

WAREHOUSE INVENTORY MANAGEMENT SYSTEM

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TECHNICAL REPORT

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Table of Contents

LIST OF TABLES.....	iv
LIST OF FIGURES	v
LIST OF Abbreviations	vi
ACKNOWLEDGEMENT	vii
	PREFACE viii
1.0 Introduction	1
2.0 Methodology	3
2.1.1 Requirements.....	4
2.1.2 Design	6
2.1.3 Implementation	16
2.1.4 Verification	20
2.1.5 Maintenance	20
2.2 Technologies Involved.....	20
2.2.1 Hardware Requirement	20
3.0 Result and Discussion	22
3.1.1 Login	22
3.1.2 Dashboard	23
3.1.3 View and Print.....	24
3.2 User Manual (Mobile Application).....	27
3.2.1 Login	27
3.2.2 Main Page.....	29
3.2.3 Warehouse Transfer	30
4.0 Project Design Consideration	36
5.0 PROJECT MANAGEMENT AND COSTING.....	38
5.2.1 Cloud Storage.....	40
6.0 Conclusion	41
References.....	43
Appendix A.....	44

LIST OF TABLES

Table No.	Title	Page
2.1	Barcode Descriptions	18
2.2	NuGet packages	19
2.3	Requirement to run the system	20
2.4	Requirement to develop the system	21
3.1	Mobile user manual (login)	27
3.2	Mobile user manual (main page)	29
3.3	Mobile user manual (Warehouse Transfer)	30
3.4	Mobile user manual (Scan barcode)	32
3.5	Mobile user manual (Items List)	34
5.1	Project costing	39

LIST OF FIGURES

Figure No.	Title	Page
2.1	Waterfall model	3
2.2	Framework of the system.	5
2.3	Mind map of Barcode Inventory System	6
2.4	Entity	7
2.5	Cardinality	7
2.6	ER diagram of Warehouse Inventory Management System.	10
2.7	Flowchart of Login Module	12
2.8	Flowchart of System Main Page Navigation module	13
2.9	Flowchart of Inventory Sub Menu Navigation module	14
2.10	Flowchart of Login, Main Page and Browse Item modules	15
2.11	Visual Studio Community IDE 2019	16
3.1	Login screen	22
3.2	Error message for Login Form	22
3.3	Dashboard	23
3.4	Inventory options	24
3.5	All Inventory Barcodes	24
3.6	Inventory category options	25
3.7	Save table format icons	25
3.8	Save option	25
3.9	View PDF	26
3.10	View Excel	26

LIST OF Abbreviations

Abbrev	Description
IDE	Integrated Development Environment
SQL	Structured Query Language
JSON	JavaScript Object Notation
URL	Uniform Resource Locator
EAN	European Article Number
ERD	Entity Relationship Diagram

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Firstly, we want to extend our thanks to Universiti Malaysia Perlis (UniMAP) and the School of Computer and Communication Engineering (SCCE) for giving us such an opportunity that allows us to practice the knowledge we had gained throughout the years of study by implementing it in a real-life situation of problem solving.

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PREFACE

Inventory Management System is important to ensure everything is in order when handling huge amounts of materials and its quality within huge facilities such a factory's warehouse. It is important to keep track of fluctuation of incoming and outgoing materials that happen daily for these facilities. It is also a useful tool to monitor the shortage of materials which may affect the production rate of the factory. The problem at hand is that the current inventory management being used is time consuming and difficult.

One way to do such inventory management is by having a Windows Form application system with C# language that can instantly track and update the information on materials. The objective is to provide a better management system that is better and have more functionality compared to the previous system being used. To achieve this, the scope of this project is to focus on the aspects such as to make, delete inventory, add new inventory, keeping track of inventory materials, supplier and order. This information will be stored within the database. This also allows to alert when materials are running low.

In developing the system, Waterfall development method is chosen. Firstly, a mind map is drawn to group and arrange each function. Before the next process will begin, each step must be fully fulfilled. This makes it easier to focus on the flow in achieving the project scope. The expected result of the system's user interface will be user-friendly which will enable even people with no IT background to be able to handle it easily. The system is also expected to serve its functionalities and reduce the workload of the inventory management.

1.0 Introduction

Inventory Management is one of the essential parts of the organization. Inventory management is the process of efficiently monitoring the constant flow of units into and out of an existing inventory this is because inventory management can help to minimize costs and improve productivity. A car manufacturing business involves a continuous flow of material and supplies to keep up with demands. These simple methods require three steps, which are determined when the material is obtained and added to the inventory, by comparing the receiving quantity to the previous on-hand balance, when the material is removed from the inventory, another new balance is determined by deducting the quantity removed from the quantity on hand before removal.

From time to time, it may be found that the recorded on – and the balance differs from the quantity on hand for a variety of reasons. In these instances, the recorded are changed by adding, as necessary to the on-hand balance either by subtracting or hanging from it. To prevent the flow disturbance, most try to keep track of the quantities of the element on hand. Though, as the number of inventories increases and the rate of material flows either into or out of stock increases, it becomes hard to track the inventories. If this situation occurs, it takes some sort of record keeping.

