as it captured the queueing tickets registration and verify the digital tickets.

Next, to have a virtual queueing system on a mobile device. Other than the software itself to be in the device, it could mean the integration of SMS text as a form of communication that serve as an alarm or reminder to customers before the calling of their ticket. Enabling customers to leave and stay at their own remote space.

Another important features to have in a queueing management system is to add additional queueing parameters other than the restricted response of the system.

Business owner's will be able to see the additional parameters. This allows both business's owner and customers to manually add or reduce their wating time such as by adding a defined additional parameter enabling business owner to extract important queueing data.

Real time monitoring is equally important to have in a virtual queueing management system, enabling both business owner and customer to access the total unit of queueing line. Real time monitoring allows customers to access their queueing status, aware of the current position in queue and their position in the queue. It also allows them to see the estimated of the total waiting time taken. Business owner will able to monitor the real time activity, traffic and queueing situation of the customers.

The last important feature to have in a virtual queueing management system is digitalised and cloud-based. By making it into a mobile cloud computing, it will become a better system for both mobile device user and the business owner by interconnecting between the mobile computing, cloud computing and wireless network. Using cloud-based application will also able to reduce usage recourse in mobile devices. Cloud computing is a parallel substitute of traditional mainframe as the technology continues to advance.

2.5 Queueing Analytic in Aiding Customer's Experience

Analytics are commonly use to read the information that lies within the pattern of data. it is also widely implemented by organization to improves the quality of their business. On the broad scale of this purpose, big data analytic played the part in uncovering hidden pattern and collations. The era of big data has created many opportunities and challenges (H. Ouyang and B. L. Nelson 2017)

In order to overcome the unsatisfied customers caused long queue, business owners need to know the data of queueing situation. Such as, the total number of people in line and the average waiting time for each customer. Granville, K. (2019) state that Queuing analysis serves the purpose on predicting the system performance

on queueing. There are many other factors that can be the variables of queuing analysis. Having a good queue analytics allows business owners to access information on factors that will cause your customers satisfied.

implementing queueing analytics enable you to access the information it able to capture and retrieve. comprehensive queueing analytics allows business to manage both their employees and customers. Next, by having queue analytics, organization can evaluate where they should provide more employees to cater to the customers or when do they need less of them so that employee can have a calm working day. Lastly, it will improve customer's experience as online queueing system features like virtual queuing, self-check-ins and mobile alerts that keep customers informed and in control of their wait experience.

2.6 Comparative Study

Table 1: Existing System Comparison

Name	QueQ	ReQueue	YQueue	0Q
Developer	Thailand	Kuwait	Singapore	Malaysia
Industry	FandB, Service sectors	FandB	FandB	Banking Sector
How it works?	• Reserve within a default distance • Outlet can customize their distance access to their queuing tickets • Queue length updated in real time • Mobile application	• Order from selected restaurants and reserve their queuing ticket. • Users can choose their preferred restaurant's features • Updated queue length in real time • Mobile application	• Prompt to scan the merchant's code from their stall. • Allow to order food and beverages • User have to pay before getting the food prepared • Mobile application	• Allow user to reserve their queue from wherever they are • Users are allowed to select their selection service. • Real time update on queue length

	• Automatically send an alert once the number is close to the user's	• Automatically send an alert once the number is close to the user's	• Automatically send an alert once the number is close to the user's	• Real time update on queueing estimated time taken. • Automatically send an alert once the number is close to the user's

2.5.1 Functionality Comparison

Table 2: Functionality Comparison

	QueQ	ReQueue	YQueue	0Q
Able to issue queueing ticket from wherever (Pre arrival distance)	Reserve within a default distance	Yes	Only after reaching selected premise	Yes
Customisability	Outlet can customize their distance access to their queuing tickets	Users can choose their preferred restaurant's features	Not available	Business owner able to customise customer's waiting time by manual add/reduce time.
Real time update on queue length	Yes	Yes	No	Yes
Real time update on queueing estimated time taken.	No	No	No	Yes

CHAPTER 3
METHODOLOGY/PROJECT WORK

3.1 Development Life Cycle

System development life cycle (SDLC) is the standard business implementation utilised by system developers on developing system application. Consist of particular work stages starting from planning, requirement gathering, designing, developing, test and deployment of the system. SDLC helps developers to stays in developing guidelines and it helps developers to reduce costs and fasten system delivering process. Moreover, it ensures the developing system to be in its best quality that can meet user's expectation by taking care of each gathered requirements.

For this project system development life cycle, the method that I'm using is called Improved waterfall methodology. Improved waterfall methodology is mostly the same with the traditional waterfall methodology. It's a methodology that use linear and sequential approach with specific pre-defined activities. It divides software development processes in different phases. By using waterfall methodology, it ensures developer to complete each phase before moving to the next one.

However, for improved waterfall methodology to circle for a few times during design, development and testing phase as it's the most crucial part in developing system application. The benefits of using this methodology, despite having a few addition laps on certain phases, it still stays in the set timeline, therefore it would not allow the project to be overdue.

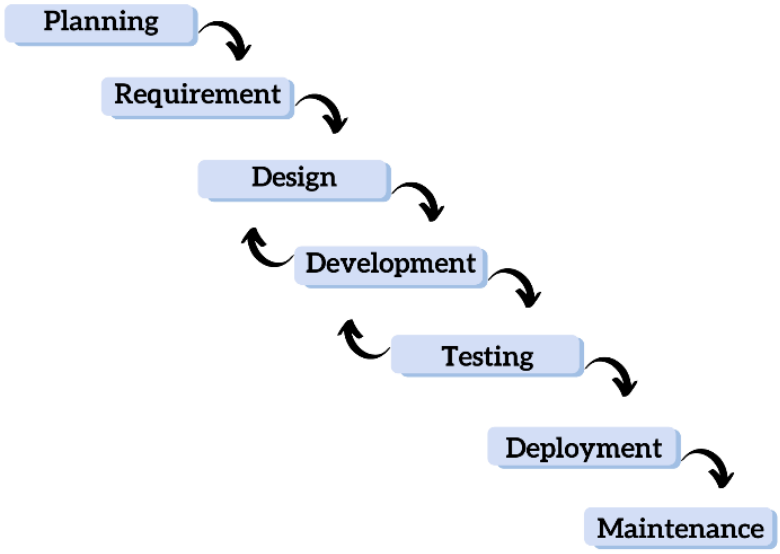


Figure 7 Improved Waterfall Methodology

i. Planning

Discovering and clarify problem statement. From there, the objective of the project will be determined in order to conduct requirements analysis. The expected output and functions were also planned in the phase.

ii. Requirement

In this step, various ways of gathering requirement are conducted in order to gain deeper understanding on completing this project objectives. For this project, literature study and conducting interview or surveys has been conducted. Focusing on seeking requirement specification.

iii. Design

After studying the requirement specifications, I will then prepare for the system design by designing the system flow structure, system architecture, user's interface and other project related documentation.

iv. Development

Guided by the system design format, the development then will be initiated. Starting from executing the project flow structure, back-end coding, the interface design with the front-end coding and developing the database structure for this project.

v. Testing

The developed prototype will then be tested by possible users. Any amendments will be taken back to the design and developing phase for a few cycles to ensure the project meets its requirements.

vi. Deployment

Once the project passed the testing phase, the prototype will then be deployed as a complete system to serve it purpose.

vii. Maintenance

For this phase, the system will be regularly assessed and update to ensure its not outmoded. Any existing bug or problem received can be fixed immediately.

