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QUEUEING MANAGEMENT SYSTEM

USING RASPBERRY PI

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Contents

Chapter 1 1
INTRODUCTION 1
1.1 Background of the Study 1
1.2 Technology Background 3
1.3 Objectives of the Study 4
1.3.1 Main Objective(s): 4
1.4 Significance of the Study 4
1.5 Scope and Limitation 5
1.5.1 Scope 5
1.5.2 Limitations of the Study 6
1.6 Definition of Terms 8
Chapter 2 9
REVIEW OF RELATED LITERATURE AND TECHNOLOGY 9
2.1 Theoretical Background 9
2.1.1 Queueing Disciplines 9
2.1.2 Waiting Line Structures 10
2.1.3 Queueing Behaviors 13
2.2 Review of Existing Queuing System 14
2.2.1 Teller Automated Queueing Numbering System 16
2.2.2 QueueRite 16
2.2.3 TotalQueue 17
Chapter 3 18
METHODOLOGY 18
3.1 Iterative Development Model 18
3.2 Iterative Development Process 1 19
3.2.1 Planning and Requirements 19
3.2.2 Analysis & Design 21
3.2.3 Implementation 22
3.3 Iterative Development Model Process 2 24
3.3.1 Planning and Requirements 24
3.3.2 Analysis & Design 25
3.3.3 Implementation 25

3.3.4 Testing 26
3.3.5 Evaluation 27
Chapter 4 28
Results and Discussions 28
4.1 Results of Iterative Development Process 1 28
4.1.1 Results of Planning Requirements 28
4.1.2 Iteration 1 Analysis and Design 29
4.1.3 Iteration 1 Implementation 30
4.1.4 Iteration 1 Testing 33
4.1.5 Iteration 1 Evaluation 33
4.2 Results of Iterative Development Process 2 (Cycle 2) 34
4.2.1 Iteration 2 Implementation 34
Chapter V 45
6.1 Conclusion 45
6.2 Recommendations 46
Appendix A 47
Application Diagrams 47
Appendix B 52
Application Design 52
Appendix C 56
Survey Questionnaire 56
Appendix D 60
List of Respondents & Survey Results 60
Appendix E 66
User Test Questionnaire 66
Appendix F 69
Existing Queueing Systems Demo Screenshots 69
References 72

Chapter 1

INTRODUCTION

1.1 Background of the Study

Waiting in lines is part of everyday life. Waiting lines are formed because people or things arrive at the servicing function, or server, faster than they can be served. This does not mean that the service operation is understaffed or does not have the capacity to handle the influx of customers. Waiting lines result because customers do not arrive at a constant, evenly paced rate, nor are they all served in an equal amount of time. Customers arrive at random times, and the time required to serve each individually is not the same (prenhall.com, n.d.).

Following a lengthy queue affects the customer satisfaction and number of customers that can be served, which has an impact in giving a quality services. Queueing systems are models of systems providing service. Such a model may represent any system where jobs or customers arrive looking for service of some kind and depart after such service has been provided (Bose, 2013).

In general, queuing is a line of people waiting to be served and the movement is from a central to a specific place. Thus, a queue management system must handle and organize queue formation in the most efficient way (Uddin, 2016). In a blog by Chris Beaudoin he said that – having queue lines isn't the problem: it's slow service times that prevent the queue line from moving efficiently (Beaudoin, 2017).

Probably the most common way for managing waiting lines is when a staff member operating a queued service simply call the next person to be served. With this method, the waiting

customers have no way to know when they will be called. They can only look at the current length of the line, and make a guess when will they be served by watching its progress.

The same problem goes in Mindanao State University – GSC since every year there is a growth in a population of enrollees. The researchers of the study conducted a survey with the students of Mindanao State University – General Santos City. Ninety-three out of ninety-seven respondents (95.9%) said that they have experienced waiting in long line in different transaction services especially during enrollment in the university. The survey also identified top three problems the students have encountered during enrollment. The first problem was there where no estimation of how many students can each service counters accommodate, second is there is a possibility of cutoff while still in queue and the last problem identified is that other people tend to cut into the line when the queue is too long. For the survey questionnaire and detailed survey results refer to appendix b.

With the information gathered from the survey, the developers of the project aim to create a solution that will help address the problems existing in the current queuing system in the university. The project entitled "Queueing Management System using Raspberry Pi" makes the queuing of transactions in an orderly manner. This project is concerned in providing students a priority number based on the type of transaction the user selected and displaying on the monitor the number currently served at the service counter.

1.2 Technology Background

The proponents of the study researched on related applications to get significant comparisons with the proposed system. Unlike the other applications reviewed, the proposed syste*m* is integrated with Sign-up and Login Modules to ensure that the user can get only one priority number at a time. In the proposed system, a web page was developed to display the current priority number being served where users can view the queue status in a screen display outside the service counter like the other reviewed systems. Unlike the TotalQueue, which only has a single queue management capability, the proposed system can manage multiple queue depending on the waiting line structure of an organization.

Features	Developer's Application	Teller Numbering System	Queuerite	TotalQueue
Freeware	✓			
Check the queue status in a screen display	✓	✓	✓	✓
Get priority number number via printing			✓	✓
Get priority number via SMS				
Get priority number through mobile application	✓			
View serving number on the teller's monitor	✓	✓	✓	✓
Multiple queue management capability	✓	✓	✓	

Table 1. 1 Comparison Table of Existing Queueing Systems and Developers Application

Table 1.1 shows the features of the existing applications which is also present in proposed system. Different existing applications were reviewed in order to know what features could be incorporated in developing the proposed system. For full discussion of Related Technology, refer to chapter 2, page 13.

1.3 Objectives of the Study

From the problems identified, the project's main objectives are:

1.3.1 Main Objective(s):

- To develop a queueing management system that will manage waiting lines
- To create a mobile application for the user to be used in getting a priority number
- To be able to limit the customer transaction per service counter
- To display in a monitor each current priority number served at the counter in every service transaction

1.4 Significance of the Study

The project aims to manage lengthy queues in different transactions in the university, for example during enrollment when paying at the cashier, validation and many others. This guarantees that clients are served in a fair manner and waiting lines moves smoothly.

- Service Teller – This project could help the service teller manage high volume of client transactions for example in the registrar during enrollment in the university. The service teller will be able to see at a glance in the display screen of the system the name of the client and the number of customers left in the queue. The service teller that is assigned for

a particular transaction will only press a button in order to call for a client to be served at the counter.

- Client – there will be a priority number for each client in order to be accommodated at the service counter, it will ensure that the queue follows a "First come, first serve" basis. Whoever comes first will be served first in the service counter and then followed by the second customer and so on and so forth. Getting a priority number will be available through a mobile application. With the features provided, the customers can view the number to be served at the screen display that provided near the service counter.

1.5 Scope and Limitation

1.5.1 Scope

The project's main scope centers on the information gathered from the students of Mindanao State University. The Queueing Management System using Raspberry Pi will be developed to help manage waiting lines in the university, for example during the enrollment, as it is identified in a survey conducted. The study is focused on transactions that involve queue as part of the process and can also be used in any matter where a potential lengthy line will arise.

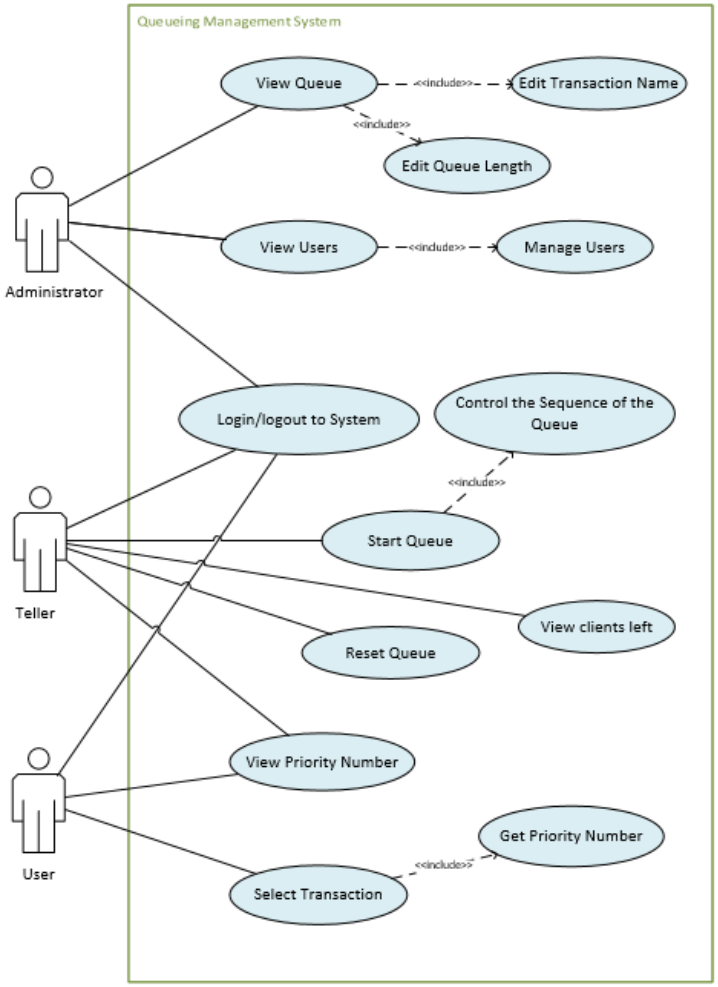


Figure 1. 1 Overall Use Case for the Queueing Management System

1.5.2 Limitations of the Study

The study is limited within the bounds of Mindanao State University – General Santos City with the objective to develop a queueing management system for any transactions that may involve waiting in lines. The project will be able to help manage waiting lines by giving a priority number to clients through a mobile application. First come first serve queueing discipline will be used for establishing the queue to ensure that the clients are served in fair manner. Discussing and using other queuing disciplines and calculating estimated waiting time for each priority number will not be included in this project. For full discussion about queueing disciplines, refer to chapter 2.

The application has limitations for some of its features:

- The system is not capable of sending notification to the user if it's his/her turn to be served, however the system has a web page where the user can view the counter and its corresponding now serving priority number.
- The application in getting priority number is only limited to users with Android phones. Other smartphones that have an operating system aside from Android are not included.

1.5.2.1 *Specific Limitations*

Administrator	*Service Teller*	*User*
Set transaction name for each queue	Start queue	Select transaction to enqueue
Set the number of slot per queue	Call the next number	Get priority number
Manage user account	Reset the queue	View his/her priority number

Table 1. 2 Queueing Management System User Roles

a) Area and Demographics

The researchers limited the target users to students or any customers/clients that may undergo waiting in line in different transaction services within the Mindanao State University. The scope of the study only covers the university because it would be easier for the researchers to conduct the study with sufficient respondents who are only within the campus. For these reasons, the researchers feel that the project will have a good result in improving the current waiting line system where the researchers themselves have experienced especially during enrollment.

1.6 Definition of Terms

Raspberry Pi – is a small single-board computer that is plugged into a computer monitor or TV, and uses a standard keyboard and mouse.

Web Server – is a program that uses a HTTP (Hypertext Transfer Protocol) to serve the files that form Web Pages to users, in response to their requests, which are forwarded by their computers' HTTP clients.

Transaction Services – kinds of the service that operates by the tellers in the queues.

Teller – person responsible in the flow of priority number that will call if the customers will be accommodate

Priority Number – a number that will guarantee you a spot in the queue of transaction corresponding to a Queue and Service, created for a customer

Queue – a line that is being formed by the customers by the transaction

Transaction – a process that is being done by the tellers

Customer - any individual that uses a service

Chapter 2

REVIEW OF RELATED LITERATURE AND TECHNOLOGY

This chapter presents gathered information and technologies by the researchers which have relevance to the study and can serve as reference in understanding the nature of the topic.

2.1 Theoretical Background

Queues are a common every-day experience. Waiting in lines are experienced by the customers commonly in customer service industries such as banks, retail stores, transportation, as well as manufacturing industries when items wait to be processes in assembly line. Queueing theory or also known as a waiting line theory is mathematical study of the congestion and delays waiting lines. This theory can be used to model and predict wait times of the customer and the number of customer arrivals. (Leanne, 1970). Queuing theory examines every component of waiting in line to be served, including the arrival process, service process, number of servers, number of system places and the number of customers. (Investopedia, 2018).

2.1.1 Queueing Disciplines

Queueing discipline refers to how the queue is managed (based around rules allowing customer to join or leave the queue (Jones & Robinson, 2012) Page 204) and it

determines which customer is served next. The most common examples that are used in queueing systems are the following

A. FIFO (first in, first out) or FCFS (first come, first serve). This selects customers based on who has been waiting the longest in line.
B. LIFO (last in, first out) also called LCFS (last come, first serve). In poorly organized systems this might occur, but it is likely to lead to a high level of customer complaints about the unfairness of the system.
C. SPF (shortest processed first). This queueing system in which brief transactions with sooner – as in six-items-only queue in a supermarket. This can work well but only if users understand it and respect the concept.
D. SIRO (serve in random order). This occurs especially in busy areas where there is no obvious queue – for instance, in bars and clubs on Saturday nights.

2.1.2 Waiting Line Structures

According to (Jae K. Shim, 1999) service systems are usually classified in terms of their number of channels (for example, number of servers) and number of phases (for example, number of service stops that must be made). Four basic structures describe the general conditions at the service facility:

- The single channel, single phase case is the one in which arrival units form a waiting line and are serviced by a single service facility. The one-clerk parts department is illustrative.

Figure 2. 1 Single-channel, Single-phase Structure

- The multiple-channel, single-phase case is illustrated by a two-or-more-clerks' parts department since customers can be serviced by any of the clerks (channel).

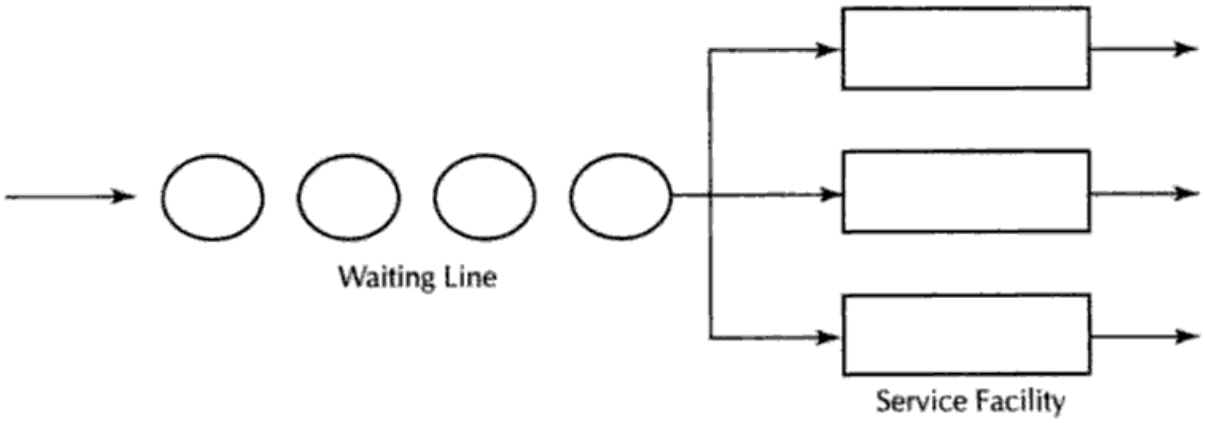


Figure 2. 2 Multiple-channel, single-phase structure

- The single-channel, multiple phase case is illustrated by a simple production line where there are a series of operations (phases) and the unit to be processed goes through the series for complete processing.

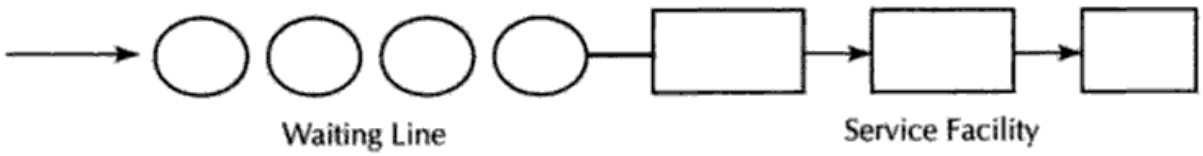


Figure 2. 3 Single-channel, multiple phase structure

- The multiple channel, multiple phase case is illustrated by duplicate productions lines in parallel

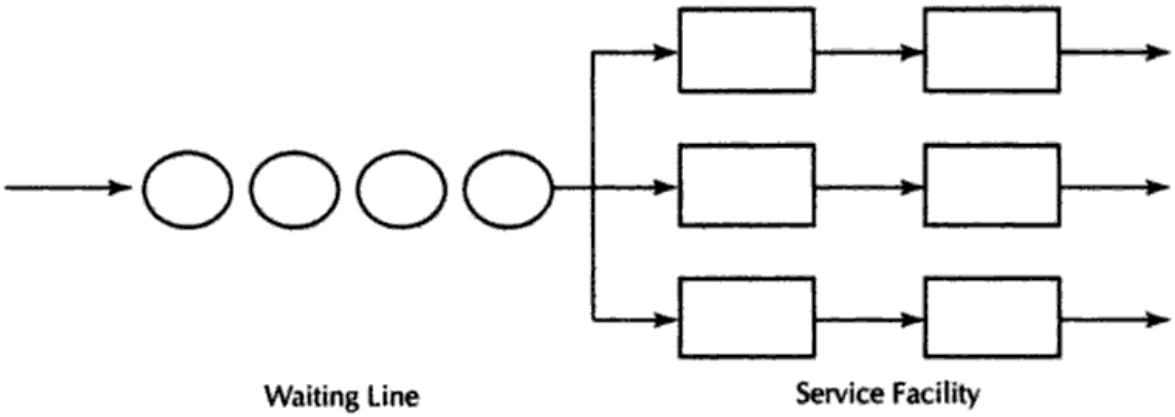


Figure 2. 4 Multiple channel, multiple phase structure

Of course, a complex network of waiting lines could involve combinations of any or all the four basic structures.