3.2 System Design

3.2.1 Users Module and System Functionalities

There will be two types of Users for this system, Admin and Customer. Diagrams below illustrated the set of use cases for each user module. This project's diagrams are illustrated using Unified Modelling Language (UML) and wireframe. Use case diagram and system structure needs to be designed before this project able to move to designing the user's interface

3.2.1.1 Admin's Module

In Admin's Module, the user has the following sets of use cases:

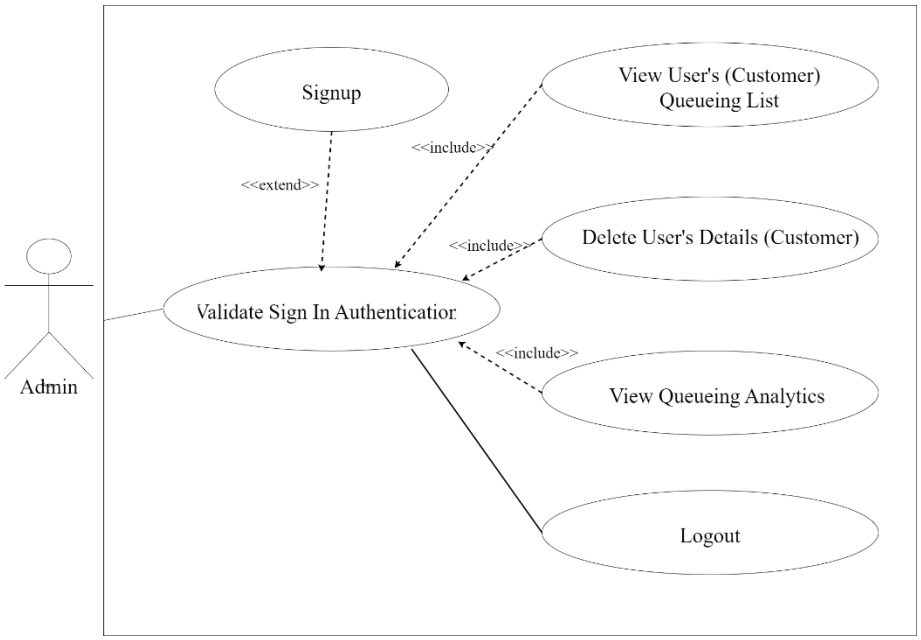


Figure 8 Admin's Module

3.2.1.1.1 Validate Sign in Authentication

i. **Description:**

This use case describes how the user will only be able to signs into the Admin Module through validation,

ii. **Pre-conditions:**

The user's account must has registered under the Administration's category during signing up process.

iii. **Post-conditions:**

If success:

The user is logged in to the system.

If failure:

The system will send an alert of access denied message on the system interface.

3.2.1.1.2 View Customer's Queueing List

i. **Description:**

This use case describes how the user views Customer's queueing list.

ii. **Pre-conditions:**

The user is logged in to the portal and authenticated as Admin.

iii. **Post-conditions:**

If success:

The user can view Customer's queueing list.

If failure:

The user will not be able to view the Customer's queueing list.

3.2.1.1.3 Delete Customer's Details

i. **Description:**

This use case describes how Admin deletes a Customer's Details

ii. **Pre-conditions:**

The user is logged in to the portal and authenticated as Admin.

iii. **Post-conditions:**

If success:

The violation record is deleted.

If failure:

The violation record is not deleted, and the system will display an error message.

3.2.1.1.4 View Queueing Analytics

i. **Description:**

This use case describes how Admin view set of Queuing Analytics graphs.

ii. **Pre-conditions:**

The user is logged in to the portal and authenticated as Admin. Admin then click on the graph icon to redirect to the Queuing Analytics page.

iii. **Post-conditions:**

If success:

User will be able to Queuing Analytics page

If failure:

The system will display an error message.

3.2.1.2 Customer's Module

In Customer's Module, the user has the following sets of use cases:

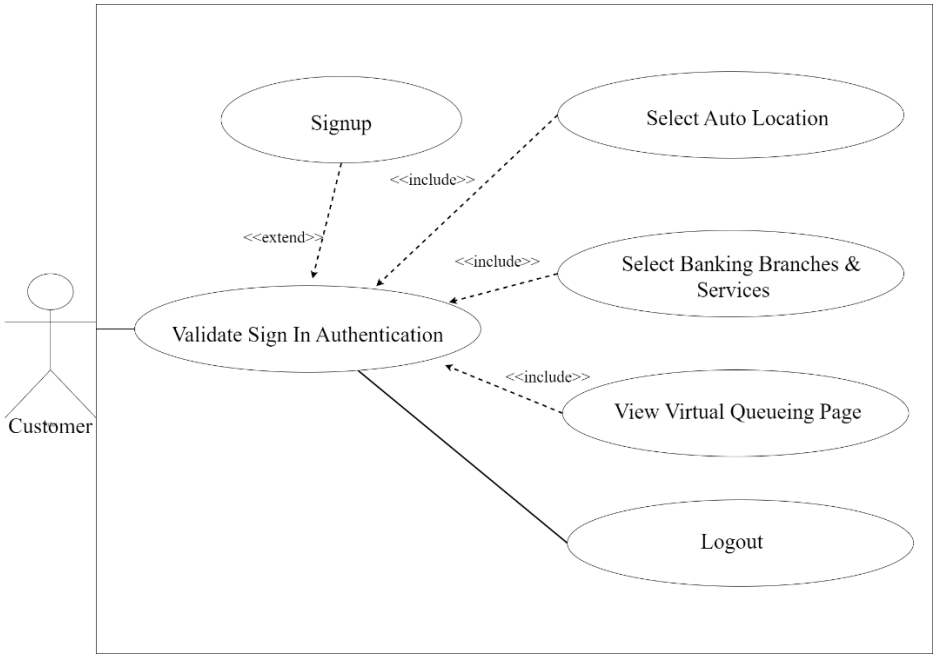


Figure 9 Customer's Module

3.2.1.2.1 Validate Sign in Authentication

i. **Description:**

This use case describes how the user will only be able to signs into the Customer's Module through authentication.

ii. **Pre-conditions:**

The user's account must has registered under the Customer's category during signing up process.

iii. **Post-conditions:**

If success:

The user is logged in to the system.

If failure:

The system will send an alert of access denied message on the system interface.

3.2.1.2.2 Select Auto Location

i. **Description:**

This use case describes how the user select Auto Location to locate a banking branch.

ii. **Pre-conditions:**

The user is logged in to the portal and authenticated as Customer.

The user is located on reachable place of the Auto Location function.

iii. **Post-conditions:**

If success:

The user can auto a banking branch

If failure:

The user will not be able to auto locate a banking branch and have to select manually.

3.2.1.2.3 Select Auto Location

i. **Description:**

This use case describes how the user select Auto Location to locate a banking branch.

ii. **Pre-conditions:**

The user is logged in to the portal and authenticated as Customer.
The user is located on reachable place of the Auto Location function.

iii. **Post-conditions:**

If success:
The user can auto a banking branch
If failure:
The user will not be able to auto locate a banking branch and have to select manually.

.

3.2.2 System Architecture

Image below shows the proposed system architecture for 0Q system application to visualize the flow of the system. This system has two structured flow, business owner's flow, and customer system application flow.

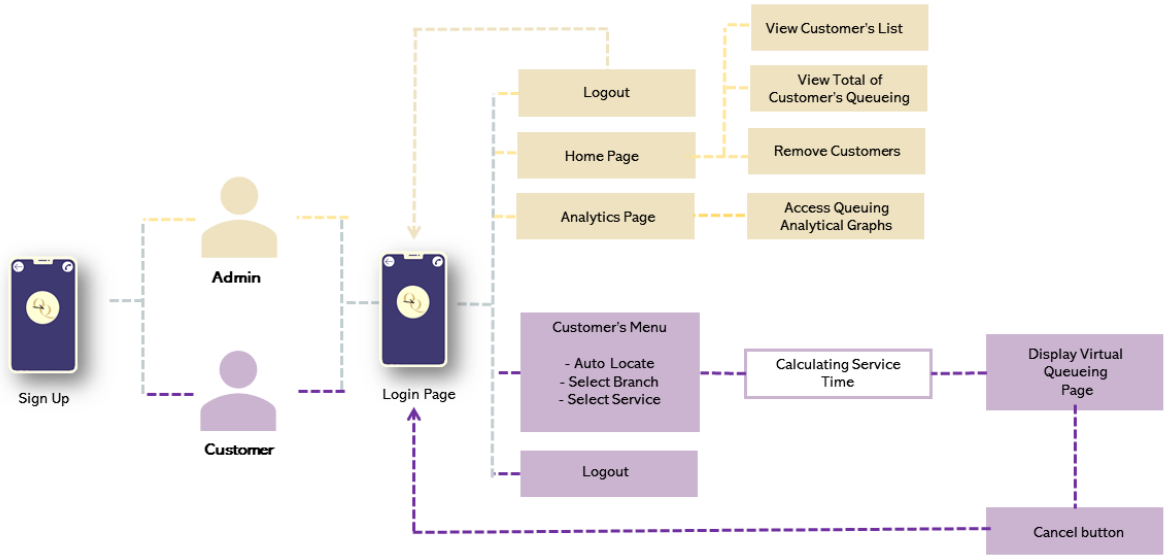


Figure 10 ZeroQueue System Architecture

i. Admin's System Application Flow

Before user authenticated as Admin, users must sign up and register their accounts. For this project, Admin is implemented on banking employees. On Login Page, users are prompted to key in their username and password to log in into the website. Then, it will immediately redirect them to the Admin's Dashboard Page. On that page consists Home Page and Analytics Page. Admin can also logout from the account through this page. On Home Page, users will be

able to view customer's list, total number of queueing customers, and remove customers from the list.

On Home Page, user can view the customer's ID, email and their selected services. Users will then manually remove the customers from the list after the customer has been served. On Analytics page, the user will be able to access queueing analytics graphs, these graphs consist of daily total of visitors, weekly total of visitors, most selected service and average time taken for a person.

ii. Customer's System Application Flow

For the first usage of the website, users must first register themselves on the Sign-Up page and select the category of customers. After successfully key in the registered email and password, user will then be directed to the Customer's Menu Page. On this page, users can use the auto locate function to auto locate themselves to the nearest banking branch. If not, users can manually input the registered banking branch and select the options of available services such as retrieving banking statements, issuing deposits and withdrawals, general banking activities, creating a new accounts, loan or complicated banking duties and others. Users can also logout from their account on this page and will be redirected to the login page

After users selected their desired services, users will be redirected to the Virtual Queueing Page. On this page, users are able to see the total number of customers ahead and the estimated time taken for the waiting time. The estimated waiting time is calculated by the selected services of each user as it has been allocated to a certain time. For example, the regular banking activity are estimated to be 3-5minutes and a longer banking service such as issuing a loan

may take up to 20-30 minutes. For each previous user's time taken will be summed and calculated and estimate the time that it will take the current user to queue. Users also will be able to click on cancel to leave the queue

3.2.3 System Flowchart

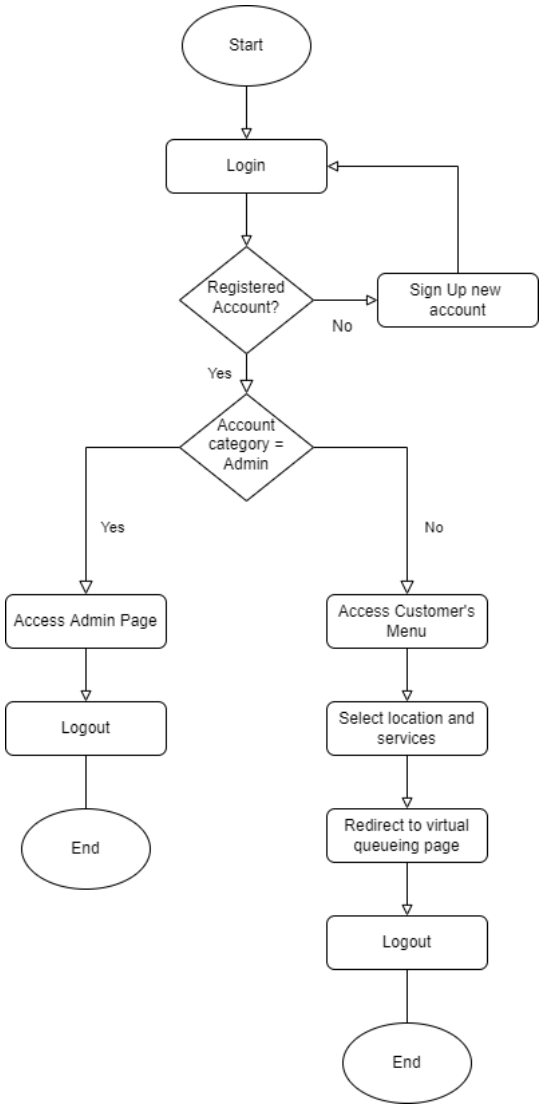


Figure 11 ZeroQueue Flowchart

3.3 Tools

To achieve this objective on developing the web based virtual queueing system, these are the tools that has been used

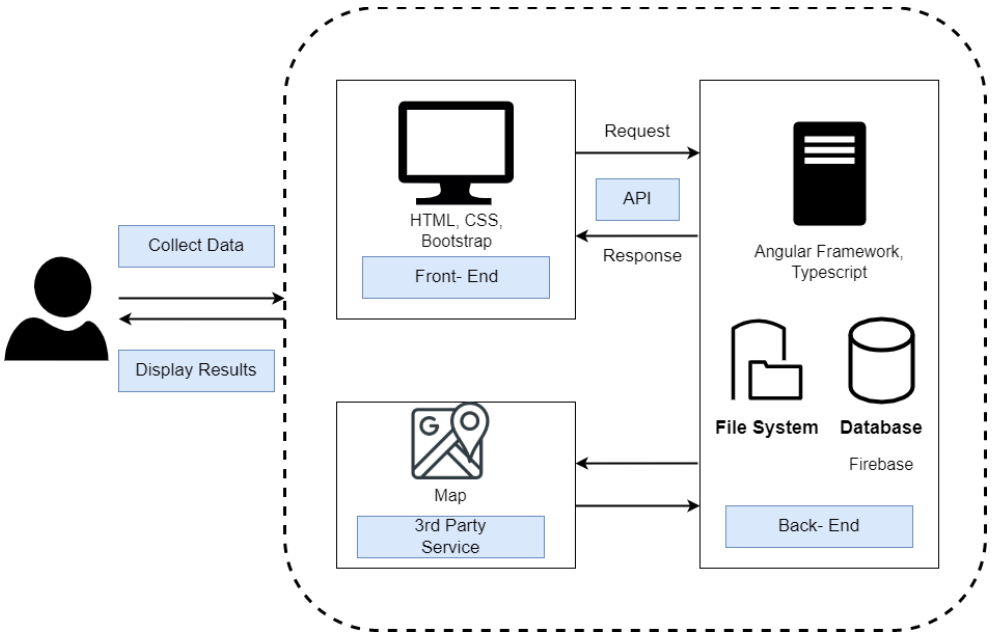


Figure 12 Web Application Architecture

i. Visual Studio Code

Visual Studio Code is used to develop the html code for the 0Q's user interfaces since it's a powerful source code editor and it's really convenient to use as it instantly allows to see the outcome of the code without having to debug it each time.

ii. Angular Framework

This project also implements the Angular that work as a framework for application design and development. This allow this project to be built responsively and capable of deploying in web and mobile web. This is important as the prospected users of this system would most like to use it on the mobile devices.

iii. Firebase

For this project, firebase is used to store the data using their Firestore database and the real time database. Firebase also helps the system authenticates the users. This software is able to synchronize data between the used device and centralized storage in the cloud.