2.1.3 Queueing Behaviors

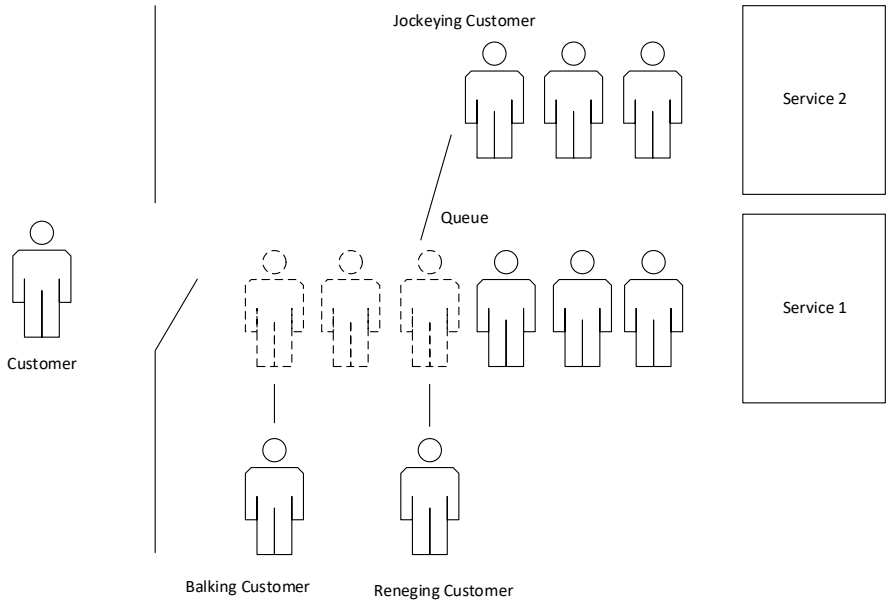


Figure 2. 5 Queuing Behaviors

There are some behaviors of the customers occur when they experience to wait in line in the service according to (Jones & Robinson, 2012). A customer may balk, renege, or jockey. Balking occurs when the customer decides not to enter the waiting line believing that the queue will take too long to wait to disperse to suit their needs and interest. For example, a student wants to pay in the cashier which is one of the process to be enrolled but unfortunately the student saw that the line was too long so the student decided to not to leave and come back later.

A sign that your system in waiting line is poor when the customers appear to be renege. Reneging occurs when the customer decided to enter the waiting line but leaves before being accommodated in the service. For example, a student enters the

waiting line to pay in the cashier but suddenly the student become impatient and decided to leave in the line because the student realize that it will take a long to time before the student can be accommodate in the service. However, in this behavior customer may be deterred from leaving the waiting line by its length. (Zhou & Soman, 2003) Found that as the number of people behind in the waiting line increases the consumer is less likely to renege, largely because they felt better relative to those behind them who were seen as less fortunate than themselves.

Another behavior of the customer is jockey. Jockeying occurs when a customer changes from one line to another, hoping to reduce the waiting time. A good example of this is picking a line at the grocery store and changing to another line in the hope of being served quicker.

2.2 Review of Existing Queuing System

There are a lot of queueing system that already exist. The researchers reviewed and identified how it works and studied the basic functions to help provide a better understanding of the topic. The following are the queueing systems that were reviewed:

a. Teller Automated Queueing Numbering System
b. Queuerite

c. TotalQueue

Features	Developer's Application	Teller Numbering System	Queuerite	TotalQueue
Freeware	✓			
Check the queue status in a screen display	✓	✓	✓	✓
Get priority number number via printing			✓	✓
Get priority number via SMS				
Get priority number through mobile application	✓			
View serving number on the teller's monitor	✓	✓	✓	✓
Multiple queue management capability	✓	✓	✓	

Table 2. 1 Comparison Table of Existing Queueing Systems and Developers Application

Table 2.1 presents features of the developer's application. It summarizes the features of other existing applications that is also present in the developer's application.

2.2.1 Teller Automated Queueing Numbering System

Is a network-based system where you can connect multiple computers. The system has three applications, 1st is the user display where the user can enter their name and transaction, 2nd is the screen display where numbers appear automatically, and 3rd is the cashier display where all the transaction caters sequentially (https://tesear.blogspot.com/2014/08/teller-automated-queuing-numbering.html). For demo screenshots of the application, refer to *appendix f*.

Features
• Multiple queue management capability • Check the queue status in a screen display • View serving number on the teller's monitor

Table 2. 2 Features of Teller Automated Queueing Numbering System

2.2.2 QueueRite

Queuerite is a complete enterprise software system for customer queue management system. This software allows businesses to systematize the procedure for customers as they line up and wait for their turn to be served. By using the Queuerite software, customer services at the reception area will become more efficient and the confusion brought by customers' long lines will be minimized (http://queuerite.com/home.do). For demo screenshots of the application, refer to *appendix f*.

Features
• Check the queue status in a screen display • Single or multiple queue management capability • Media player capability • Tellers can call the next ticket and call again • Generate ticket number via printing

Table 2. 3 List of Features of QueueRite

2.2.3 TotalQueue

The Total Queue Software is developed by Ivant Technologies, a software firm based in the Philippines, that specializes in the development of custom business software. The company was established in 2005 and currently works with hundreds of small, medium and big business clients in the Philippines and other countries to develop custom web-based solutions and custom mobile apps (https://www.totalqueue.com/about.do). For demo screenshots of the application, refer to *appendix f.*

Features
• Check the queue status in an screen display • Single queue management capability • Media player capability • Tellers can call the next ticket, call again • Generate printed queue ticket number

Table 2. 4 List of Features of TotalQueue

Chapter 3

METHODOLOGY

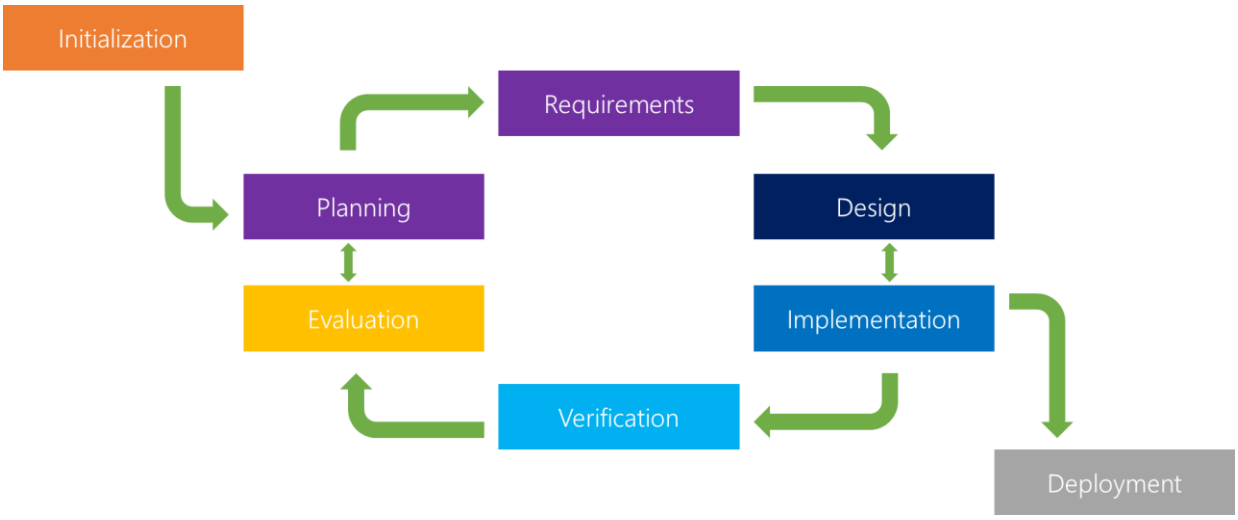


Figure 3. 1 Iterative Development Process (Powell-Morse, 2016)

The overall methodology of the project follows the Iterative Development Process showed in figure 3.1. The first would be the initial planning, then (1) identifying the requirements, (2) analyzing and designing the project, (3) implementation, (4) testing, (5) evaluation, these 5 phases will cycle go on until a complete system is ready to be deployed.

3.1 Iterative Development Model

Iterative methodology will be the main methodology used in developing the proposed system. An iterative life cycle model does not need to start with a full specification of all requirements. The development can start by specifying and implementing just part of the software, which can then be reviewed in order to identify further requirements. This process will be repeated to produce a new version of the software for each cycle of the model. (Ghahrai, 2017)

Working iteratively allows more flexibility with each repeated cycle, additional features are added, developed and tested until there is a complete system ready to be deployed to customers.

3.2 Iterative Development Process 1

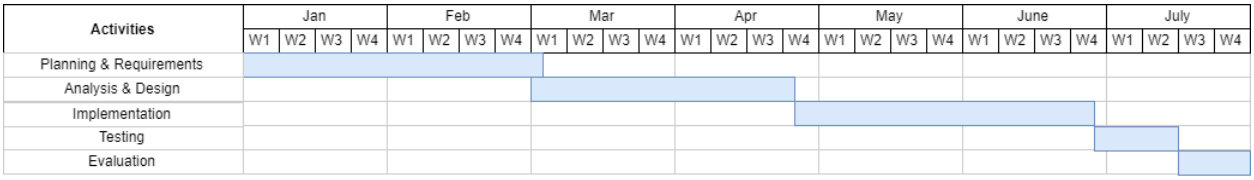


Figure 3. 2 Gantt Chart of Iterative Development Process 1

Figure 3.1 shows the overall activities for developing the proposed system for the first iteration. From the planning and requirements stage up to the evaluation.

3.2.1 Planning and Requirements

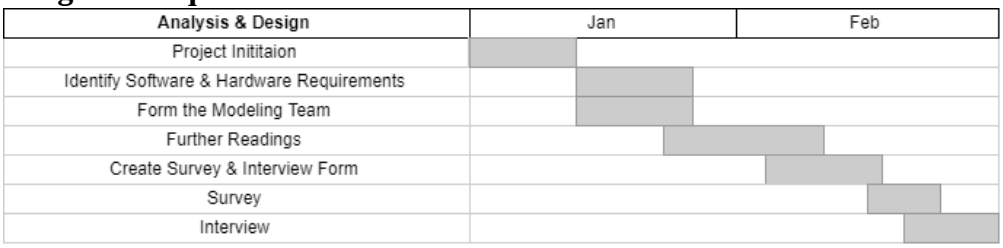


Figure 3. 3 Iterative Development Process 1 – Planning & Requirements

Activities	Carried out by	Deliverables
Project Initiation		
a) Create a proposal documentation b) Create a proposal presentation c) Present the proposal to the panel	Researchers	Proposal documentation Proposal presentation
Identify Software and Hardware Requirements		
a) Research about the primary requirements of the project b) Research on the software requirements c) Research on the hardware requirements d) Raspberry PI e) Frontline SMS f) ISMS g) Compare results	Researchers	Articles and journals from the web

h) Choose the best option that best fits the projects		
Form the Modeling Team		
a) Assign task to every member of the team b) The one who documents c) The one who develops the system	Researchers	
Further Readings		
a) Queueing theories • Queueing disciplines - Jones, P., & Robinson, P. (2012). *Operations management*. Oxford University Press. • Waiting line structures - Shim, J. K., & Siegel, J. G. (1999). *Operations management*. Barron's Educational Series. • Queueing behaviors - Jones, P., & Robinson, P. (2012). *Operations management*. Oxford University Press. b) Bose, S. K. (2013). *An introduction to queueing systems*. Springer Science & Business Media. c) Bittner, K., & Spence, I. (2006). *Managing iterative software development projects*. Addison-Wesley Professional. d) Elements of Waiting Line Analysis –	Researchers	Articles and Journals
Create Survey & Interview Form		
a) Research how to make a survey form b) Adapt and modify to best suit the criteria and needs of the project	Researchers	Survey form
Survey		
a) Create survey via Google forms b) Disseminate survey via Facebook c) Gather information from the survey	Researchers	Survey results
Interview		
a) Ask the capstone adviser for the interview form approval b) Go to the Y building of the university to gather information from service tellers c) Let them take the short interview d) Get the correspondent's name	Researchers	Ms. Angela Sanchez – MSU-GSC cashier

Table 3. 1 Task on Planning and Requirements

3.2.2 Analysis & Design

Analysis & Design	March	April
Create Review of Related Literature		
Plan Project Development		
Create Use Case Diagram		
Create Activity Diagram		

Figure 3. 4 Iterative Development Process 1 – Analysis & Design

Activities	Carried by:	Deliverables:
Create a review of Related Literature		
a) Student Q™ b) Queuerite c) TotalQueue.	Researchers	Chapter 2 (Review of Related Technology Applications)
Plan the Project Development Process		
Research Software Development Life Cycle (SDLC) a) Rapid application development b) Waterfall c) Iterative life cycle d) Spiral Model e) V-Model f) Big Bang Model g) Agile Model h) Prototyping Model	Researchers	Chapter 3 (Project methodology)
Create Use Case Diagram		
QMS overall use case	Researchers	Use case diagrams
Create Activity Diagram		
Activity get priority number Activity log in	Researchers	Activity diagrams

Table 3. 2 Task on Analysis and Design

3.2.3 Implementation

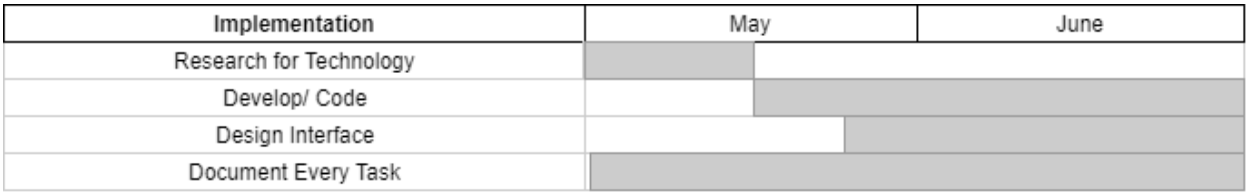


Figure 3. 5 Iterative Development Process 1 – Implementation

TASK	Carried by:	Deliverables:
Research for a Technology		
a) Borrow Raspberry Pi from Sir Rudy b) Review and read about Raspberry Pi	Researchers	Research bout Raspberry Pi in the web
Develop/Code		
• Teller Page • User Page	Programmer	User interface of the System
Design		
Front End of the System	Developer	User interface of the system
Document Every Task		
Take note activity done and results	Researchers	Chapter 4 – software used and comparisons

Table 3. 3 Task on Implementation

3.1.4 Testing

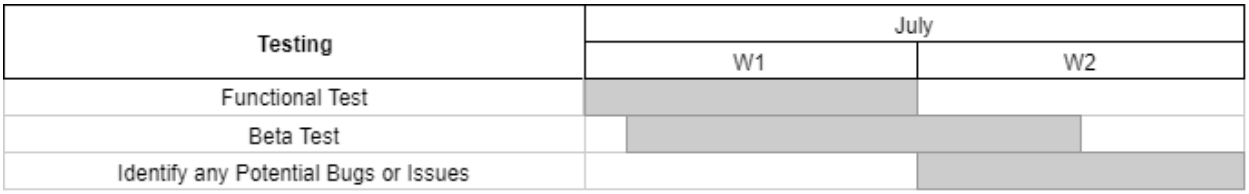


Figure 3. 6 Iterative Development Process 1 – Testing

Activities	Carried by:	Deliverables:
Functional test		
Tasks: a) Database Connection b) Identify what the system does	Developer	Know the software functionality
Beta Test		

Tasks: Test the system in transaction where will be a possible lengthy queue	- Random People	Identify what to improve on the software
Identify and locate any potential bugs or issues		
Tasks: a) Web Pages • Teller Page • Customer Page b) Database Connection	Programmer	Software

Table 3. 4 Task on Testing

3.1.5 Evaluation

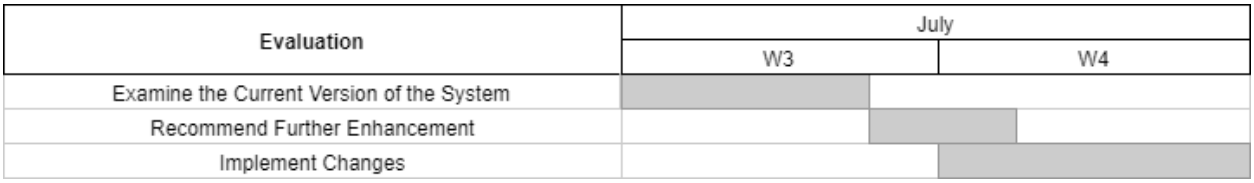


Figure 3. 7 Iterative Development Process 1 – Evaluation

Activities	Carried by:	Deliverables:
Examine the current version of the system		
Tasks: -Queuing Management System Module	Developer	Check, evaluate change other features of the Software
Recommend further enhancements		
Tasks: -Queuing Management System Module	Developer	Working software and hardware
Implement changes		
Tasks: -Queuing Management System Module -Raspberry Pi	Developer	Change some functionalities of the software

Table 3. 5 Task on Evaluation

3.3 Iterative Development Model Process 2

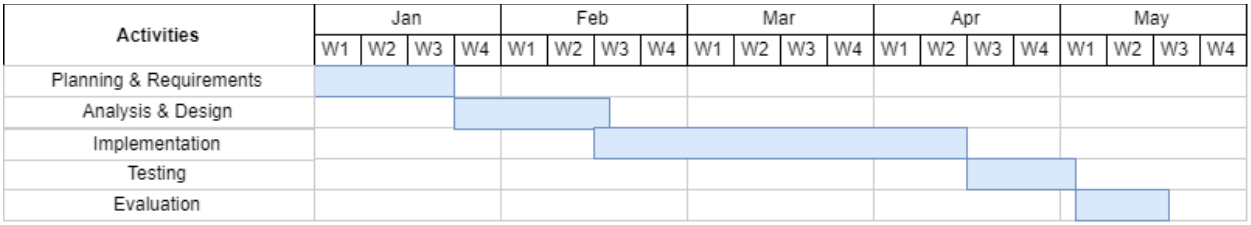


Figure 3. 8 Gantt Chart of Iterative Development Process 2

Figure 3.8 shows the overall activities for developing the proposed system for the second iteration. From the planning and requirements stage up to the evaluation.