3.4 Gantt Chart and Milestone

Table 3 ZeroQueue Gantt Chart

ZeroQueue Virtual Queue Management System	Week																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FYP2																	
Phase 1: Development																	
Initiate Prototype Development																	
Initiate User's Interface																	
Phase 2: Testing																	
Initiate Back-End development																	
Prototype Testing																	
Start Testing																	
Submission of Progress Assessment 1																	
Phase 3: Deployment and Maintenance																	
System Implementation																	
System Maintenance																	
Submission of Draft Dissertation																	
Submission od Dissertation (Soft bound)																	
Phase 4: FYP2 Completion																	
Mockup Presentation and Preparation																	
Continuation of Development Phase																	
Submission of Progress Assessment 2																	
Submission of Project Dissertation (Hard bound)																	

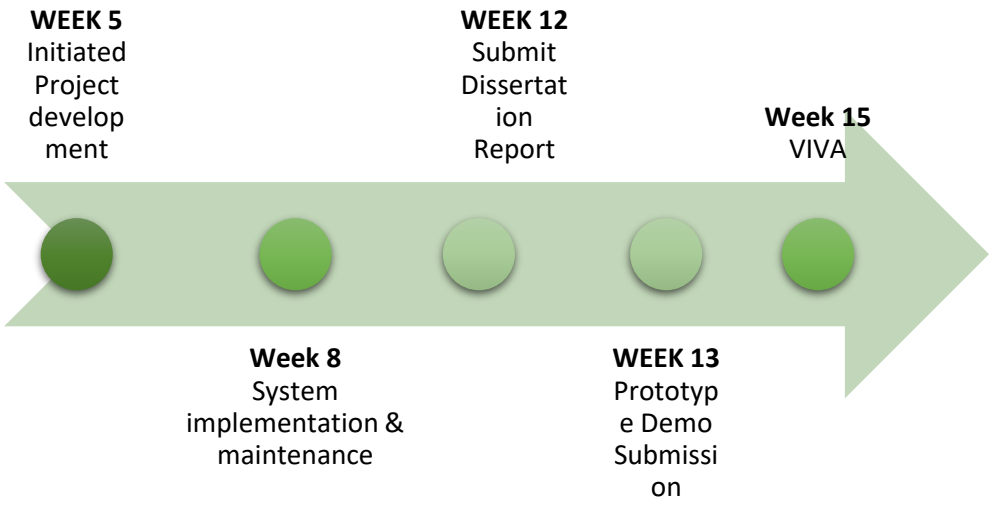


Figure 13 Zeroqueue Milestone

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Data Gathering and Analysis

4.1.1 Literature Review Findings

From previous literature review research, the findings can be simplified as:

- Bad queueing management lead to a bad impact on businesses.
- Technology plays a huge role in providing people day to day services.
- When customers are aware of the anticipated wait time prior to queueing, their perception of waiting time changes.
- The absence of a mechanism for customers to be aware of their wait time resulted in an overestimation of the wait time
- Organizations may apply analytics to business data to describe, predict, and improve business performance.
- Businesses are more capable of managing staff and catering to customer needs when they are equipped with comprehensive queue analytics.

4.1.2 Survey

A survey has been conducted in order to gain deeper finding in order to help with the development of this project. This survey for was made with Google Form and was distributed across social platforms. The survey was completed by 45 individuals aged 18 to 45 and older. The poll was primarily completed by respondents aged 18-24 years old. The following are the findings from the survey:

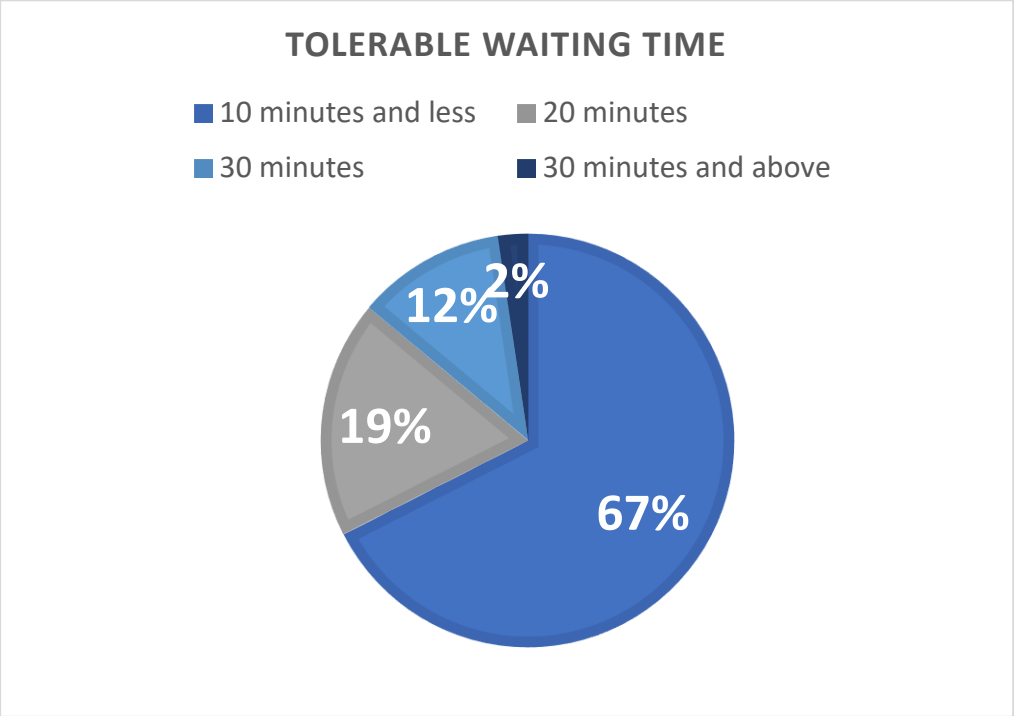


Figure 14 Survey pie chart

It is not uncommon to see banking branches with extremely lengthy queues. People would surely get in line out of desperation and the gravity of the financial tasks, despite the possibility of waiting over an hour. However,

if the money transaction was trivial, individuals would most likely avoid getting in the queueing line. Not knowing how long it would take to wait in the queue had a significant role in convincing individuals to leave. **67% of individuals feel that a wait time of 10 minutes or less is reasonable.**

93% of people would like to know how long it will take to serve them. This is one of the primary goals of this project. Despite a lengthy and exhausting line, some individuals will queue only if they know how long they will have to wait to be served. By informing them of the waiting period, they may change their daily plans accordingly, determining whether the waiting is feasible or not. This assertion is backed by **95.3% of respondents who think that knowing the projected time required to queue does affect their perspective of waiting in line**. As a company owner, allowing consumers to line without knowing how long it will take will likely cause them anxiety, which will result in dissatisfied customers

4.2 Project's Result

The ZeroQueue Virtual Queue Management System has been developed and tested for general users as well as those involved in banking operations. These are the system interfaces that have been captured. Two distinct system flows would exist. This first one would be for the administrator, while the latter would be for the customer.

4.1.1 Admin Flow

i. Login Page

This is the primary page that visitors are routed to when they first access the ZeroQueue system. Users must enter their email address and password. The database would then be updated with their information. The 'Sign In' button directs users to their respective interface based on their user category, which can be either Admin or Customer. Users who do not have an account can click the 'Sign Up Here' navigation link to be taken to the sign-up page.

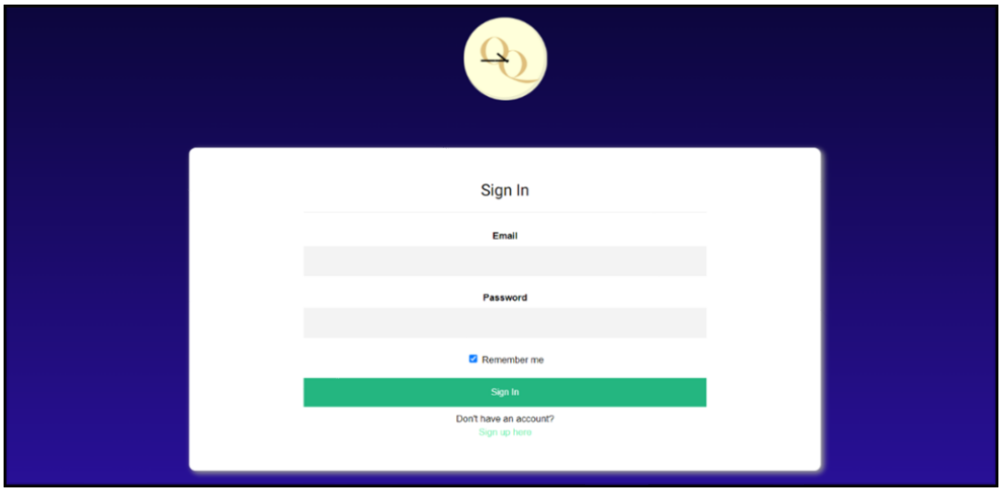


Figure 15 Admin's Sign In page

Below is the Firebase snippet of the account that has been created and signed in into the website.