3.3.1 Planning and Requirements

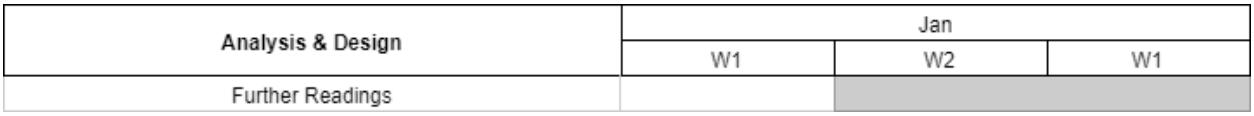


Figure 3. 9 Iterative Development Process 2 – Planning & Requirements

Activities	Carried out by	Deliverables
Further Readings		
• Queueing disciplines - Jones, P., & Robinson, P. (2012). *Operations management*. Oxford University Press. • Waiting line structures - Shim, J. K., & Siegel, J. G. (1999). *Operations management*. Barron's Educational Series. • Queueing behaviors - Jones, P., & Robinson, P. (2012). *Operations management*. Oxford University Press. e) Bose, S. K. (2013). *An introduction to queueing systems*. Springer Science & Business Media. f) Bittner, K., & Spence, I. (2006). *Managing iterative software development projects*. Addison-Wesley Professional. g) Elements of Waiting Line Analysis h) Android Software Development	Researcher, Developer	Articles and Journals

Table 3. 6 Task on Planning and Requirements

3.3.2 Analysis & Design

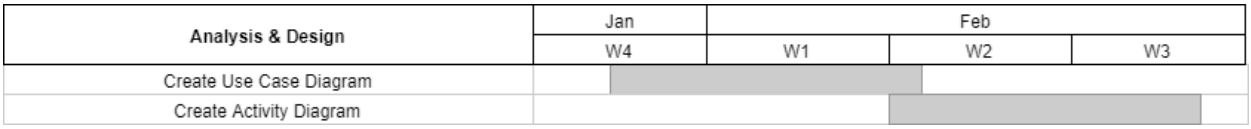


Figure 3. 10 Iterative Development Process 2 - Analysis & Design

Activities	Carried by:	Deliverables:
Create Use Case Diagram		
Queueing Management System overall use case • Admin use case • Teller use case • User use case	Developer	Use case diagrams
Create Activity Diagram		
Activity Login User Activity View Queue Activity Edit Queue Activity Manage Users Activity View Tellers Activity Start Queue Activity Control Queue Sequence Activity Reset Queue Activity Get Priority Number Activity View Priority Number	Developer, Compiler	Activity Diagrams on Chapter 5

Table 3. 7 Task on Analysis and Design

3.3.3 Implementation

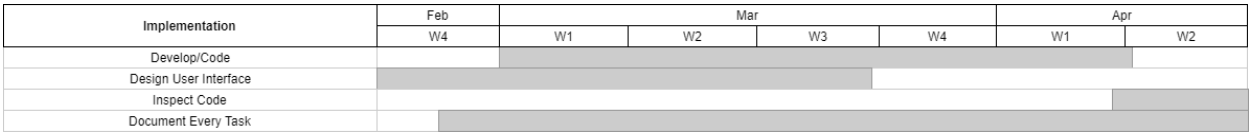


Figure 3. 11 Iterative Development Process 2 - Implementation

TASK	Carried by:	Deliverables:
Develop/Code		
• Teller Page	Programmer	Different pages of the System

• Client Mobile Application • Admin Page • Viewers Page		
Design		
• Client User Interface • Admin User Interface • Teller User Interface	Developer	User interface of the system
Inspect Code		
• Check HTML Tagging • Check PHP Codes • Check Java Android Studio Code	Programmer	Arranged & Structured Codes
Document Every Task		
Take note activity done and results	Compiler	Document Chapter 3 &4

Table 3. 8 Task on Implementation

3.3.4 Testing

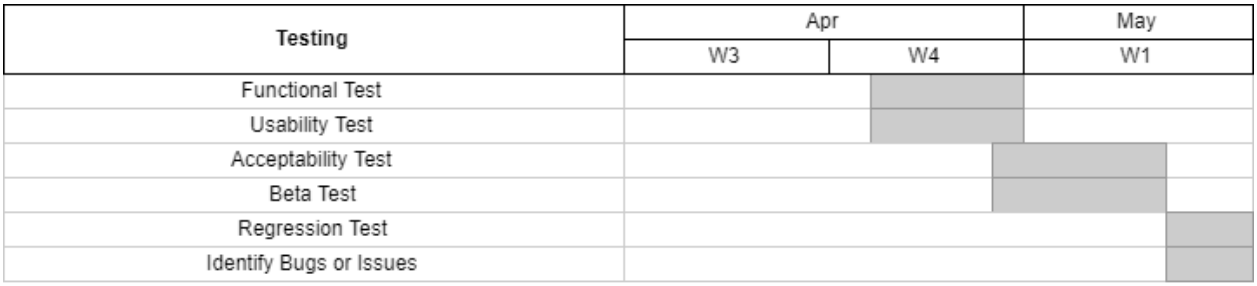


Figure 3. 12 Iterative Development Process 2 - Testing

Activities	Carried by:	Deliverables:
Functional test		
Tasks: a) Verification of the system against the functional requirements b) Manual testing on the features c) Identify what the system does	Developer, Programmer	Identify software functionality
Usability test		
Testing the usability of the developed system based on the criteria	Tellers, admin, customers	Usability Survey Form
Acceptability Test		
Testing of the acceptability of the system based on the criteria	Tellers, admin, customers	Acceptability Survey Form

Beta Test		
Tour a user about the software	Random People	Identify what to improve on the software
Identify and locate any potential bugs or issues		
Tasks: a) Web Pages • Teller Page • Admin Page b) Priority Number Distribution c) Database Connection	Developer, Programmer	System Enhancements

Table 3. 9 Task on Testing

3.3.5 Evaluation

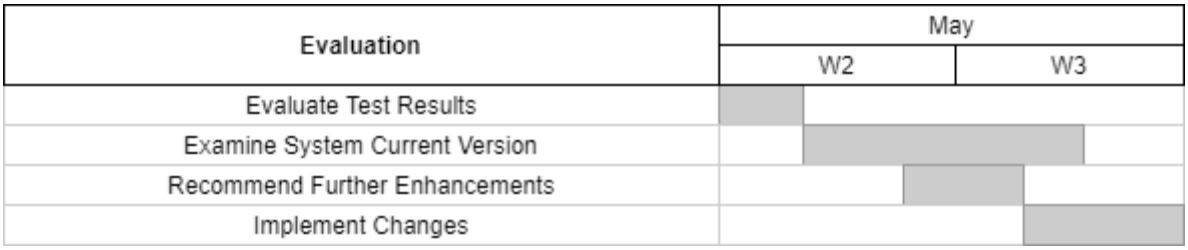


Figure 3. 13 Iterative Development Process 2 - Evaluation

Activities	Carried by:	Deliverables:
Evaluate test results		
Evaluate the results of beta testing and functional testing	Developer, Programmer, Compiler	Functionality and beta testing results
Examine the current version of the system		
• Check functionalities of the system • Compare results from the last test	Developer, Programmer, Compiler	Evaluate system functionalities
Recommend further enhancements		
• User Interface • User Experience	Test Respondents	Working software and hardware
Implement changes		
Queuing Management System Module	Developer, Programmer, Compiler	Improve some functionalities of the software

Table 3. 10 Task on Evaluation

Chapter 4

Results and Discussions

4.1 Results of Iterative Development Process 1

Iterative Development Process 1: Project Schedule

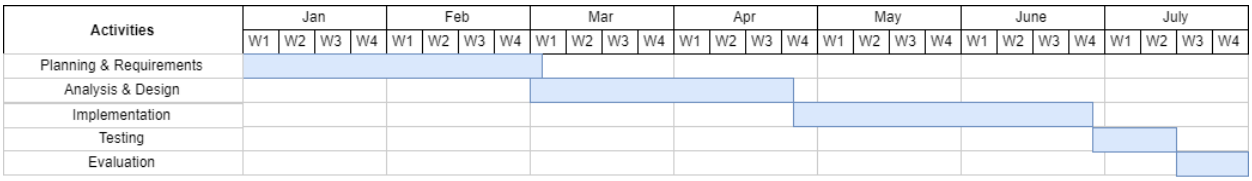


Figure 4. 1 Iterative 1 - Gantt Chart

4.1.1 Results of Planning Requirements

4.1.1.1 Iteration 1 Identifying Software and Hardware requirements

The team members researched about the raspberry pi and queueing theories that are essential in developing queueing systems. To broaden the knowledge of the project researchers, further readings was done. A research was also done about the type of methodologies and related literature about the existing technology.

4.1.1.2 Interview and surveys conducted

- An interview was conducted to gather information for the development of the system with the people that are probably experiencing lengthy queue in transaction services in the university. The researchers of the study approached Ms. Angela Q. Sanchez a school cashier of Mindanao State University – General Santos City who was one of the

appointed clerk in payment transaction by the time the interview was conducted May 11, 2018.

- From May 9, 2018 to May 16, 2018, an online survey was conducted by the researchers using Google forms to create an online survey and dissemination was done through Facebook – a social networking website. Each person known by the researchers who are student of Mindanao State University – General Santos City was personally messaged with proper introduction and a description of the said survey was provided in the link. Online survey details can be seen in *appendix b*.
- The proponents looked for a survey online and adapted the set of questionnaires specifically for the proposed Queueing System. The survey resulted 97 respondents and 95.9 % of them said that they have experienced waiting in line during enrollment. 92.8 percent of the respondents are open to the idea of having a queuing system in the enrollment. In terms of getting a queue priority number, 49.5% of the respondents preferred via printed number but this method will rely heavily on printing materials such as paper, which means more resource expense so the researchers will focus more on giving priority number via SMS since it has the second most results 44.3%. The detailed survey results refer *appendix b*.

4.1.2 Iteration 1 Analysis and Design

4.1.2.1 Review of Related Literature

There are a lot of queueing system that exists on the internet. The researchers reviewed it, looked into details to identify how it works, and studied the basic functions to help provide a better

understanding of how queuing system works. The following were the queueing systems that was reviewed;

- Teller Automated Queueing Numbering System
- Queuerite
- TotalQueue

Some of the software listed has a subscription fee and has limited features. The details of the reviewed systems can be seen in *chapter 2*.

4.1.2.2 Project Development Process

The researchers decided to follow Iterative Model in project development process because it shows that after completing the whole process of the cycle, you can start again from the beginning saving your past activities and progress. Working iteratively allows more flexibility with each repeated cycle additional features are added, developed and tested until there is a complete system ready to be deployed to customers. For further details of the project development process, refer to *chapter 3*.

4.1.3 Iteration 1 Implementation

The development of the system started. The developer started with the user and teller page. However, the prototype developed has only limited functions. Refer to *appendix b* for all application designs.

4.1.3.1 User Page of the Prototype

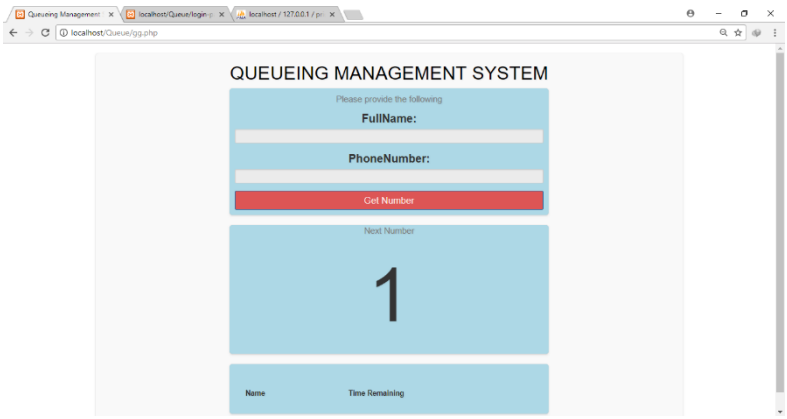


Figure 4. 2 Customer Page of the Prototype

4.1.3.2 Activity diagram in getting priority number

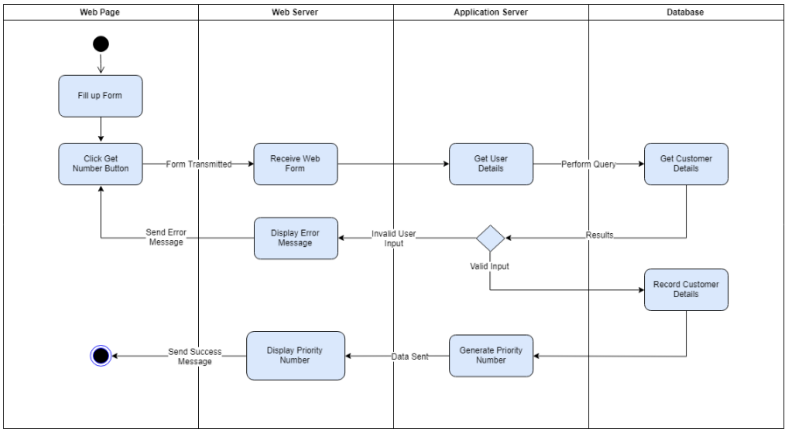


Figure 4. 3 Activity Diagram in Getting Priority Number

The activity diagram above shows the flow in getting a priority number in the system. For use cases and application diagrams, refer to *appendix a.*

4.1.3.4 Teller Page of the Prototype

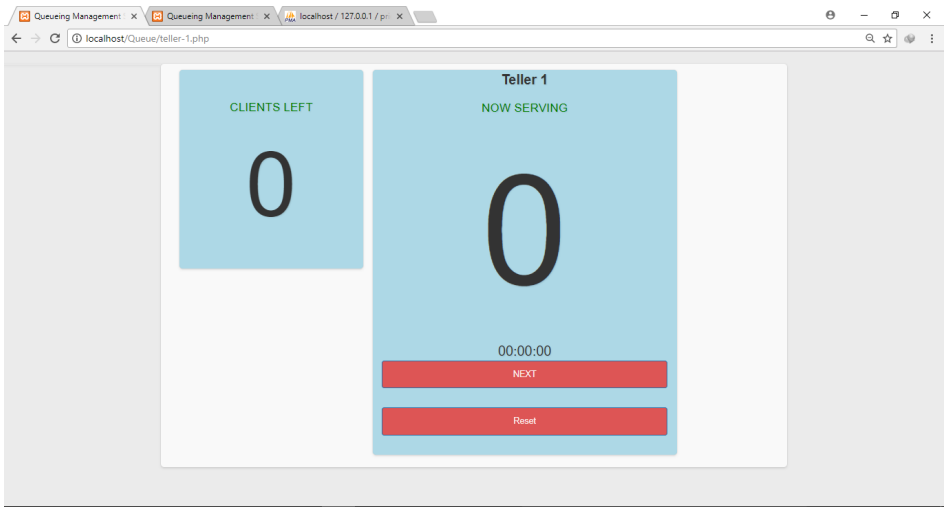


Figure 4. 4 Teller Page of the Prototype

4.1.3.5 Activity Diagram in Controlling Queue Sequence for Teller

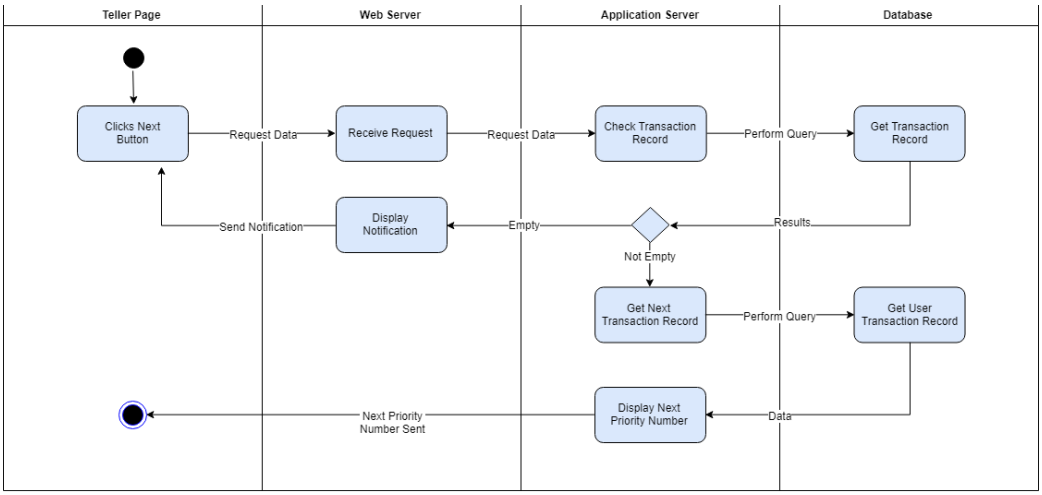


Figure 4. 5 Activity Diagram for Start and Control Queue Sequence

The activity diagram above shows the flow in starting and controlling queue sequence in the system. For use cases and application diagrams, refer to *appendix a.*

4.1.4 Iteration 1 Testing

The proponents of the system tested the system and did some basic functions to test the functionality of the buttons and other components. In the user page, a customer could see what priority number they would get. By providing name and contact number, the customer will get an SMS with their priority number through the web page developed; however, in the prototype the SMS sending functionality is not present. In the teller page on the other hand, the service teller could see how many customers are left in the queue. The service teller can call a customer by clicking the next button. Reset button will dequeue all customers remaining in the queue.

4.1.5 Iteration 1 Evaluation

The evaluation for the prototype of the system is that it needs more enhancements in its functionalities and features. In addition, the panel of researchers suggested to change the approach in getting priority number for customers, it will be through a mobile application instead of SMS.

4.2 Results of Iterative Development Process 2 (Cycle 2)

Iterative Development Process 2: Project Schedule

Activities	Jan				Feb				Mar				Apr				May			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Planning & Requirements																				
Analysis & Design																				
Implementation																				
Testing																				
Evaluation																				

Figure 4. 6 Iterative 2 - Gantt Chart

4.2.1 Iteration 2 Implementation

The second cycle or iteration of the project started. The developer researched about android development as that it is more convenient to have a queueing mobile application where the users can get a number instead of setting up a kiosk within the vicinity of service counters. Refer to *appendix b* for all application designs.