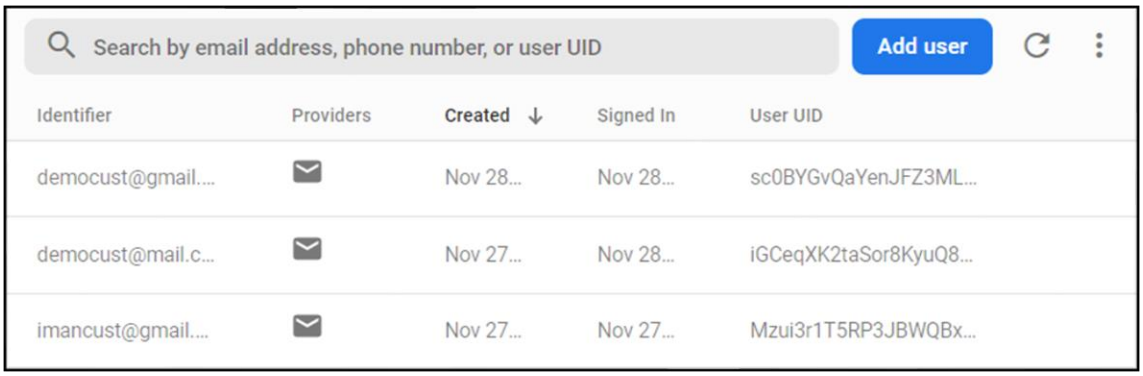


Figure 16 Firebase snippet

ii. Sign Up Page

This figure depicts the system's Sign-Up page. When a user first logs into the system, they must select a category. There are two input fields for users to enter their email address and the password they set to protect their account on this website. This page contains two buttons. When a user clicks 'Cancel,' the user is redirected to the Login Page. If, on the other hand, the user's credentials are correct and they click 'Submit,' the user is taken to the next page.

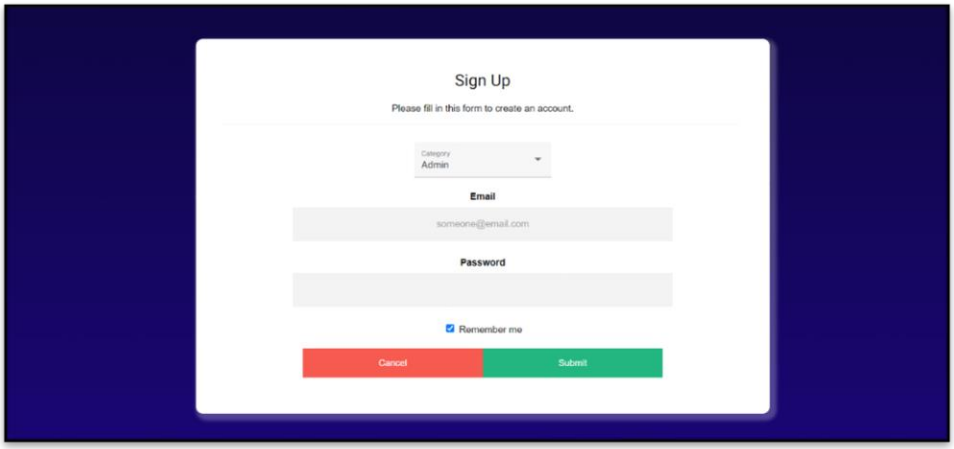
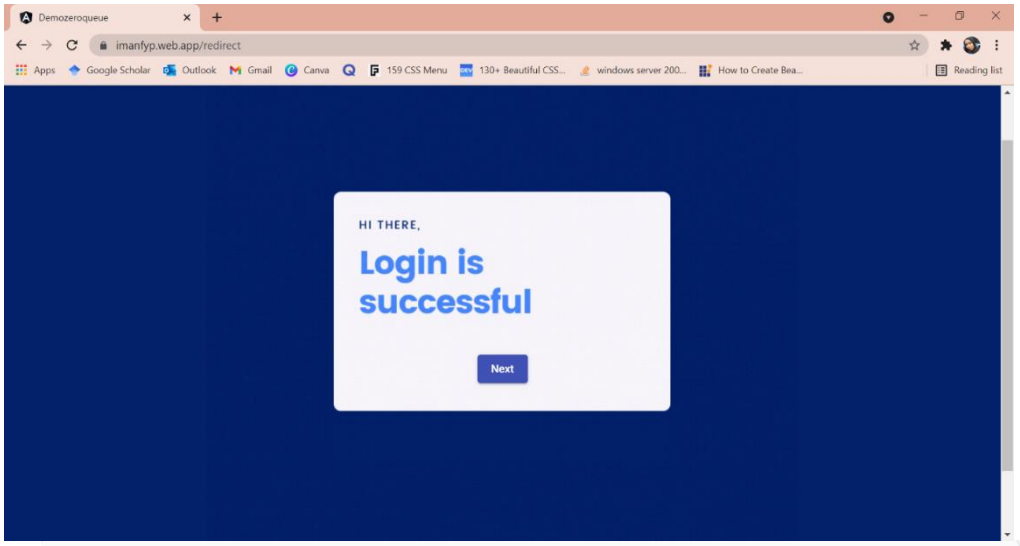


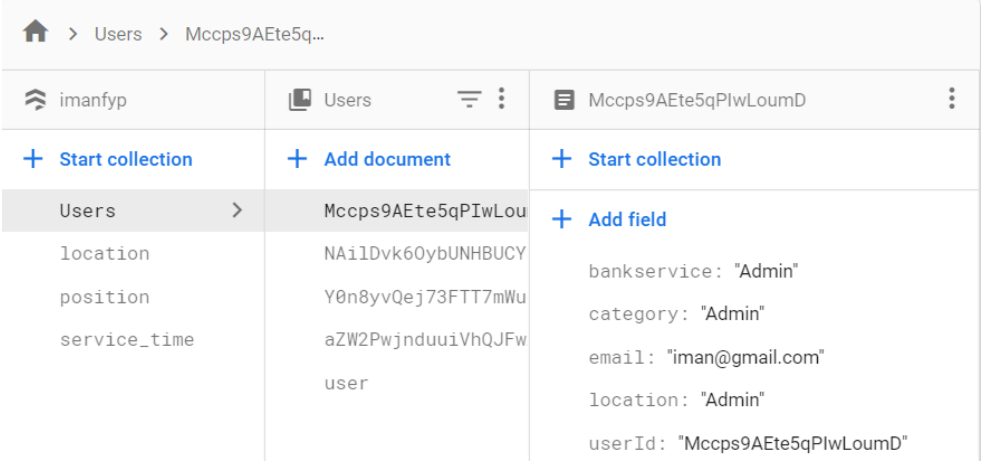
Figure 17 Admin's Sign-Up page

Below is the snippet of Firebase Database where the user's details are stored which allow the system to extract and get the information to ensure the system functionality is well done.

i. Redirect Page

From an interface standpoint, this page notified users that they had successfully logged in and would be directed to the next page after clicking the 'Next' button. However, this page is required in order for the back end to record and authenticate user categories.





Below are the snippet of the code in the Redirect Page component where data are retrieved from Firebase and will redirect the user to their respective following page according to their category.

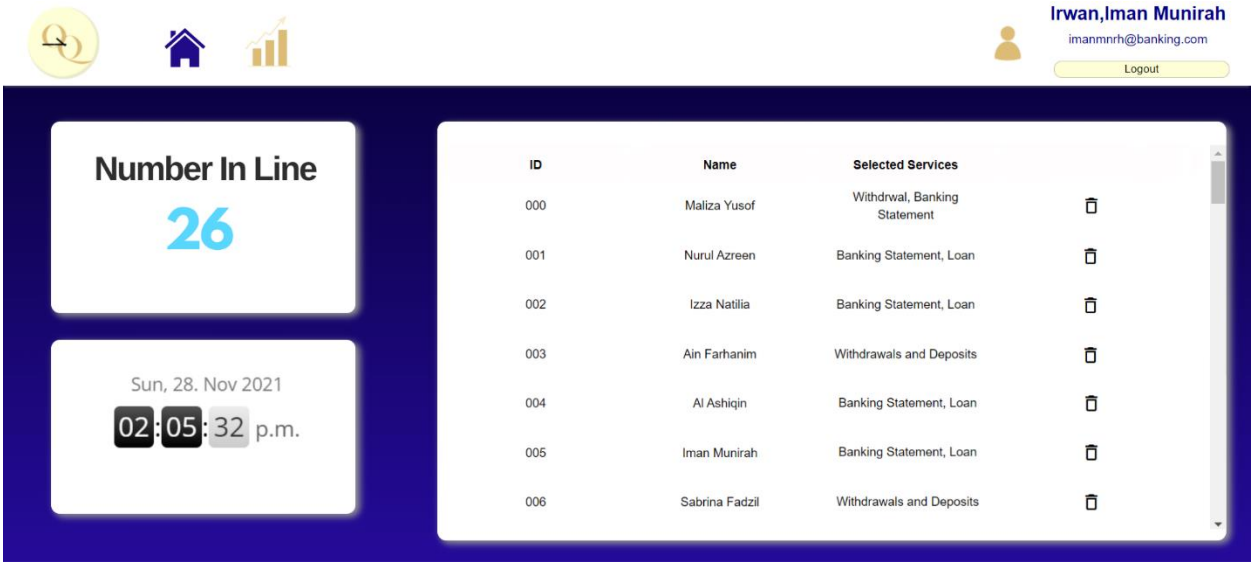
```
  getUserData() {
    let user = this.authService.getUserData();
    console.log(user);
    this.UID = user.uid;
    this.db.database.ref("Users/" + this.UID).on("value", snapshot => {
      let tmp = snapshotToArray(snapshot);
      this.userData = tmp[0];
      console.log(this.userData);
      this.category = this.userData.category;
    });

  }
  btnNext() {

    switch (this.category) {
      case "Customer":
this.router.navigate(["/menucust"])
        break;
      case "Admin":
        break;
      default:
        this.router.navigate(["/menuadmin"])
    }
```

ii. Home Page

The Home Page serves as the primary dashboard for the Admin user. From left to right, we see the ZeroQueue logo, the 'Home Page' button, the 'Analytic Page' button, the user icon, user profile, and a 'Logout' button. The user will be logged out of the system and redirected to the Login Page upon pressing the button. On the body left part, the system will display the number of customers in line. The bottom section contains the date and time. This page's primary component is the Customer's queueing list. The user has access to their ID, Name, and the services they have selected. Additionally, the user can delete a customer from the list.

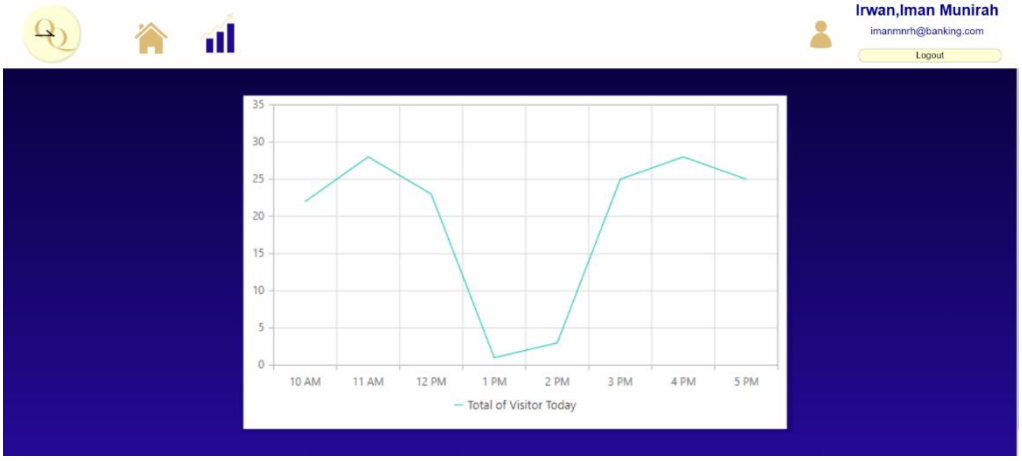


iii. Analytics Page

This page becomes available whenever the user clicks the 'Analytic Page' button. On this page, the administrator can view a graph of the day's total visitors, the week's total visitors, the most popular services, and the average time it takes for each user to complete their financial transactions.

iv. View Analytic

User will be able to click on the graph to further inspect the graph’s data.



Customer's Flow

The website was coded to be responsive for users to easily access this with their mobile devices.

i. Login Page, Sign-Up Page, Redirect Page

Both Admin and Customer uses the same page to register and logged into their account. They will then be directed to the Redirect Page to access the next page.

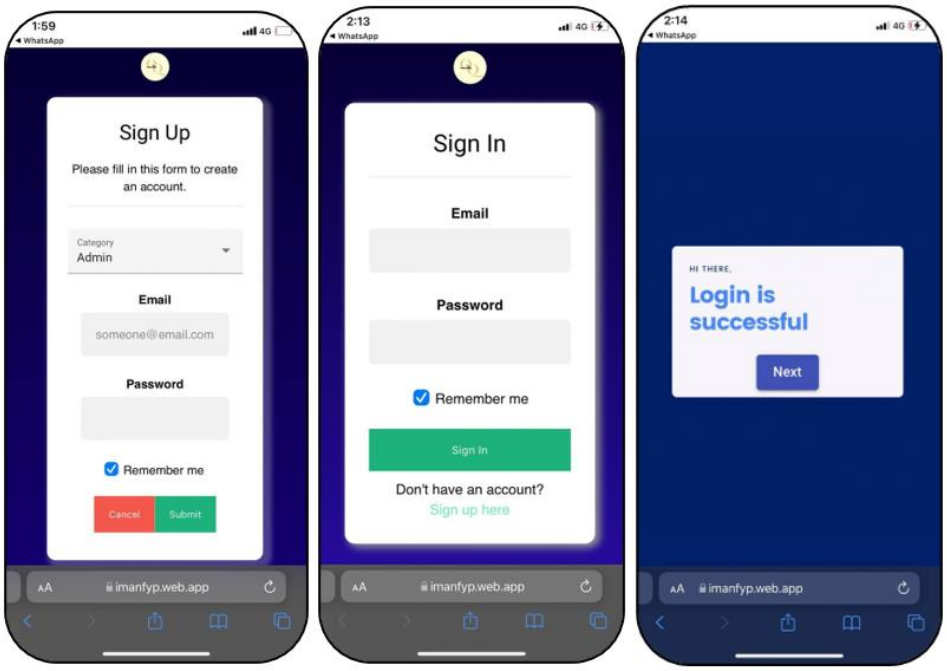


Figure 18 Customer: Login Page, Sign-Up Page, Redirect Page

ii. Customer Menu Page

Customers can use this page to auto-locate their location in order to find the nearest banking branch, or they can manually click on the branch location option. Then, the user can choose from a variety of banking services. The user will have the ability to evaluate their selected services prior to pressing any button. They will be forwarded to the login page if they click on the cancel button. They will be redirected to the following page if they do not.