4.2.1.1 The Admin Page of the System

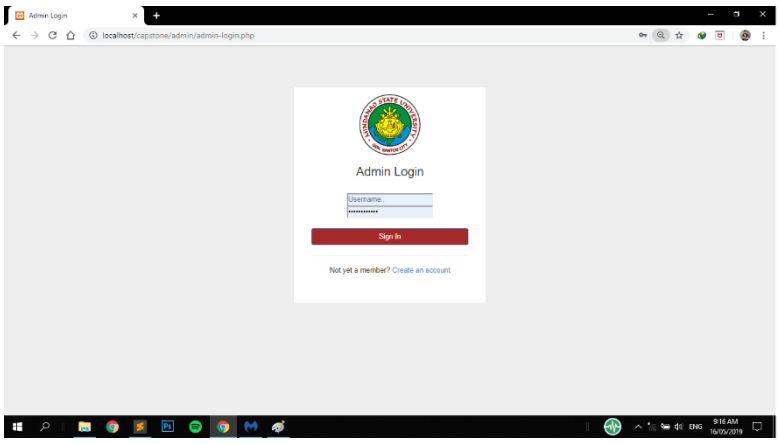


Figure 4. 7 Admin Login Page

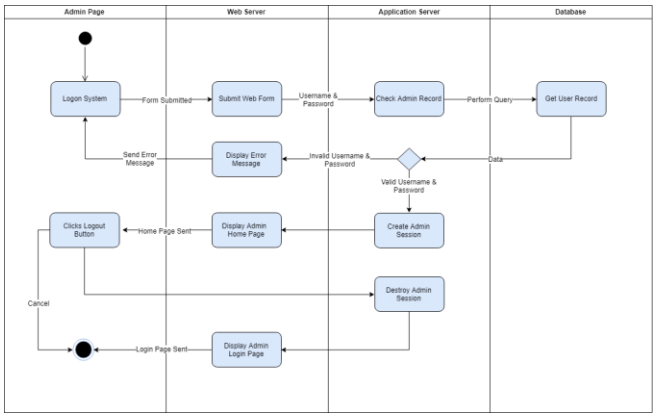


Figure 4. 8 Activity Diagram for Admin Login/Logout System

Figure 4.8 above shows the flow on how to login then logout the admin in the system.

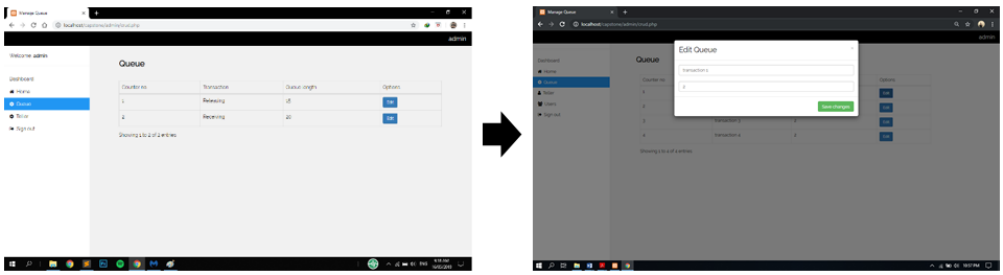


Figure 4. 9 The View and Edit Queue Page

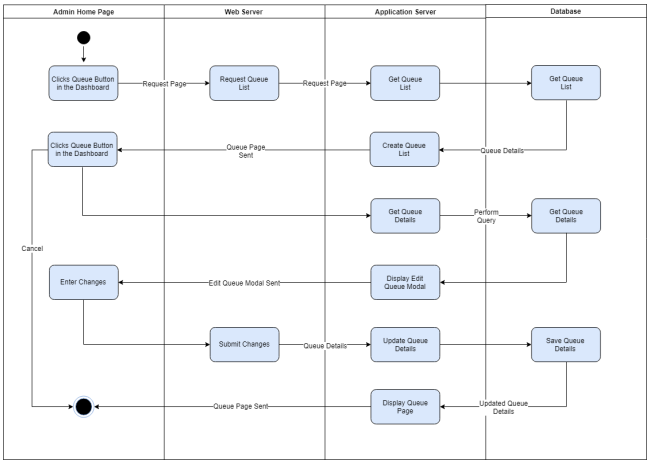


Figure 4. 10 Activity Diagram for View & Edit Queue Details

Figure 4.10 shows the flow on how to view and edit the queue details from the admin page of the system.

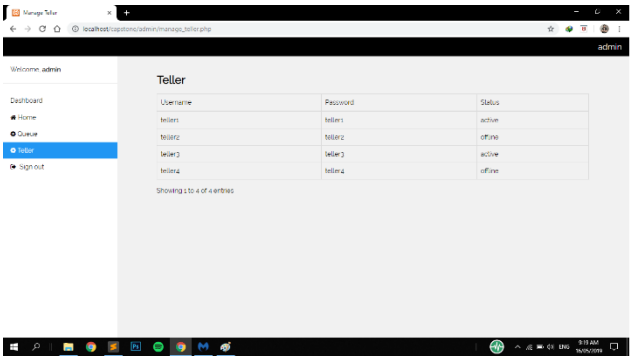


Figure 4. 11 The Admin View Teller Page

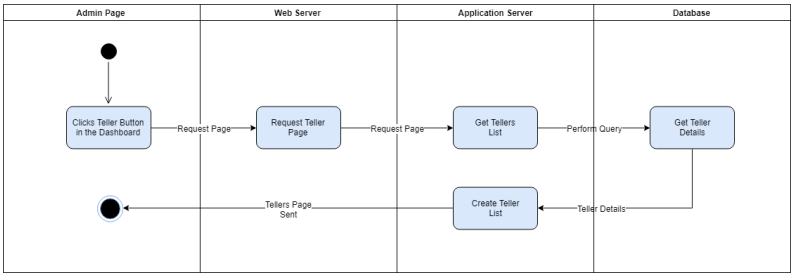


Figure 4. 12 Activity Diagram for View Tellers

Figure 4.12 above shows the flow on how view the tellers from the home page of the admin.

4.2.1.2 The Teller Page of the System

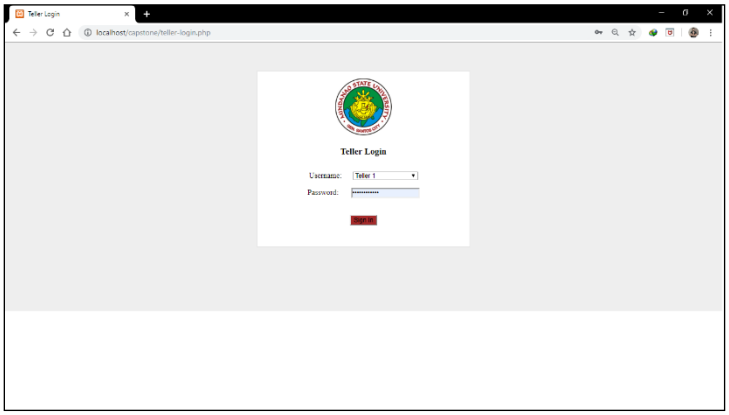


Figure 4. 13 Teller Login Page of the System

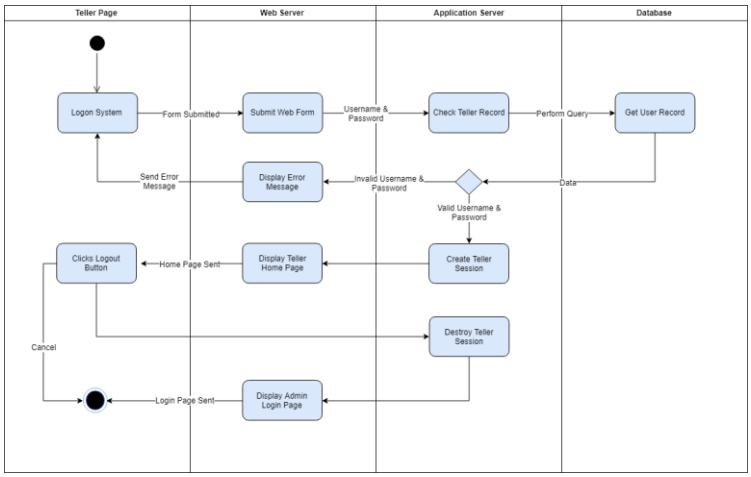


Figure 4. 14 Activity Diagram for Teller Login/Logout System

Figure 4.14 above shows the flow on how to login then logout a teller in the system.

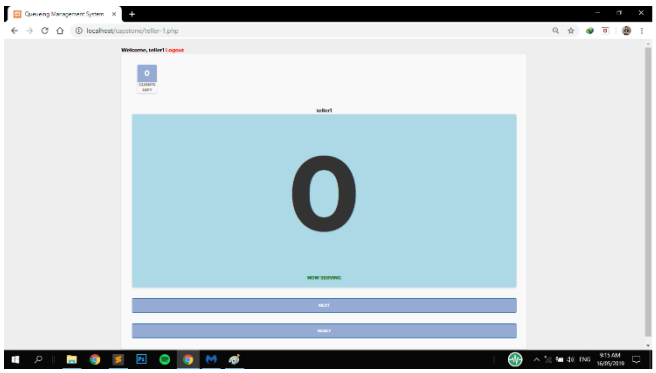


Figure 4. 15 Teller Home Page

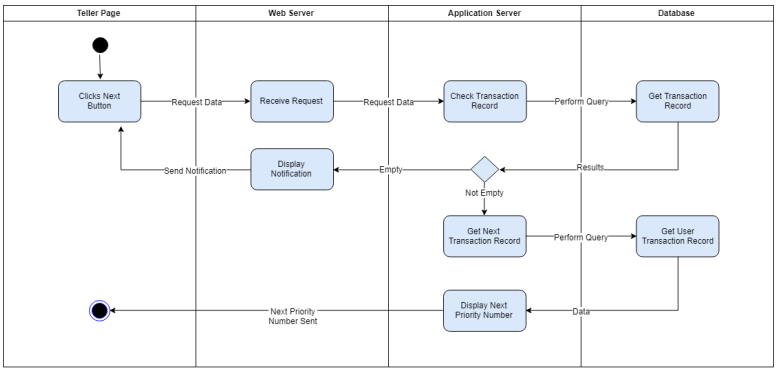


Figure 4. 16 Activity Diagram for Start and Control Queue Sequence

Figure 4.16 shows the flow on how to start and call the next number in the teller home page.

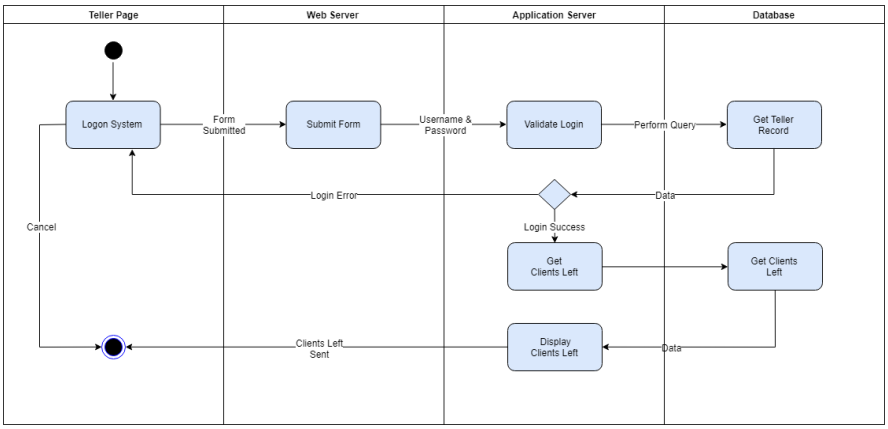


Figure 4. 17 Activity Diagram for View Clients Left

Figure 4.17 shows the flow on how the teller can view the clients left in the home page.

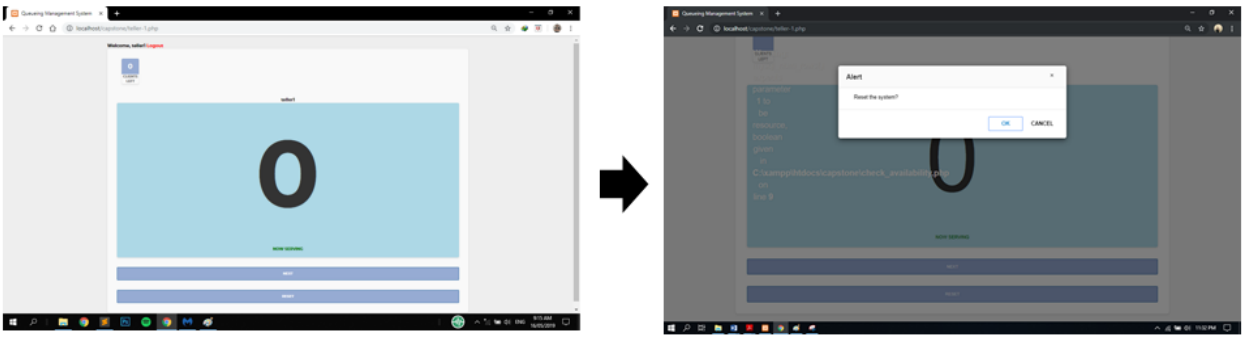


Figure 4. 18 Teller Home to Reset Queue

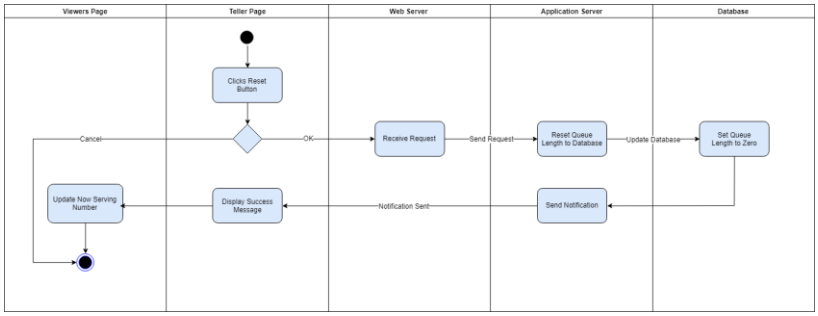


Figure 4. 19 Activity Diagram for Reset Queue

Figure 4.19 above shows the flow on how the teller can reset the queue in the system.

4.2.1.3 The User Application of the System

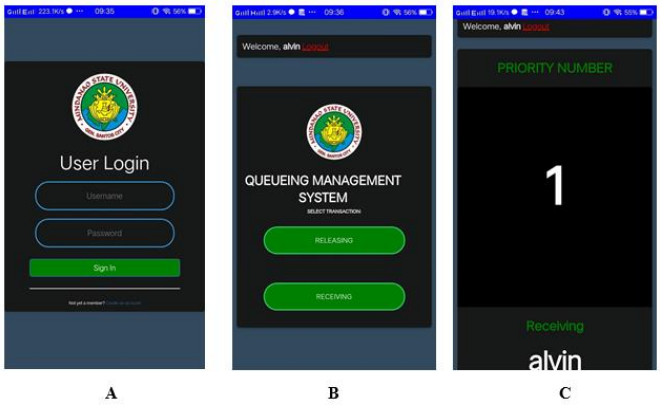


Figure 4. 20 Android Application User Interfaces

Upon launching the application, it will ask for the user's username and password. *Picture A* shows the user-interface where the user can input his/her valid username and password. After logging in, *picture b* is the interface where the user can select the transaction and get a priority number. Lastly, *picture c* displays the priority number and the selected transaction of a user.

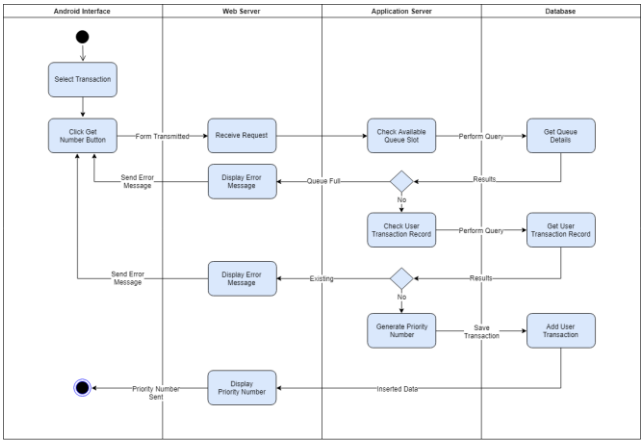


Figure 4. 21 Activity Diagram for Getting Priority Number

Figure 4.17 shows the flow on how to get a priority number in the application. Application diagrams can be seen also on *appendix a.*

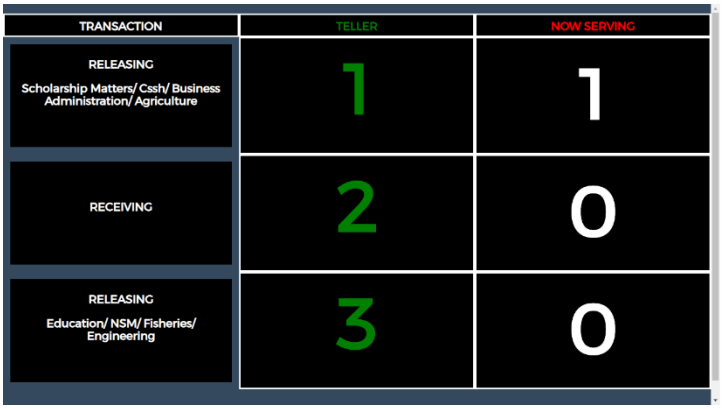


Figure 4. 22 The Now Serving Page for Viewers in Waiting Line

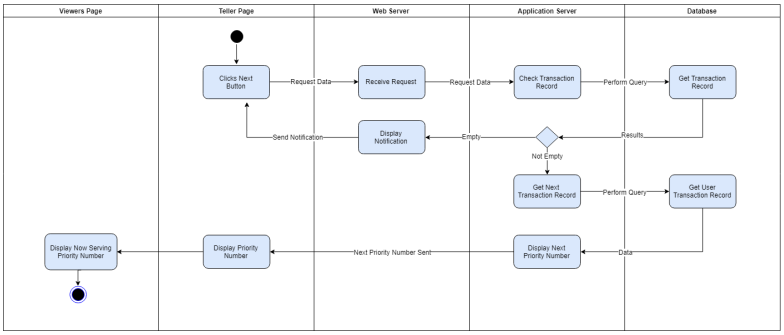


Figure 4. 23 Activity Diagram for Now Serving Page for Viewers Waiting in Line

Figure 4.23 shows the flow for displaying the now serving priority number in each counter.

4.2.2 Results of Queueing Management System Technology Acceptance

Acceptability testing is used to evaluate the application's compliance with the requirements and to assess whether the application is ready for deployment by using these categories: perceived ease of use, perceived usefulness, perceived web security, attitude and lastly intention to use. The following figures below presented the results for the acceptability testing conducted for the system. The respondents were given nineteen (19) questions, divided into five (5) categories for the acceptability test.