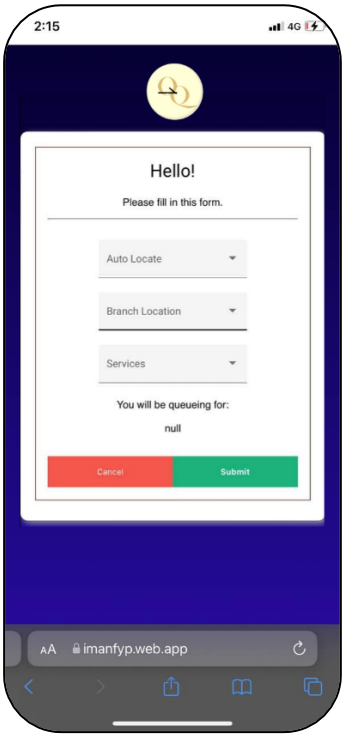


Figure 19 Customer Menu Page

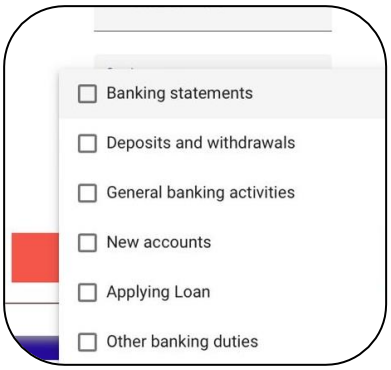


Figure 20 Service selection

iii. Virtual Queueing Page

With this page, user can access their current position in the queue, they can also access the estimated waiting time. clicking on the ‘Cancel button will redirect the users to the Customer Menu Page.

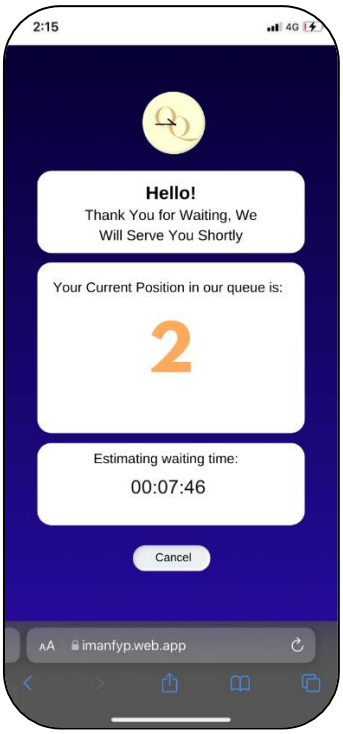


Figure 21 Customer: Virtual Queuing Page

4.3 User's Feedback on The Project's Prototype:

For the Customer's system flow, total of 36 people has tested on the project's prototype. These individuals aged 18 to 45 and older. They then followed by answering a few questions of feedback on the prototype. The following are the findings from the feedback.

i. Customer:

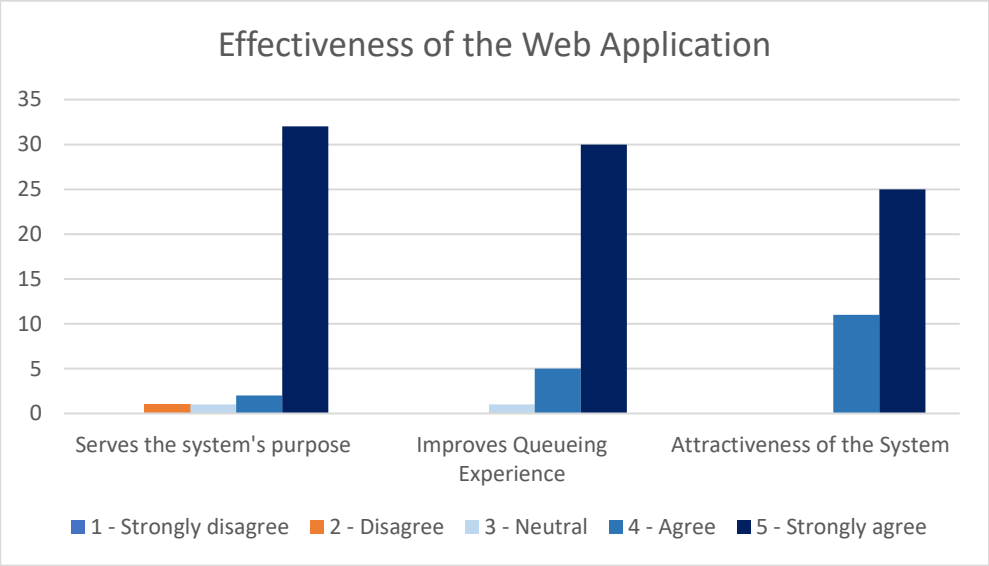


Figure 22 Customer: Effectiveness of the Application

From this bar chart, we can see that majority of testers agrees with the effectiveness of Web Application system. Starting from the statement on how the system serves its purpose, we can see that 34 out of 36 individuals agrees with the statement. 30 individuals agree on the statement that the web application improves their queueing experience. Lastly, all of the tester agrees with attractiveness of the system

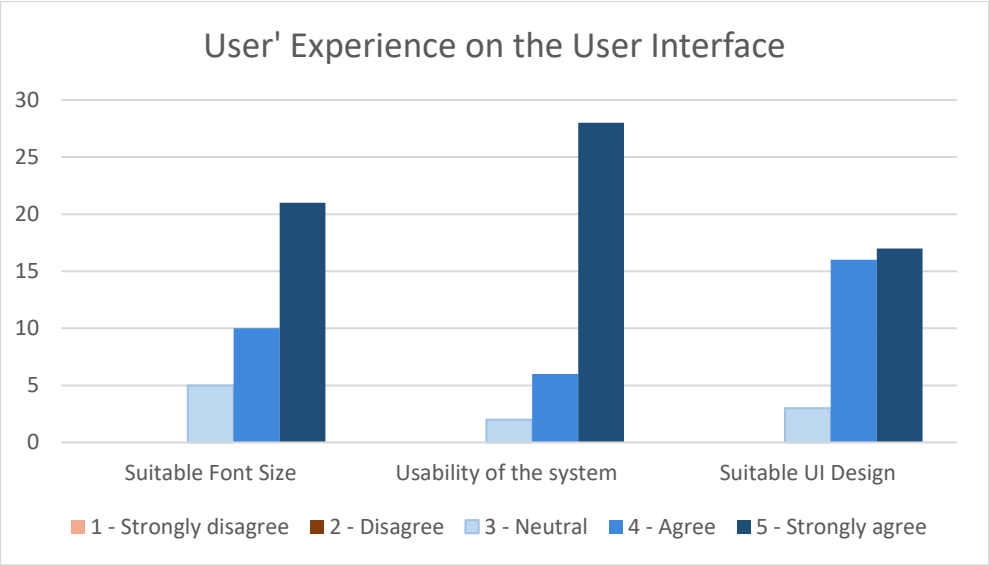


Figure 23 Customer: User' Experience on the User Interface

This bar chart shows the customer's experience on the User Interface, 25 individuals agree with font size, 28 people strongly agree on the usability of the system and 33 people agrees that this web application have a suitable UID design.

ii. Admin's feedback:

For the Admin's system flow, there is a limitation on distributing the prototype to individual who is working with banking sectors. total of 14 people has tested on the project's prototype. The following are the findings from the feedback.