The survey instrument was adopted from the set of questions from TAM (Technology Acceptance Model) made by Fred Davis in 1989. For detailed acceptability results, refer to *appendix f.*

6.50 – 7.00	Strongly Acceptable
5.50 – 6.49	Acceptable
4.50 – 5.49	Slightly Acceptable
3.50 – 4.49	Neutral
2.50 – 3.49	Slightly Unacceptable
1-50 – 2.49	Unacceptable
1.00 – 1.49	Strongly Unacceptable

Table 4. 1 Scale of Acceptability

4.2.2.1 Perceived Ease of Use

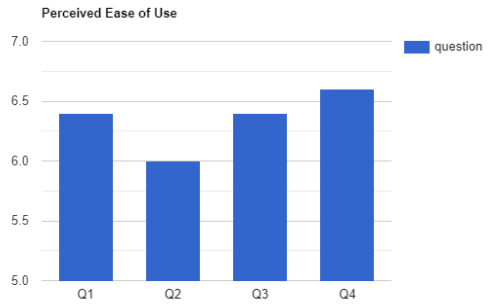


Figure 4. 24 Perceived Ease of Use Graph

This test was made to identify whether users sensed if the given web system will able to perform the necessary tasks. On question 2, the users find it slightly hard to interact with the system but despite that, an arithmetic mean of 6.35 shows that is particular part of the system is acceptable.

4.2.2.2 Perceived Usefulness

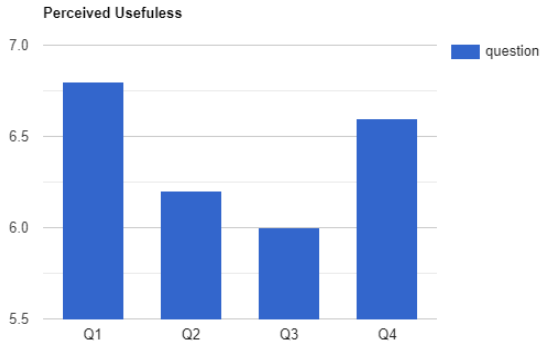


Figure 4. 25 Perceived Usefulness Graph

This test was made to identify whether users sensed if the given web system will able to perform the necessary tasks. With an arithmetic mean of 6.4, the result showed the users agree that the system is indeed useful.

4.2.2.3 Perceived Security

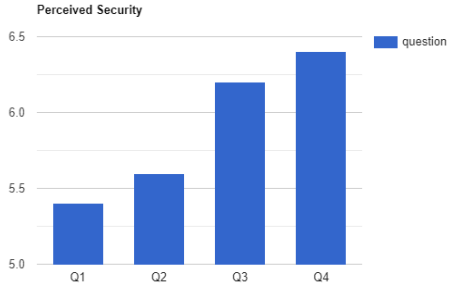


Figure 4. 26 Perceived Security Graph

This category was made to determine whether users feel safe when putting the users' personal information, surprisingly question 1 has an arithmetic mean of 5.4, which is the lowest among the four questions. The users are not fully convinced of the safety of their personal information. Despite this, the system's overall arithmetic mean for security is 5.9, which is still acceptable according to table 4.1.

4.2.2.4 Attitude

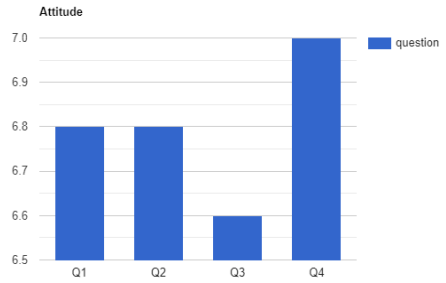


Figure 4. 27 Attitude Graph

This test was conducted to determine the general attitude of the users when using the system. With the an arithmetic mean of 6.8 in the four questions, the result is strongly acceptable according to table 4.1 which means that the users shows an optimistic and positive attitude when using the system.

4.2.2.5 Intention to use

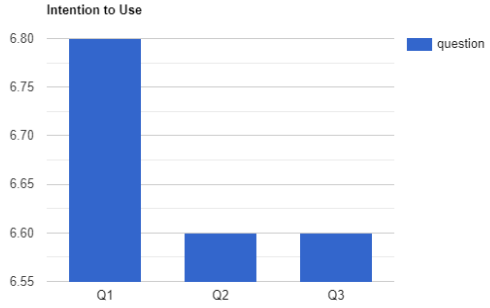


Figure 4. 28 Intention to Use Graph

With an arithmetic mean of 6.67, the result for the Intention to Use was determined to be strongly acceptable according to table 4.1. The result also indicates that the users are willing to use the proposed system.

4.2.2.6 Overall Result

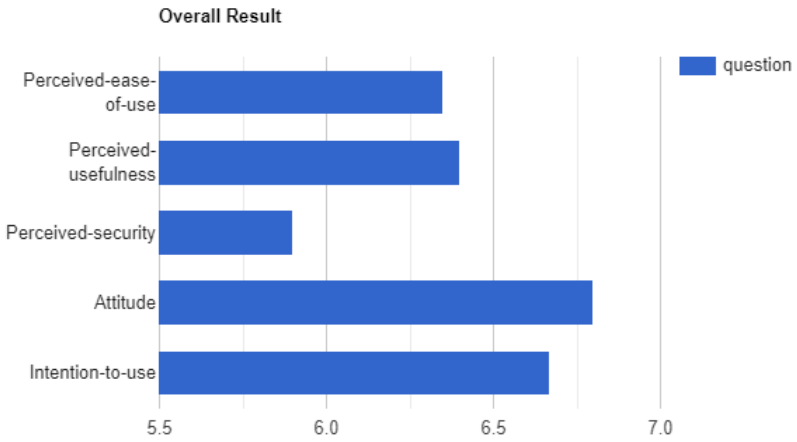


Figure 4. 29 Overall Result Graph

The over-all result has an arithmetic mean of 6.424. This means that the proposed system is acceptable for places where waiting lines may occur.

Chapter V

Conclusions and Recommendations

6.1 Conclusion

Currently the Mindanao State University-General Santos City is not using queuing system in service transactions that are experiencing a lengthy queue. The process still goes by just waiting in the line and waiting for your turn to be accommodated in the service counter. The customers especially the students in the university are experiencing waiting in long lines particularly during enrolment. In a survey conducted by the researchers it says that students usually experience lengthy queues in paying at cashier, college and department fees, encoding of subjects and validation at the registrar. Students who are part of the university may find it inconvenient to stand on a protracted queue.

The objective of the system is to manage waiting lines by having a priority number for students to avoid other customers who cut in the line as it is identified as one of the problems by the researchers. With a mobile application, clients are able to view their priority number when they will be accommodated in the service counter. In order to meet the set objectives, the developers used different strategies in developing and analyzing the proposed system.

The results of the usability and acceptability testing shows that the Queueing Management System was acceptable with an overall arithmetic mean of 6.424 from the five technology acceptance categories. This evaluation shows that users are willing to use the proposed system.

6.2 Recommendations

Queueing management system despite its functions is still potential for improvement and enhancement in terms of the priority number distribution, the waiting time calculation and user interface. For future research and system development, the following changes or features were recommended:

- User Interface - the approval of the queueing system from the users depends on the interface of the system and its environment. From time to time, it is then subject to improvement and enhancement.
- Queueing Scheme - there are many queueing schemes available, this study only focused on some areas of this scheme. It depends on what scheme an organization or client follows Other queueing schemes could be researched and integrated for future system development.
- Priority number distribution – it is recommended by the developers to explore other medium of distributing priority number such as physical ticket printing or SMS.
- Waiting Time Calculation - the developed system does not have a waiting time algorithm as it is a very complex task but it is highly recommended by the developers to try research on waiting time algorithms and integrate them for the system will be more reliable and efficient if there is an including estimated waiting time for each priority number.

Appendix A

Application Diagrams

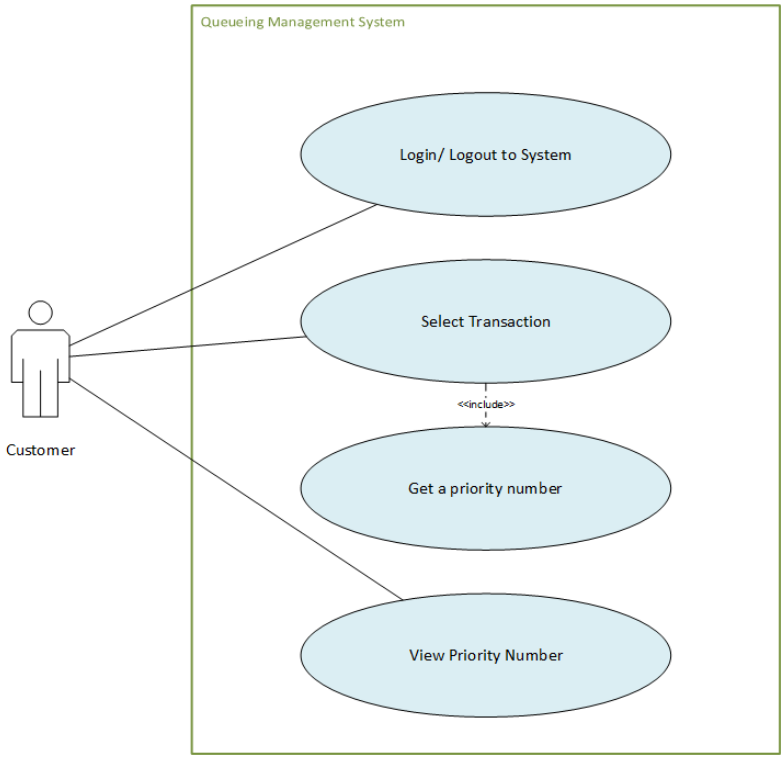


Figure 1 Use Case for Customer

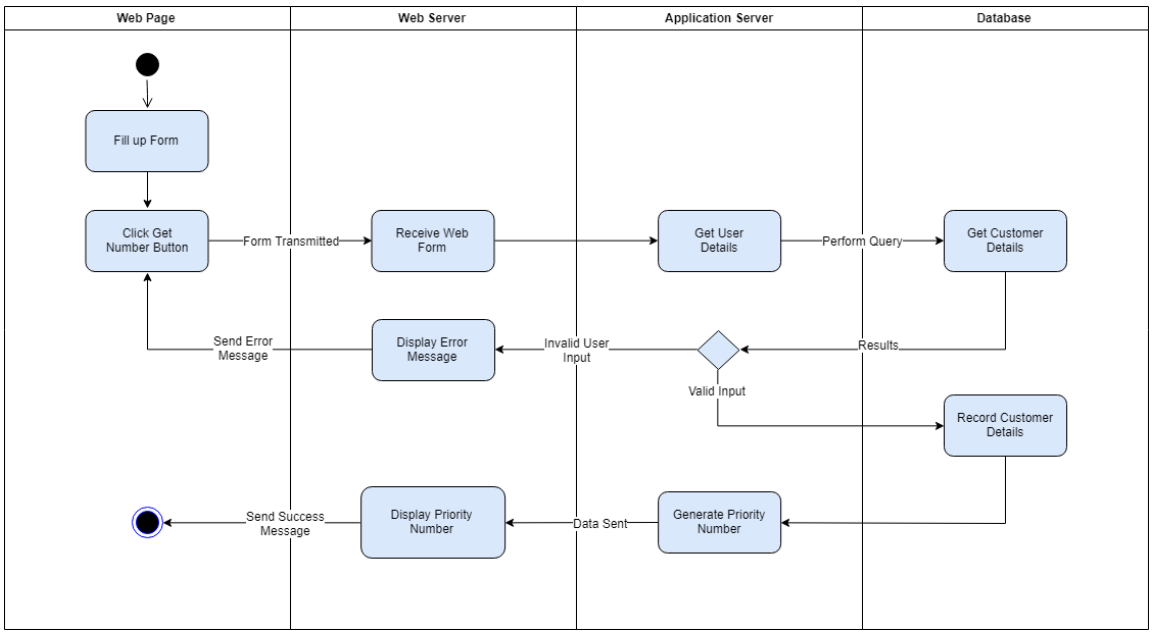


Figure 2 Activity Diagram in Getting Priority Number

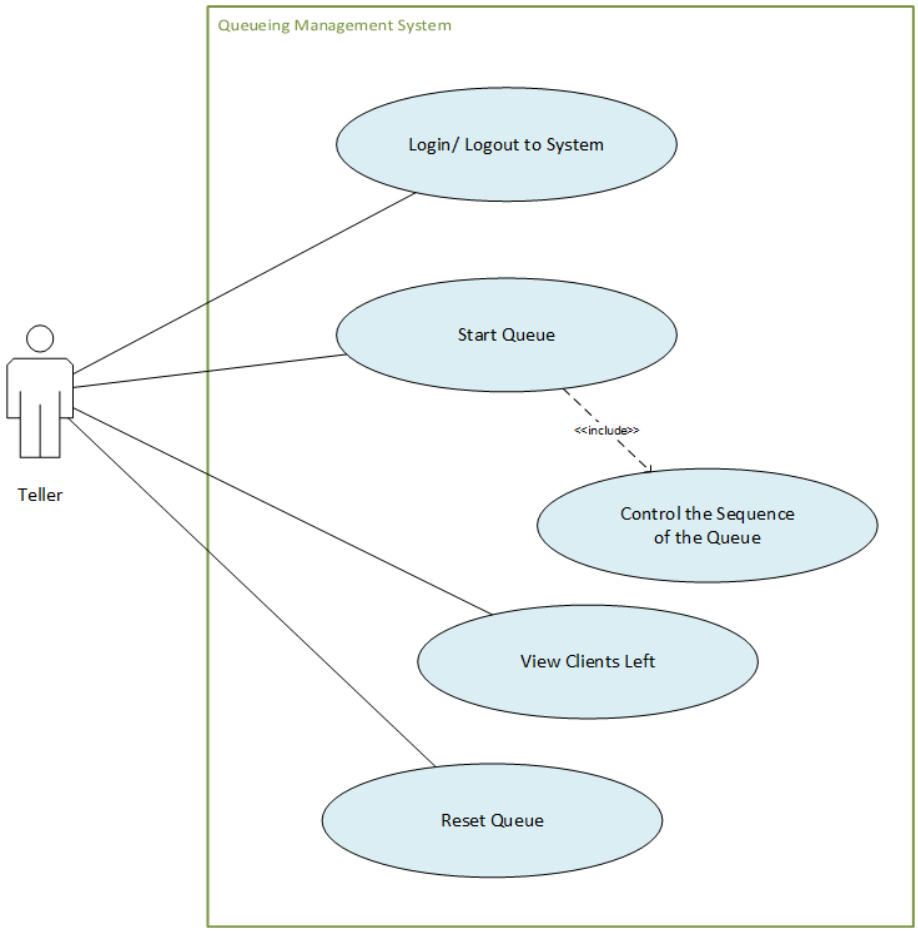


Figure 3 Use Case for Teller

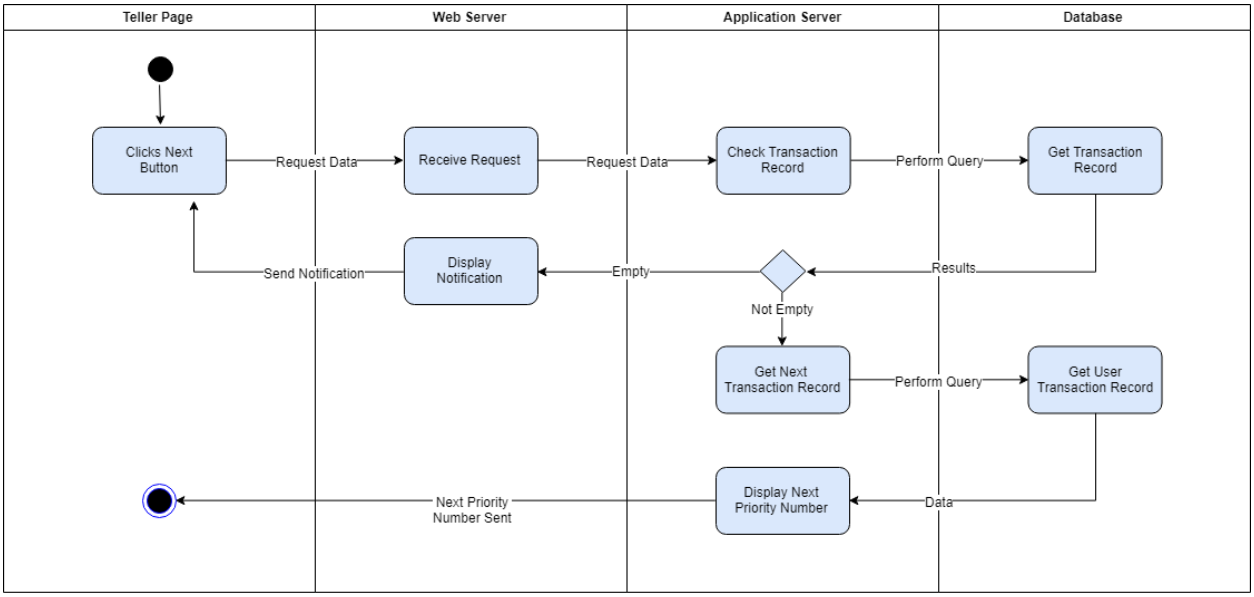


Figure 4 Activity Diagram for Start and Control Queue Sequence

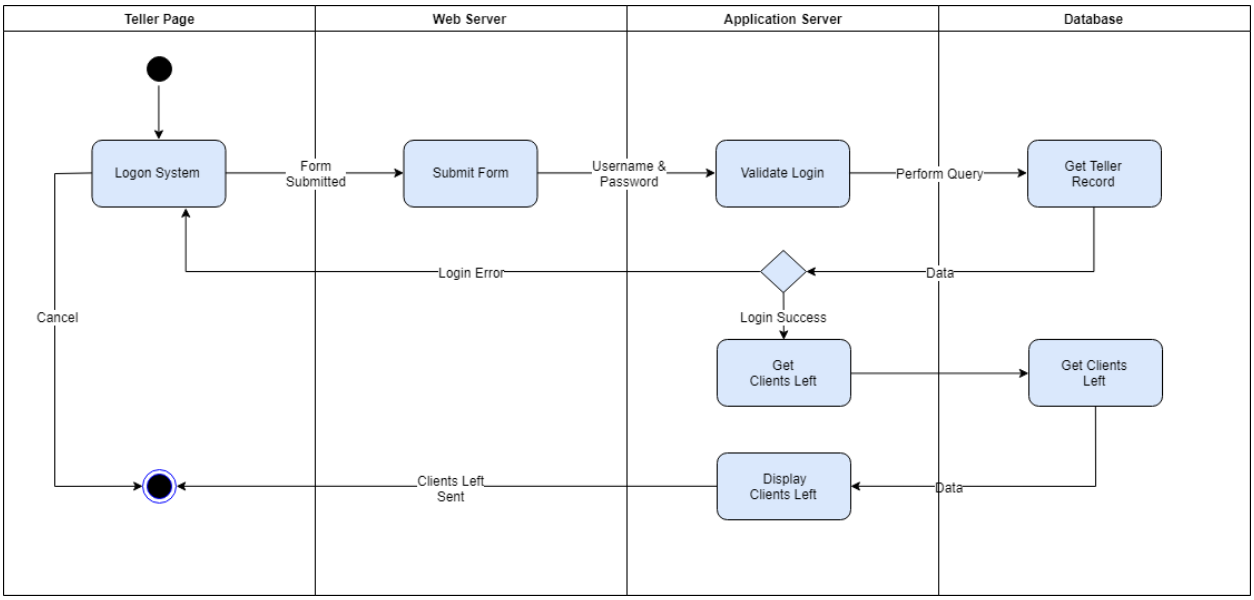


Figure 5 Activity Diagram for Viewing Clients Left

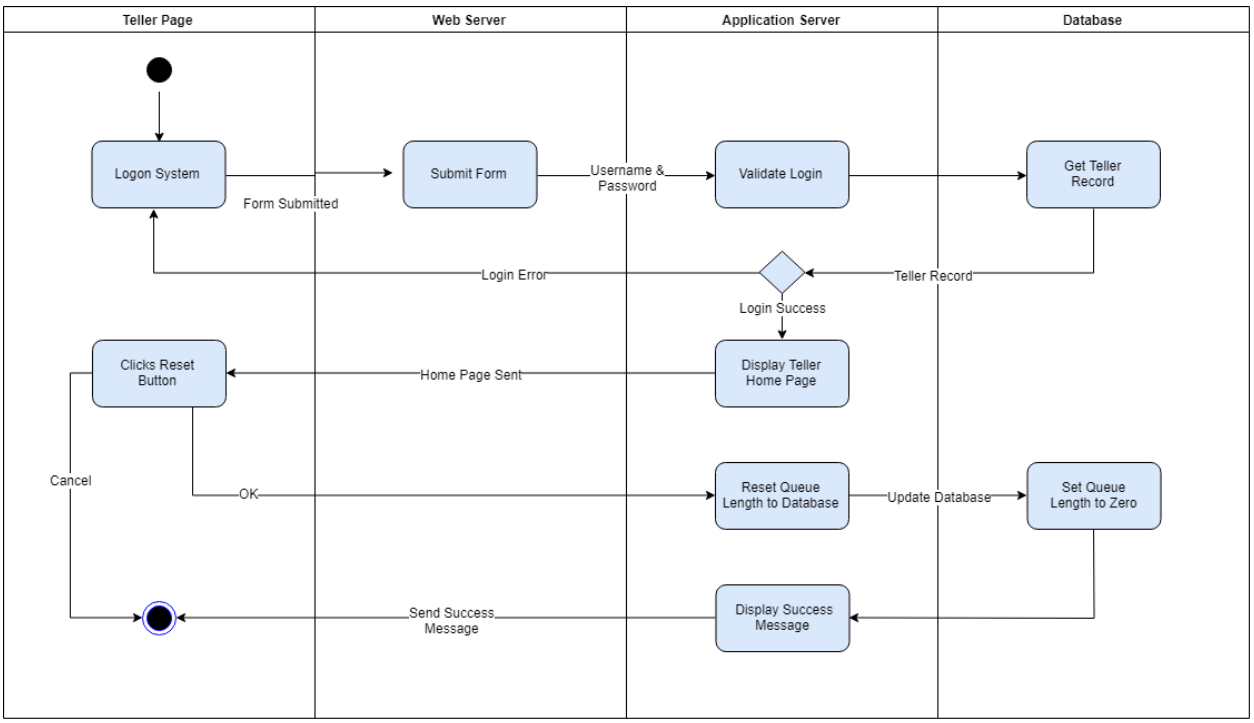


Figure 6 Activity Diagram for Reset Queue

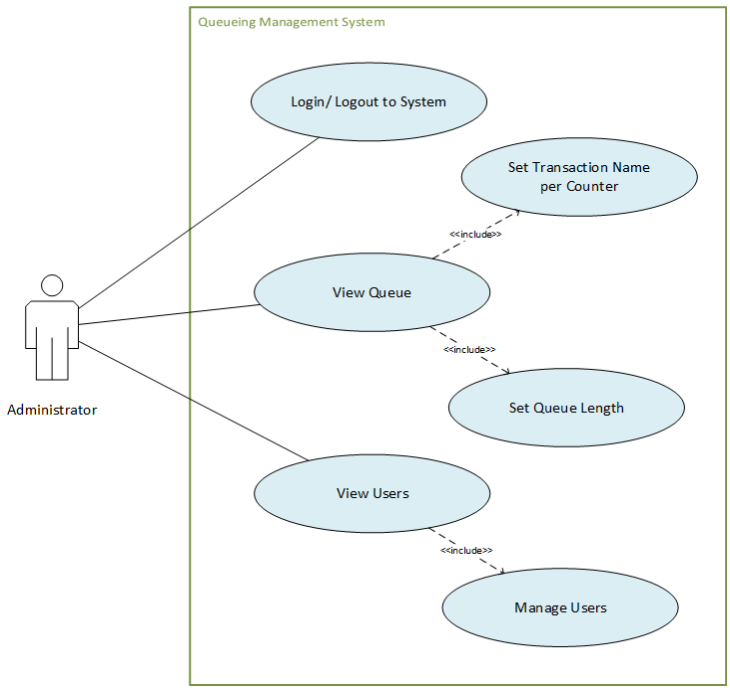


Figure 7 Use Case for Administrator

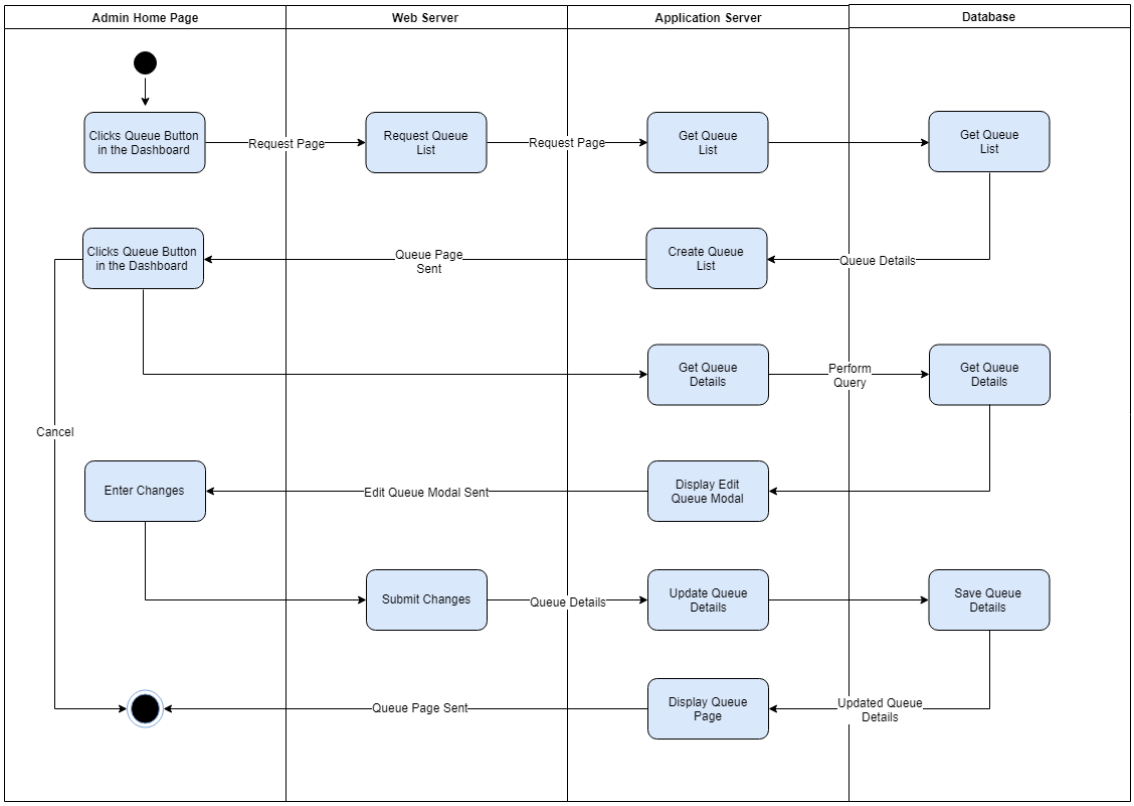


Figure 8 Activity Diagram for View and Edit Queue

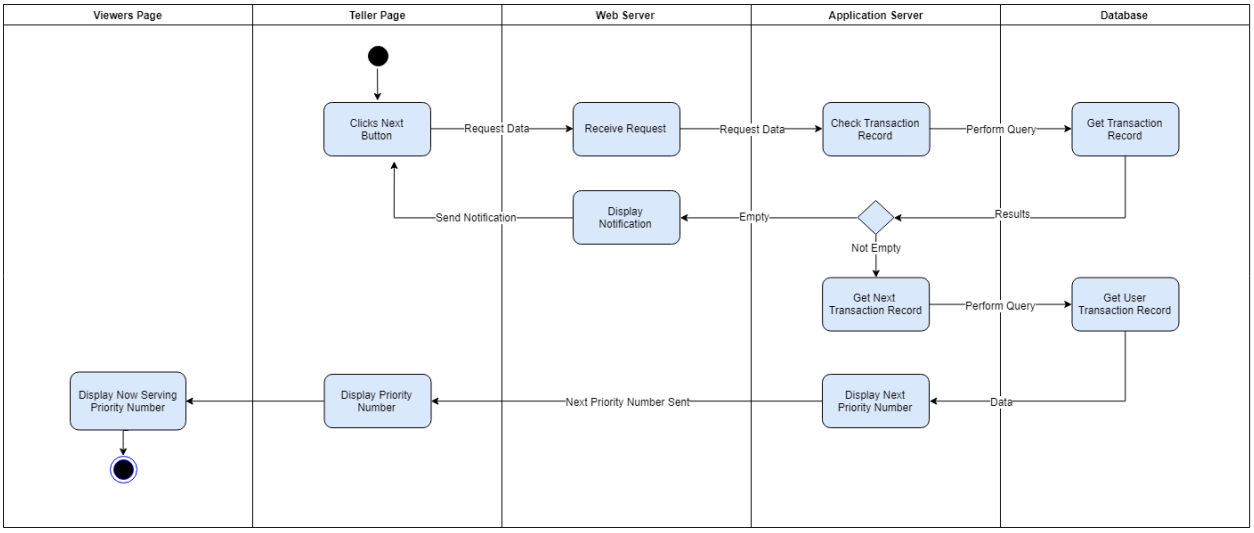


Figure 9 23 Activity Diagram for Now Serving Page for Viewers Waiting in Line

Appendix B

Application Design

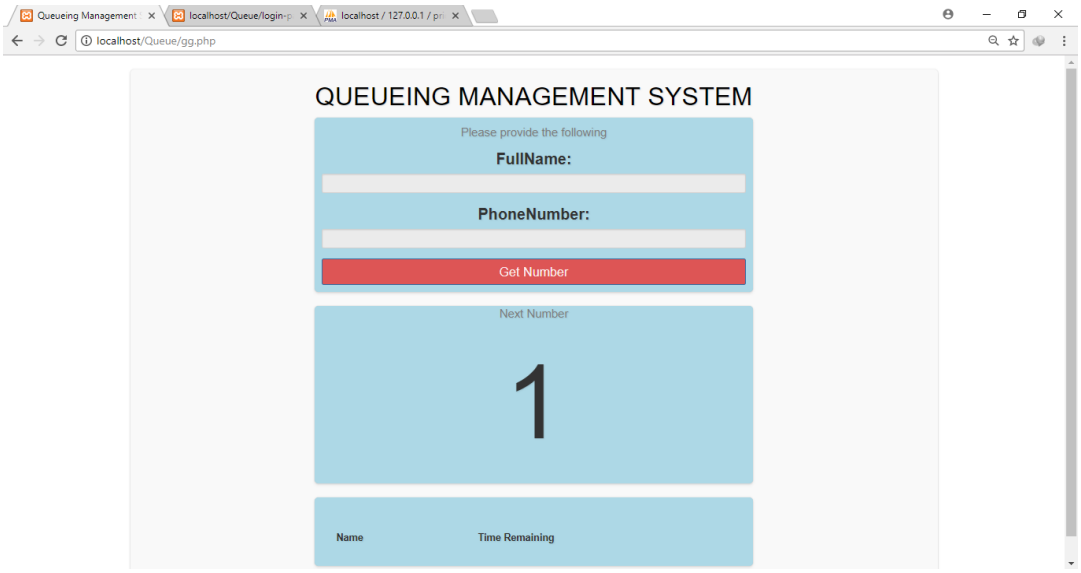


Figure 10 Customer Page of the Prototype

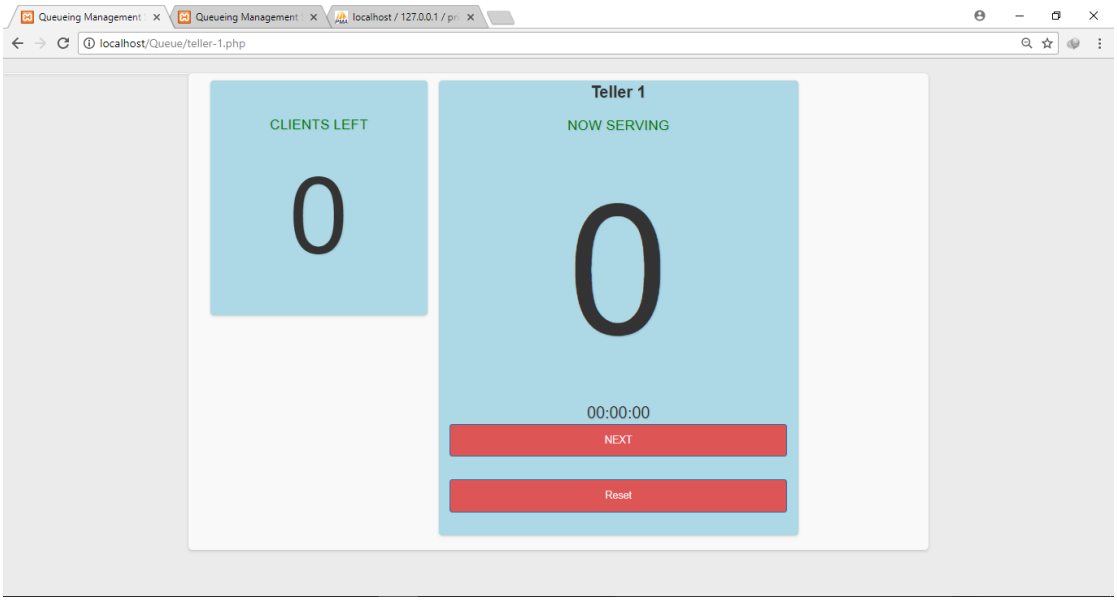


Figure 11 Teller Page of the Prototype

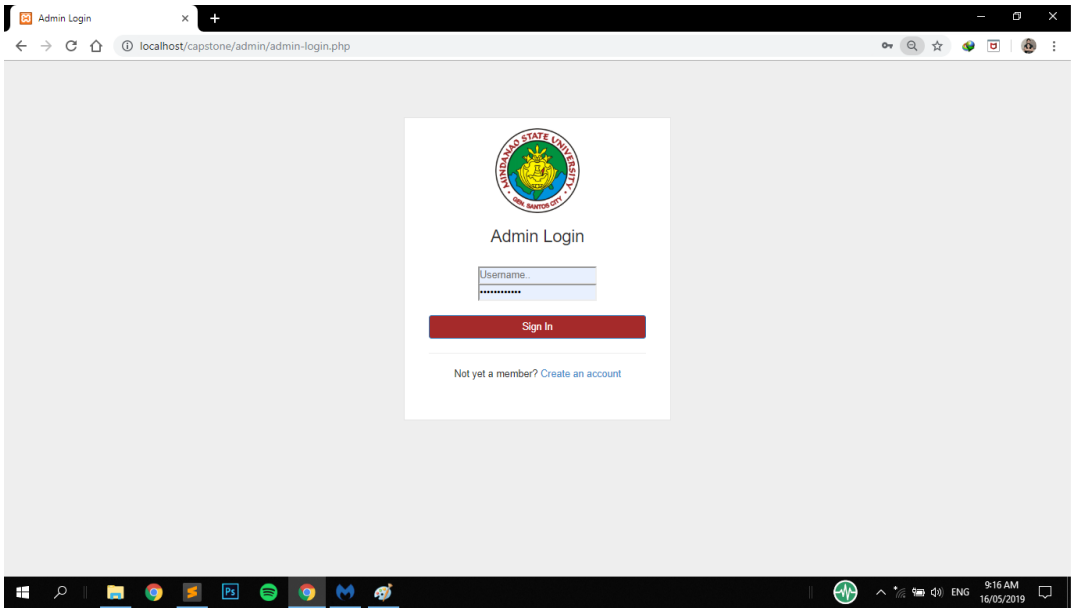
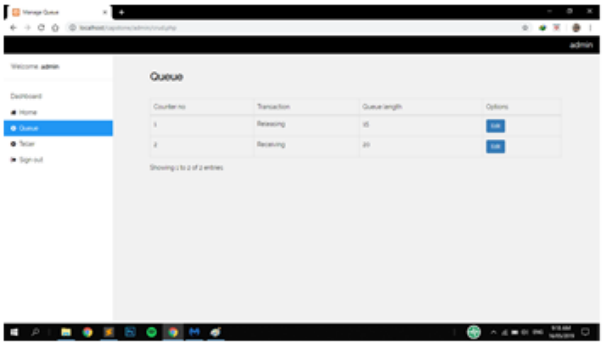