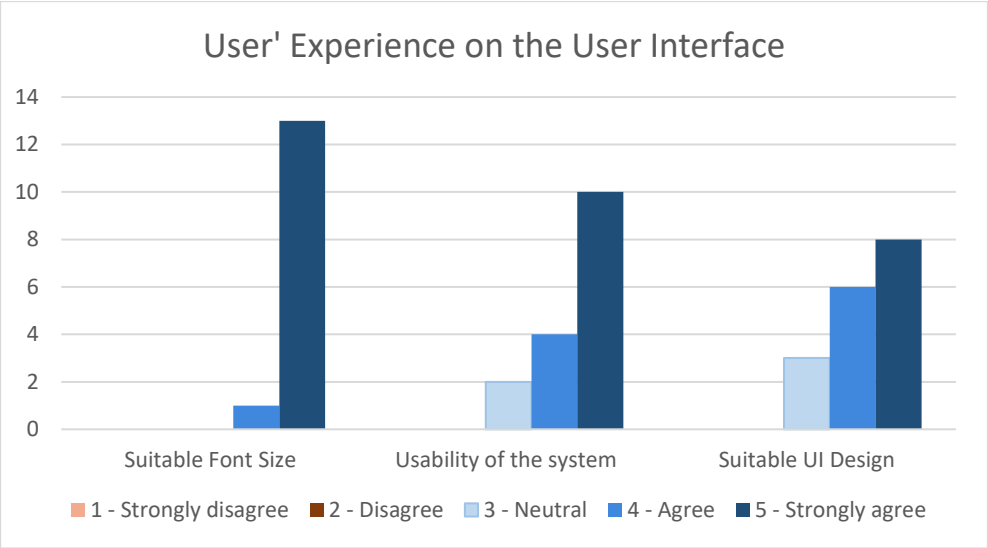


Figure 24 Admin: User' Experience on the User Interface

From this bar chart, it is shown that majority of testers agrees with the User's experience on the user interface. Starting from the suitability of the used font size, the usability of the system and the suitable User's Interface design.

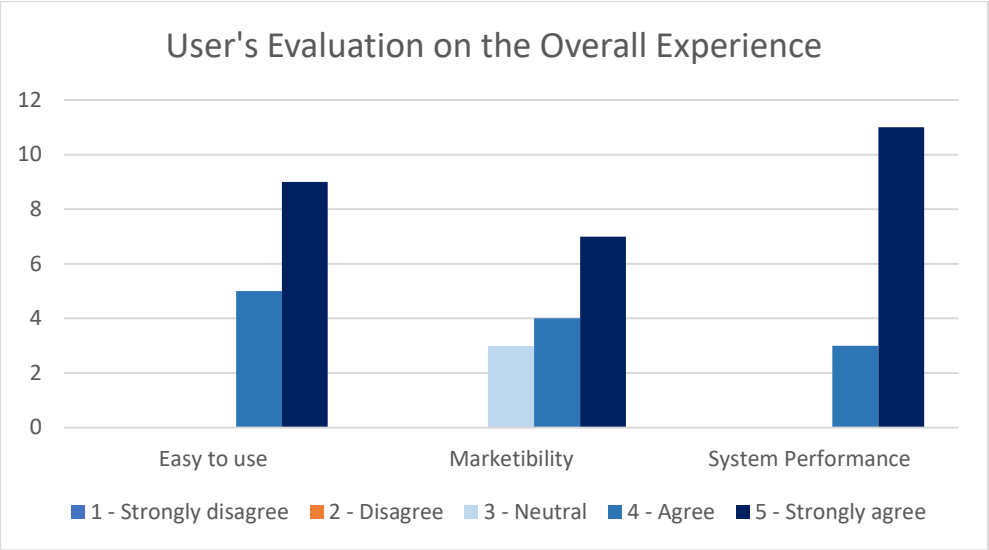


Figure 25 Admin: User's Evaluation on the Overall Experience

Overall experience of this project, 100% of the admin tester agree with the system performance and the web application being easy to use. 7 individuals strongly agree on the marketability of the system, 4 individuals agree and 3 individuals on the neutral stand

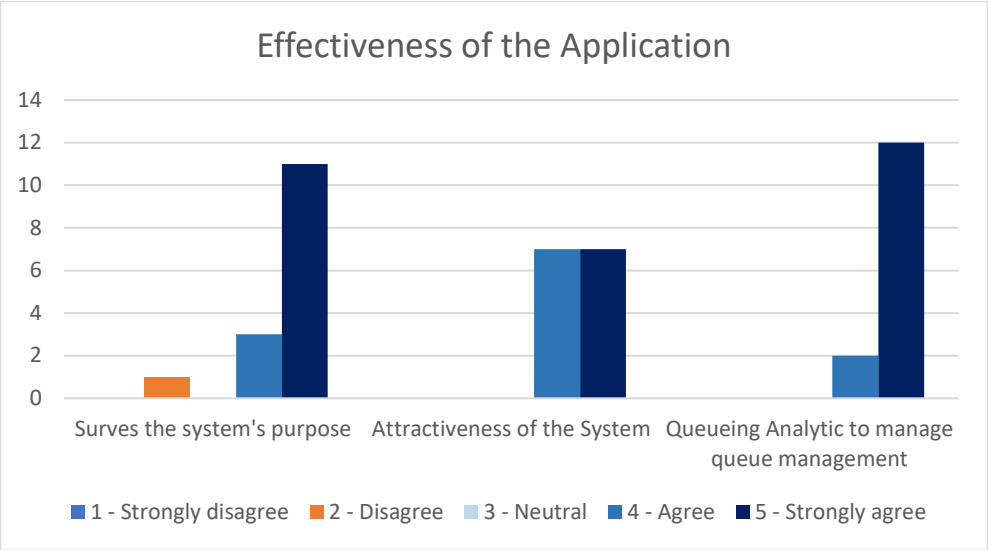


Figure 26 Admin: Effectiveness of the Application

The effectiveness of this web application is measure by the attractiveness of the system and whether or not the system serves it purpose. 2 individuals disagree with the system being able to serve its main purpose. However, 11 individuals strongly agree on that statement. 100% of the testers agree with the attractiveness of the system. 100% of the individuals agree that the queueing analytic features is a great initiative to manage queuing management.

CHAPTER 5
CONCLUSION AND FUTURE WORK

5.1 Conclusion

0Q, A System Application for Banking Sector's Queue Management is aimed to make queueing experience during this pandemic quicker and safer. The first objective of this projects is to study the importance of knowing the estimated waiting time in lines and the impact of it to customers. To achieve these, literature studies has been conducted on this matter and the findings were all acknowledging that knowing the time taken it will take to wait will change the perception of customers towards waiting in line. This has also been backed up with the surveys answer that asked the same question. Moreover, I also gain findings on this matter from the user's feedback where 77% agrees that the app improves queueing experience.

The next objective of this project was to design and develop a virtual queueing web-based system incorporating Angular framework and Firebase. This has been achieved gradually by following the System Development Life Cycle. The project has been planned since FYP1 period. Requirements on developing this project has been researched and gathered. The project is then designed to construct the flow of the system, flow of data and user's interfaces of the system. User testing has been repeatedly conducted to improve the system. Zero Queue is now deployed and successfully built.

The last objective of this project is to evaluate user's acceptance on the virtual queueing system. As can be seen on 4.3 User's Feedback on The Project's Prototype we can see that both tester from Admin and Customer's side give positive and constructive feedback. It is stated that overall experience on the web application is high, the majority of tester agrees with the usability of the system, serves the system's purpose and the usability of the app is high.

This project also has the aim to aid banking sectors to run their business smoothly in terms of managing customers queueing line as during this time, they are not allowed to have a lot of customers in their premises at a time. The bank management can now gain insightful charts from the analytical graph that has been provided in the Analytic Page. All things considered; this project has been successfully developed within the time frame.

5.2 Future Work

The study and development for this virtual mobile queueing system shall be continued in the future. Many more improvements can be made on the system in order to enable the system to continue improving in serving its objectives. A few ideas have been thought as the product's future work. These are:

i. To incorporate a single sign on feature.
   This is to enable banking workers to be automatically signed in once they're connected to their banking Intranet network.
ii. To add postpone feature for customers
iii. To have better authentication process

This is because of the redundant that has been cause by the Redirect Page, for future enhancement, I would like to find another method on directly authenticate users.

iv. To add more business intelligence features that could help banking institution manage their operating business.

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