Figure 12 Admin Login Page



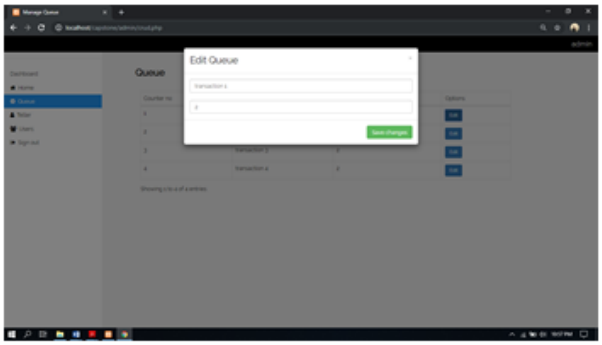


Figure 13 Admin View and Edit Queue Details

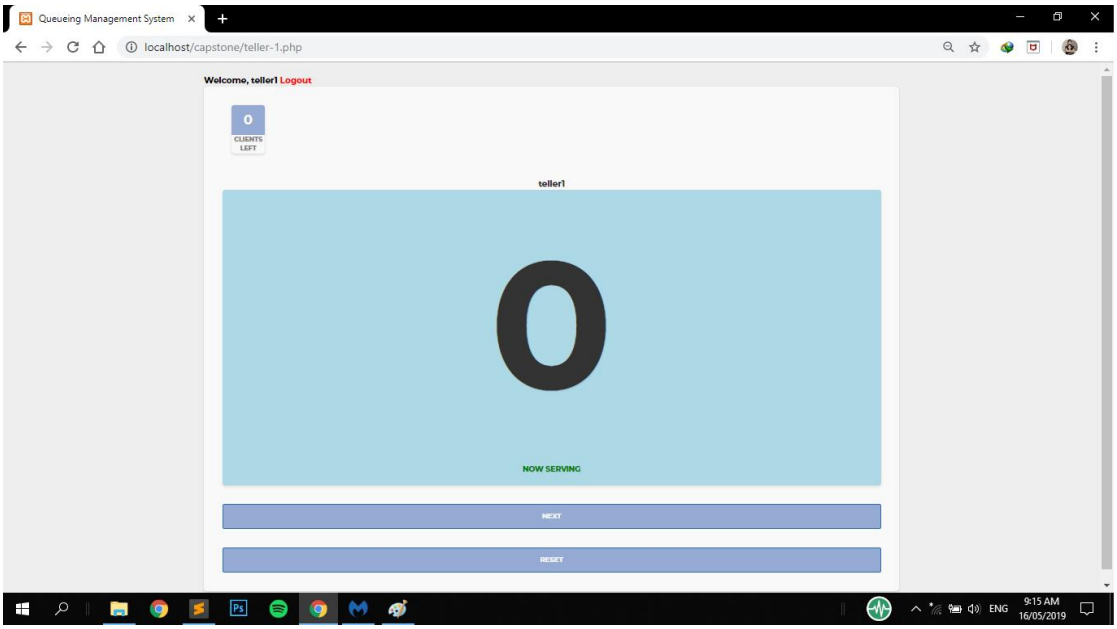


Figure 14 Teller Home Page

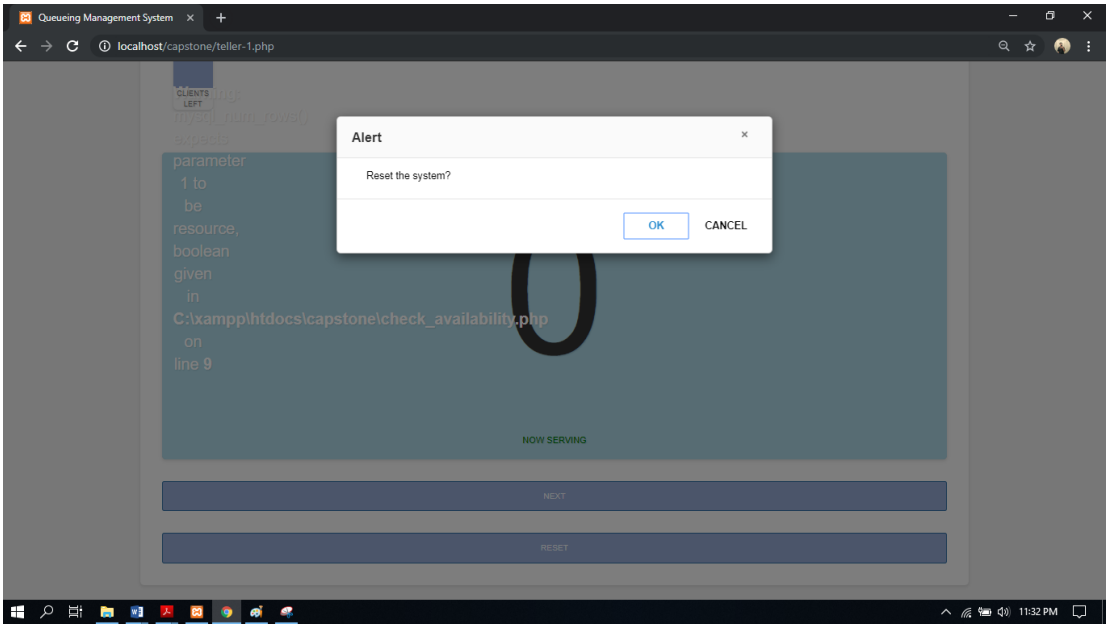


Figure 15 Teller Reset Queue Confirmation Alert

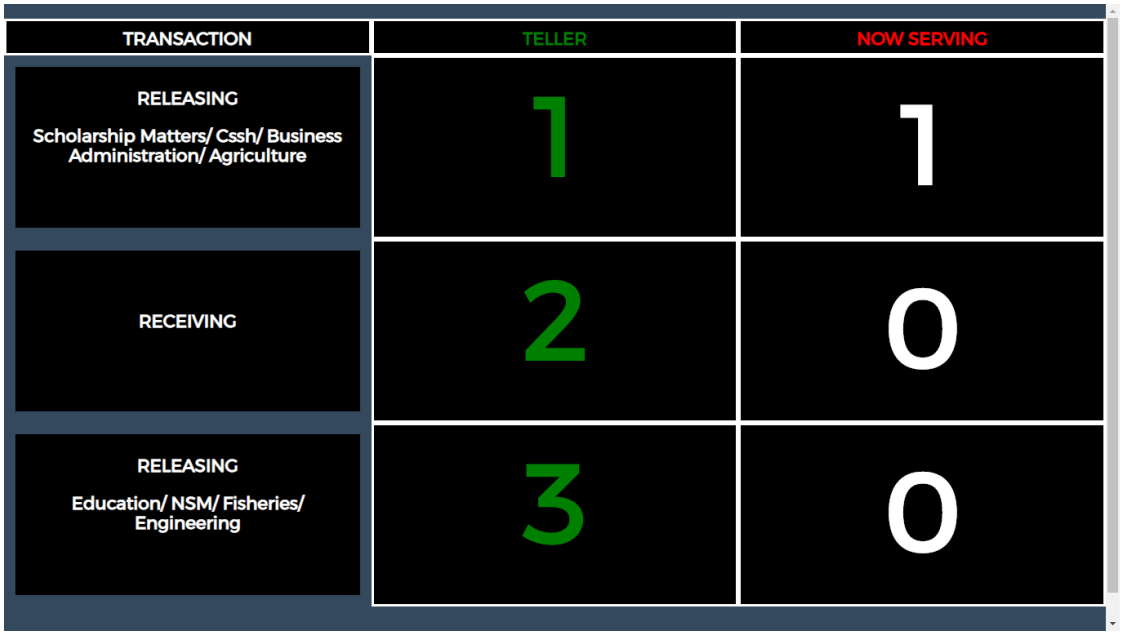
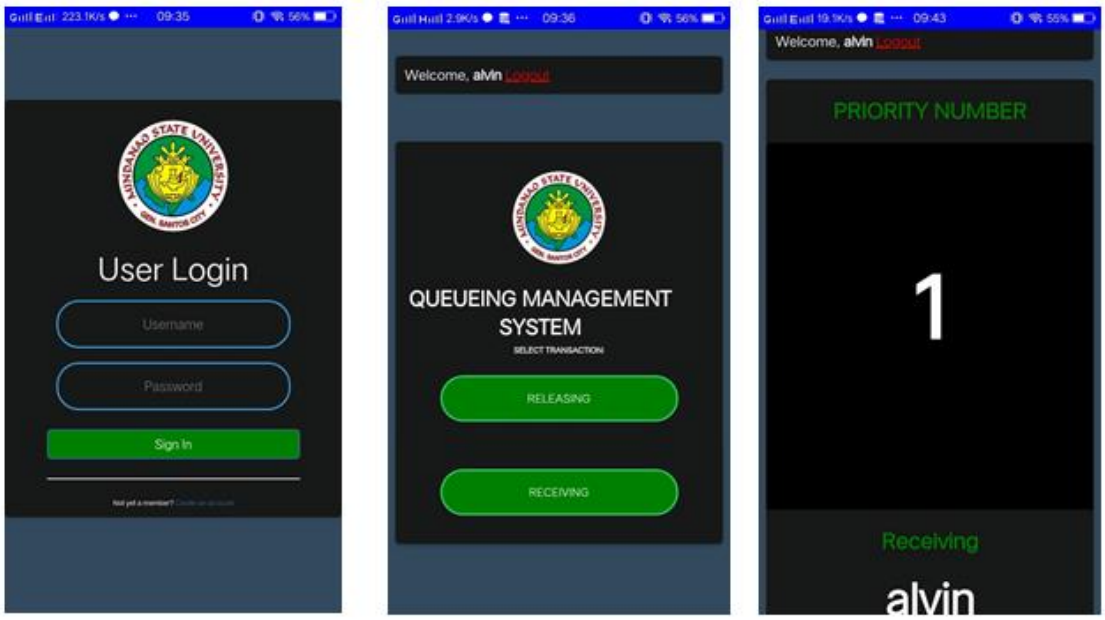


Figure 16 Now Serving Viewers Page



A **B** **C**

Figure 17 User Application Interface

Appendix C

Survey Questionnaire

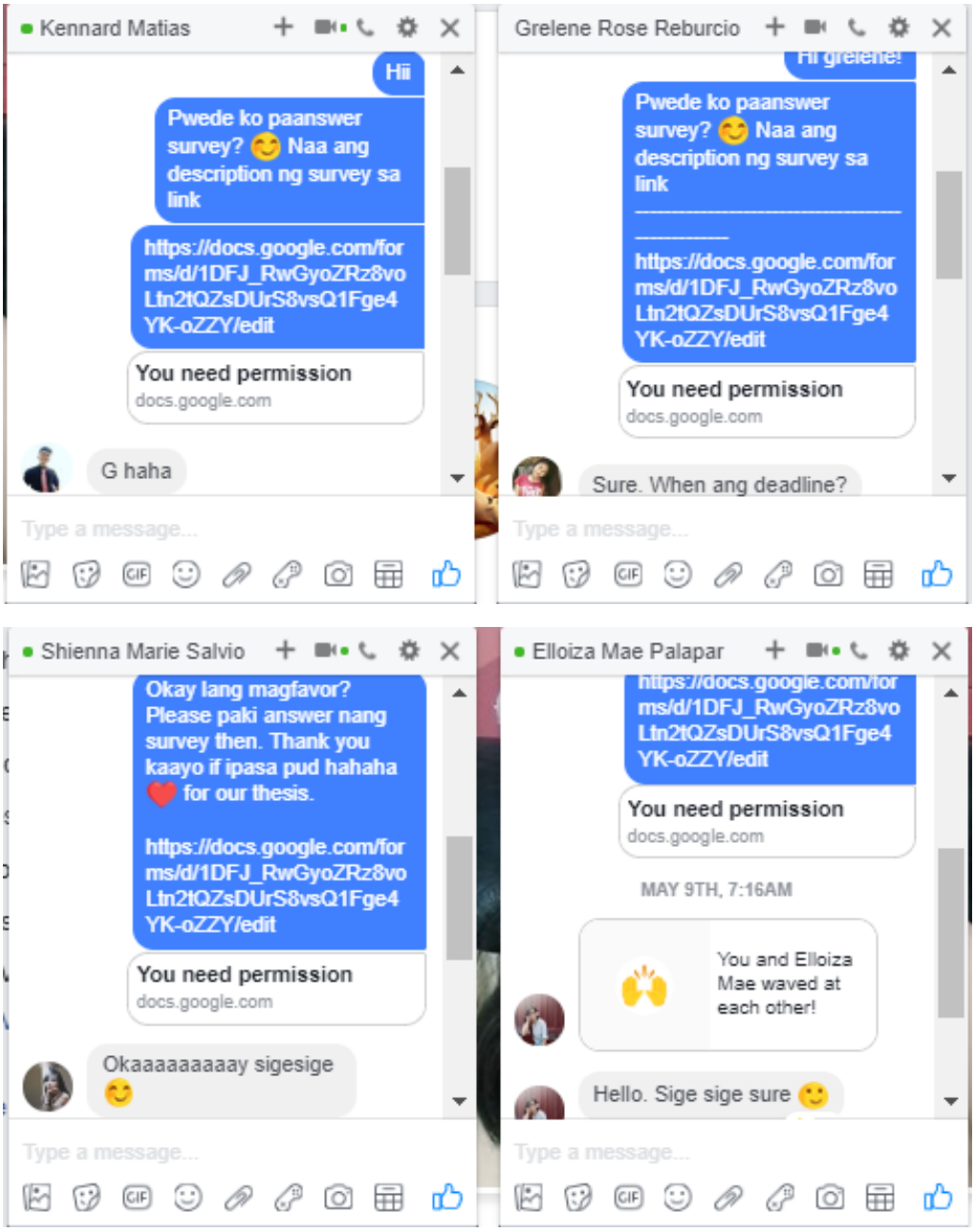


Figure 18 Survey dissemination through Facebook

Queueing Management System using Raspberry Pi

We third year students, pursuing a degree of Bachelor of Science in Information Technology is proposing to create a Queueing Management System using Raspberry Pi for Mindanao State University. The aim of this study is to develop a queue management system that will manage waiting lines in the university. For us to be able to do so, we need your help by answering the survey questions below. Thank you. (P.S. We collect email addresses for authentication only.)

* Required

Email address *

Your email

Name (optional)

Your answer

1. Do you experience waiting in long line during the enrollment? *

- ◯ Yes
- ◯ No

2. In what instance do you experience to wait in long line? (You may choose more than 1) *

- ☐ Encoding of Subjects
- ☐ Paying at Cashier
- ☐ Validation
- ☐ Other:

3. How long do you wait before you can be accommodated at the service counter (min/hrs)? (in other words "gaano ka katagal sa pila bago makapunta sa cashier etc.") *

Your answer

4. How long does the process take in the service counter? (in other words "gaano ba katagal magbayad sa cashier etc.") *

- ○ below 2 mins
- ○ 2 - 5 mins
- ○ 5 mins above
- ○ Other: _____

5. Rate the current waiting in line system for enrollment *

	1	2	3	4	5	
Poor	○	○	○	○	○	Excellent

6. What problems did you encounter in waiting in line for the enrollment? (You may choose more than 1) *

- ☐ Others cut in line
- ☐ no information regarding how long the wait will be
- ☐ possibility of service cut off while still waiting in the line
- ☐ waiting in long line requires time, effort and patience
- ☐ no estimation of how many students can be accommodated in service counters within office hours
- ☐ Other: _____

7. Do you like the idea of having a queuing system in the enrollment? *

- ○ Yes
- ○ No

8. Which way do you prefer in getting a queue priority number? (You may choose more than 1) *

- [ ] Printed Number
- [ ] Via SMS
- [ ] Via Number Tags
- [ ] Other: _____

SUBMIT

Appendix D

List of Respondents & Survey Results

Email
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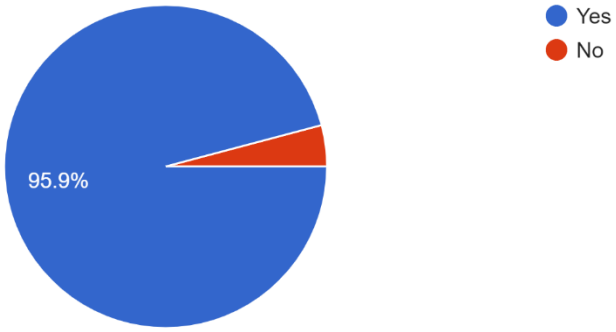
accarmona@yahoo.com
fjasilumii@gmail.com
ian.sunio123456789@gmail.com
fortaleza192@gmail.com
gelynmaecadungog@gmail.com
precyjanedipus@gmail.com
mycahnailon4@gmail.com
yashgilay@gmail.com
letroc123@gmail.com
beabae1111@gmail.com
mhounicmhounic@gmail.com
amanieadal@yahoo.com
aloysiushamac@gmail.com
ajohnrey15@gmail.com
acanadianarose@gmail.com
neggieniceabella14@gmail.com
judyflee24@gmail.com
nifaresayisab@yahoo.com

merlinabaldoka@yahoo.com
alvinjoshuasubere@gmail.com
daisyluzmonsalesreyes@gmail.com
lumingkit_sda@yahoo.com
doraemiejan@gmail.com
mayangmaring@gmail.com
genilo.terez@msugensan.edu.ph
beamsflores@gmail.com
pantonial.joshuajohn@yahoo.com
jirahcanilao@gmail.com
zoversalipodin01@gmail.com
bezaleltesta1025@gmail.com

nalamweenajoyce@yahoo.com.ph
rapunzelnavarro@gmail.com
lynette9543@gmail.com
butchlendio12@gmail.com
eyuylims@gmail.com
imjarrahpearl@gmail.com
theunrequieted@gmail.com
renspaba@gmail.com
badi.kassy@yahoo.com
patchh1248@gmail.com
aui@yahoo.com
novieann.ferro@msugensan.edu.ph
marielleabe17@gmail.com

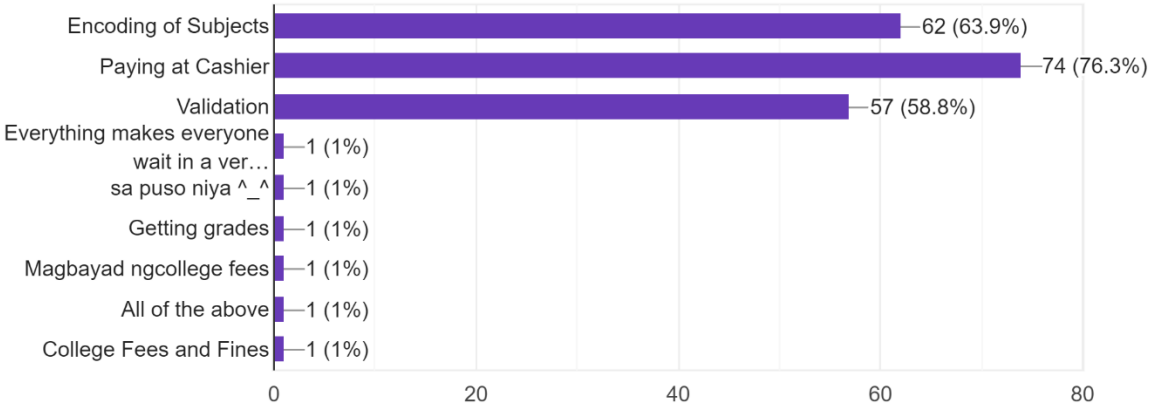
1. Do you experience waiting in long line during the enrollment?

97 responses



2. In what instance do you experience to wait in long line? (You may choose more than 1)

97 responses



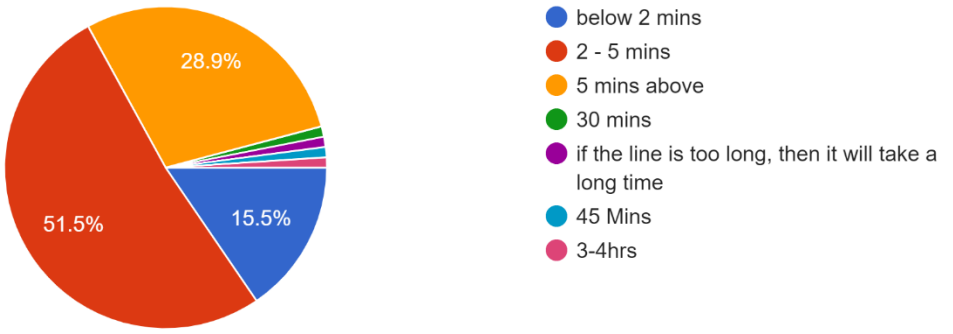
3. How long do you wait before you can be accommodated at the service counter (min/hrs)? (in other words "gaano ka katagal sa pila bago makapunta sa cashier etc.")

97 responses

HOURS
1 to 2 hrs
15min
20-30 minutes
7 hours
3p mins to 1 hour
It depends on the situation but most of the time it takes more than an hour.
30 mins - 1 hour
minimum of 4 hours
60+ mins.

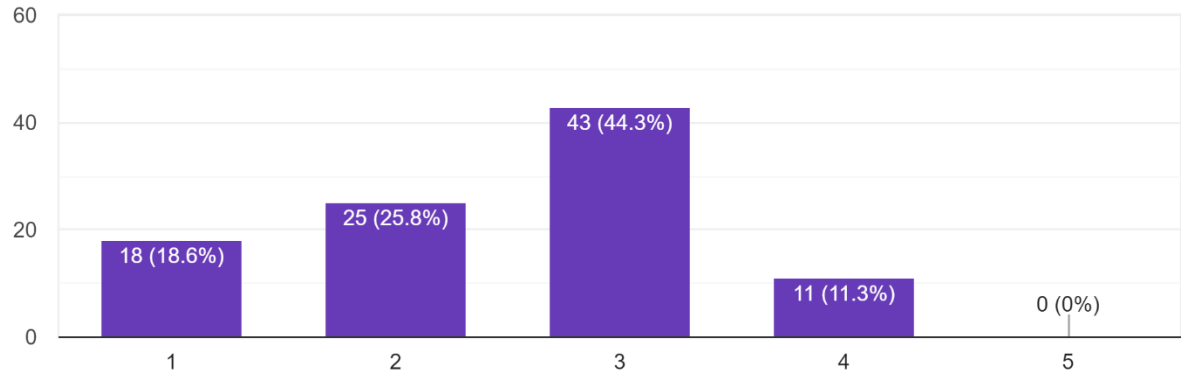
4. How long does the process take in the service counter? (in other words "gaano ba katagal magbayad sa cashier etc.")

97 responses



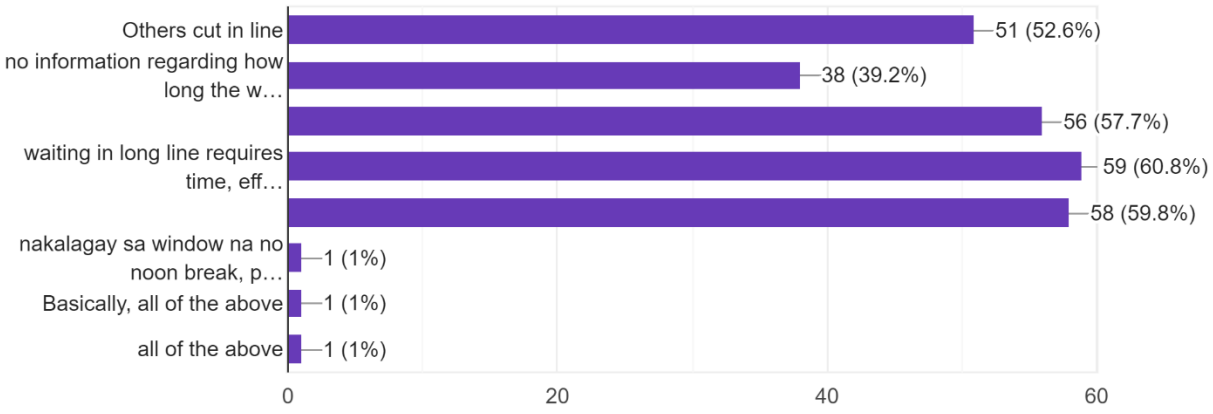
5. Rate the current waiting in line system for enrollment

97 responses



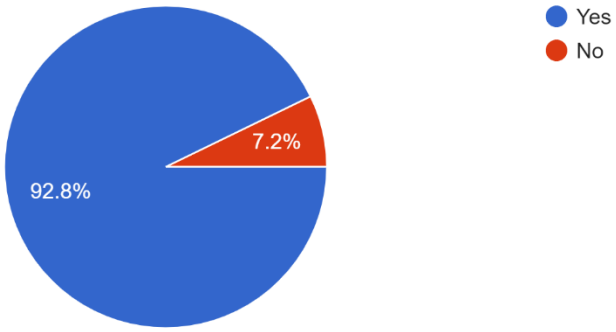
6. What problems did you encounter in waiting in line for the enrollment? (You may choose more than 1)

97 responses



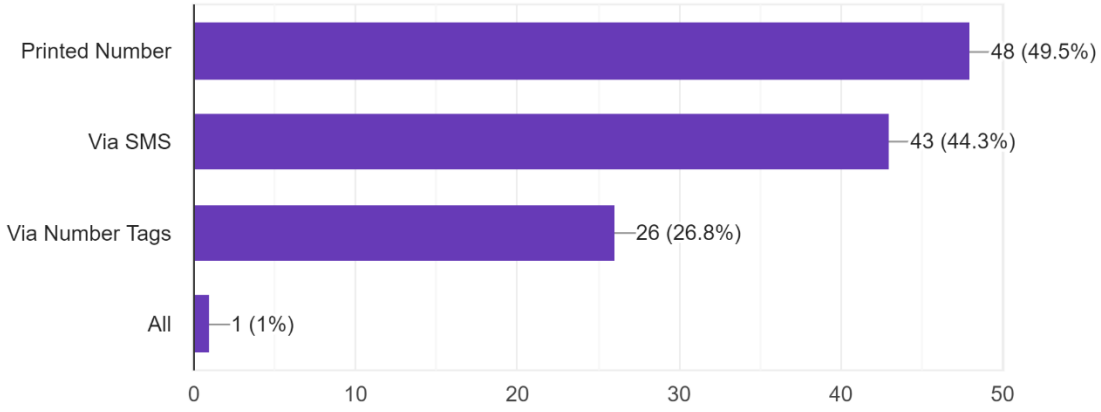
7. Do you like the idea of having a queuing system in the enrollment?

97 responses



8. Which way do you prefer in getting a queue priority number? (You may choose more than 1)

97 responses



Appendix E

User Test Questionnaire

Queueing Management Using Raspberry Pi– General Santos City

Name (optional): _____

Date: _____

Signature: _____

Position: ☐ Staff ☐ Student

The following questionnaire determine the level of acceptability, usability and intention to use this queueing management system. This is a Capstone project built by Alvin Joshua V. Subere, John Kyle O. Lastimosa and Adrian Ralph C. Taculod, who are taking Bachelor of Science in Information Technology at Mindanao State University - General Santos. Please indicate the extent to whether you agree or disagree with each of these statements by marking a check mark (✓) the scale provided. Thank you very much!

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Perceived Ease of Use	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1) Using the Queueing System is easy for me.							
2) I find my interaction with the use of the Queueing System clear and understandable.							
3) It is easy for me to become skillful at the use of the Queueing System.							
4) Overall, I find the use of the Queueing System easy.							

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Perceived Usefulness	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1) Using the Queueing System would enable me to accomplish my task more quickly.							
2) Using the Queueing System would make it easier for me to carry out my task.							
3) I would find the Queueing System useful.							
4) Overall, I would find the Queueing System to be advantageous.							

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Perceived Web Security	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1) I would feel secure sending sensitive security information to the Queueing System.							
2) The Queueing System Application is a secure means through which to send sensitive security information.							
3) I would feel completely safe providing sensitive security information about myself over the Queueing System Application.							
4) Overall, the Queueing System Application is a safe place for personal information.							

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Attitude	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1) Using Queueing System is a good idea.							
2) I would feel that using Queueing System is pleasant.							
3) In my opinion, it would be desirable to use Queueing System.							
4) In my view, using Queueing System is a wise idea.							

	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
Intention to Use	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1) I would use the Queueing System to get a priority number to a specific transaction.							
2) Using the Queueing System for reserving priority number.							
3) I would see myself using the Queueing System for waiting in line.							

Appendix F

Existing Queueing Systems Demo Screenshots

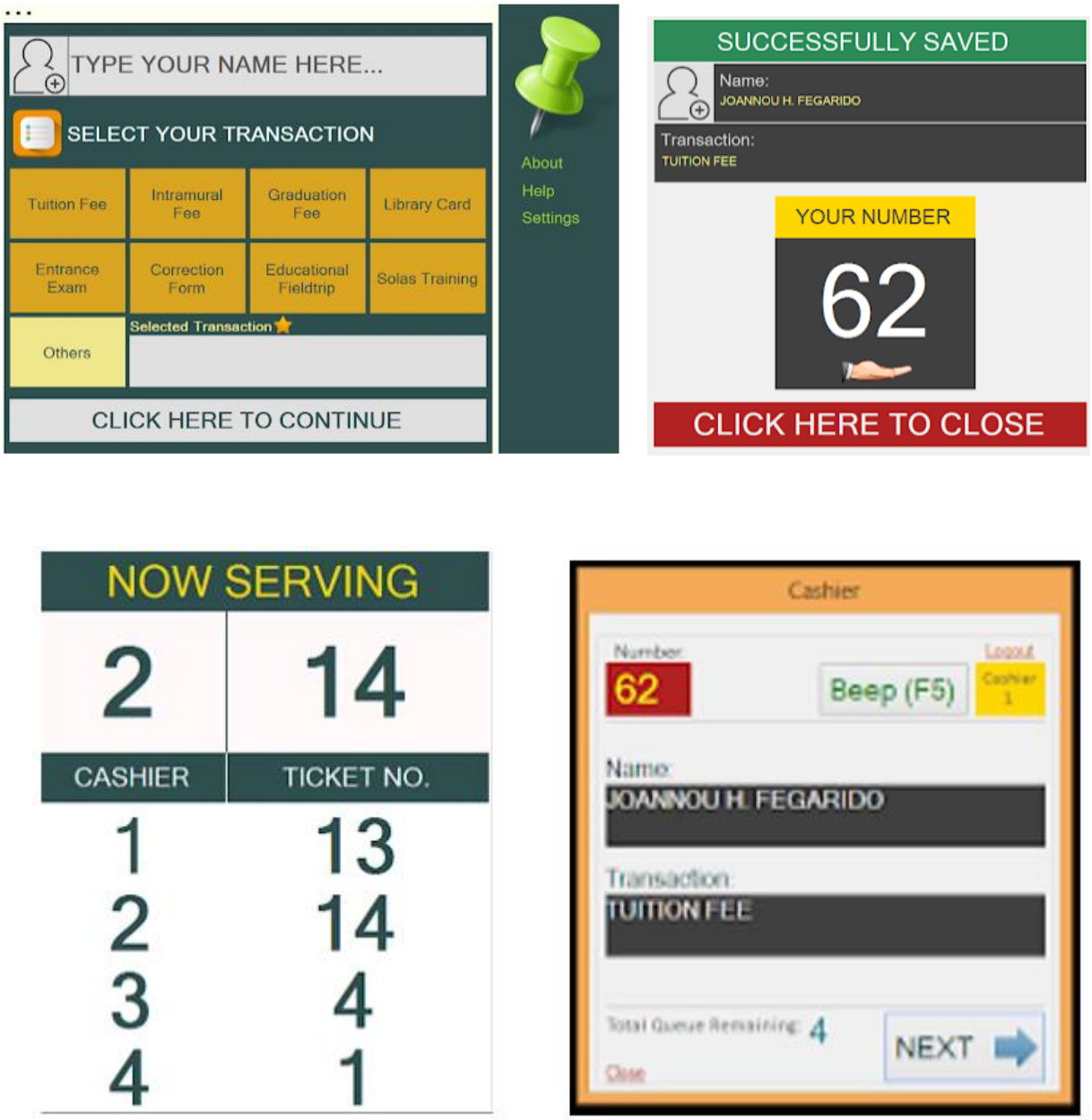


Figure 19 Teller Automated Queueing Numbering System Demo

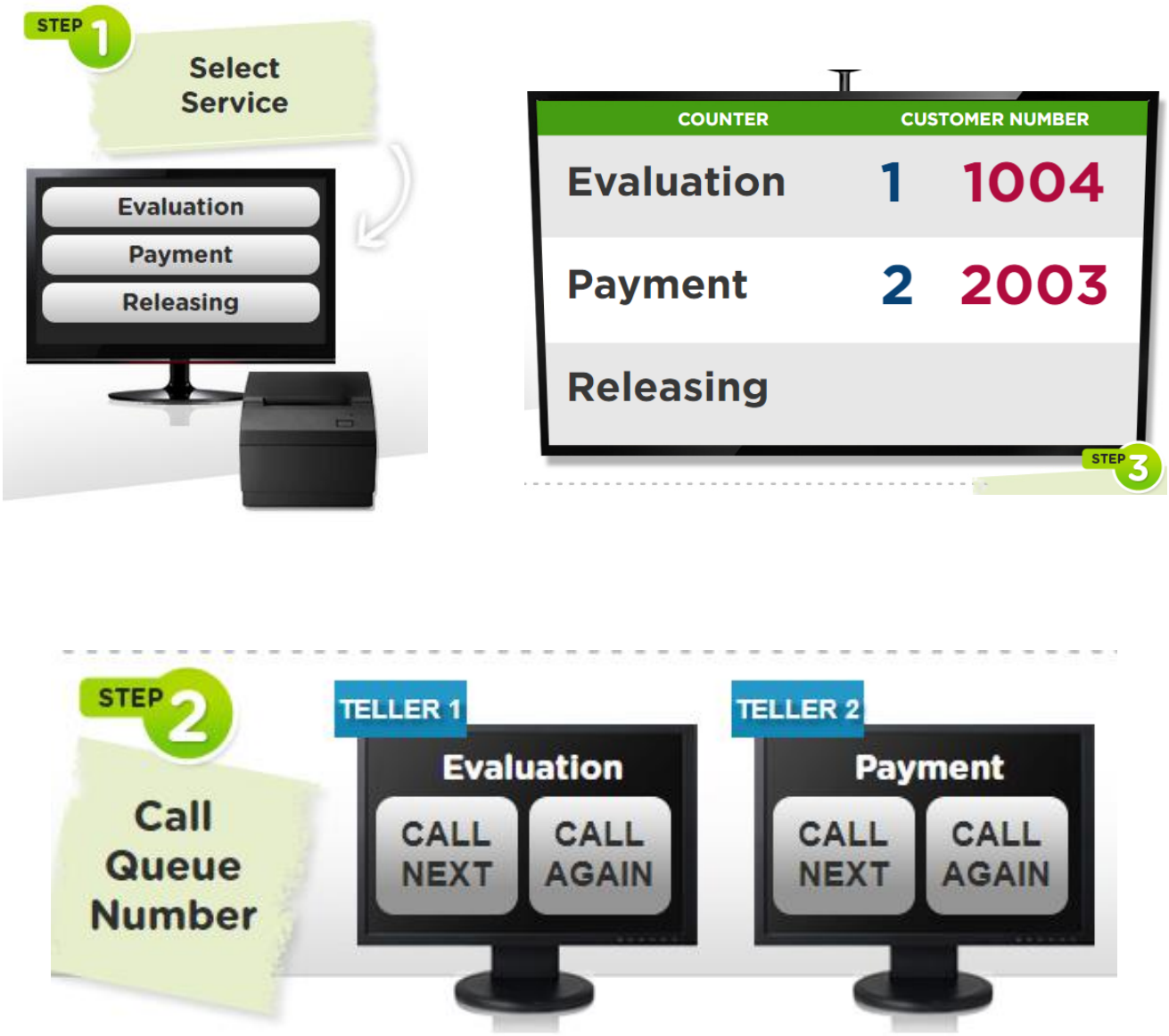


Figure 20 QueueRite System Demo

Figure 21 TotalQueue System Demo

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