Typically, record-keeping requires many individuals. When we are dealing with all these things, it introduces extra expenses in recruiting new workers, and meanwhile the company faces certain risks created by carelessness and employee mistakes. And it will also take some time to handle all the Inventory Management operations. Our project purpose is therefore to build a Barcode Inventory System Barcode, in its simplest form, is a set of bars and spaces representing alphabet or numeric data for identification of a particular product, service or a process. Barcode technology is the best-known and most widely used method of Automatic Identification This will improve stock management efficiency by using a barcode scanner, provide well-being manpower in monitoring inventory availability with auto featured function, and manage inventory successfully by automatically sending the order to the supplier when the stock is below the reorder point.

1.1 Problem Statement

One of the main problems involving a manufacturing company is having too much product in inventory or too little on hand as this will cost them money and consequently, profit. When there are low in stock this will push back all the production resulting in low profits and delay the production. While overstocking is just as harmful understocking as it occupies space in the warehouse. The contrast of overstocking is when manage stock that are high in demand. There are some seasons in every year where company receive higher demand of new car to be manufactured. Buying work in progress item in larger lot and holding inventory is found to be cheaper for the company than buying frequent small lots. In such cases one buys in bulk and holds inventories at the plant warehouse.

Sometimes it takes time to acquire and to keep track of all the inventory in warehouse and on request, especially for big company with growing size of inventory. Besides from inventory, others information that are also very important such as supplier's information, manage order, and car manufacturing process also required huge paper works.

When we are doing the management manually, a very critical problem that every mankind cannot

be avoided is carelessness. It is normal for human to make mistakes, but it will cost company significantly in a long run. There are many factors that may influence and decrease the employee's performance during their workday. Factors such as fatigue, emotional stress, multitasking, and so on. Therefore, inaccurate data might be recorded manually. Wrong calculation or typo error could mean losses or extra expenses that need to bear by company.

1.2 Objectives

The purpose of this project is to provide a better management system that will be better and have more functionality compared to the previous system being used which was quite time consuming and had limited functions to its user. The objectives include:

1. To ensure stable inventory supply for automotive manufacturing assembly station, therefore control overstocking and low-volume stock.
2. To provide proper functions in inventory management system including material, suppliers, and order information in a user-friendly database system with reduced time.
3. To ensure accurate data recorded in database and able to generate accurate reports.

1.3 Scope of project

This project is subjected to several scopes that will work like a guideline on how the project is conducted to ensure it will be able to achieve the targets, the aspects are as the following:

- i. To ensure stable inventory supply for automotive manufacturing assembly station.
- ii. To record the inventory and the details of the inventory including the material, supplier, order, and each of this information shall be stored within the database.
- iii. To display the material information and supplier information in an organized manner.
- iv. To send alerts when the inventory levels are low available and allow the option to order more material.
- v. To give alert for inventory which are in high demand by assembly line at the moment.
- vi. To be able to trace history of every record, including car manufacturing record, purchase order, warehouse transfer.

The aim is that by achieving these aspects will allow it to be implemented within the company to assist the inventory manager record the inventory.

2.0 Methodology

This part will explain about the procedure and methodology of The Inventory System. Firstly, the flow of the project is created to make it easier for planning methods of the project for which we used *Waterfall Development Method*. The mind map was drawn initially to group and arrange each function. Next, the requirements and problems being faced are discussed along with design specifications and the implementations. Then, the hardware requirements for the application and development of the system are specified. The Gantt chart is presented as the guideline that provided a graphical illustration of a schedule that helped to plan, coordinate, and track specific tasks in this project. All the information and theories are collected for several sources including journals, previous research, internet and with the guidance from supervisors.

2.1 Waterfall Development Method

This method is the most traditional *Software Development Life Cycle (SDLC)* which is a strict linear model consisting of sequential phases with an emphasis on distinct objectives. Before the next process will begin, each step must be fully fulfilled. This means that any phase in the development process only begins if the previous phase is completed. There is normally no mechanism to go back to the previous phase and modify the project and direction.

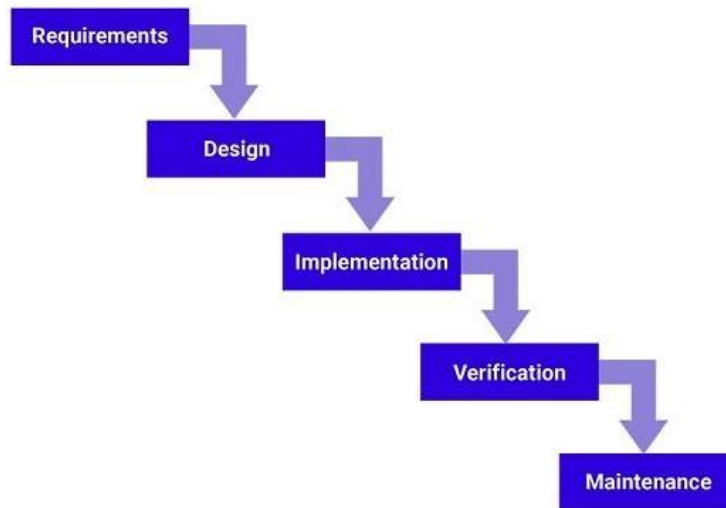


Figure 2.1. Waterfall model

2.1.1 Requirements

By understanding the current requirements and problems faced by automotive warehouse, we refer to one of automotive manufacturing warehouse in Malaysia which is located at Kulim, Kedah. We gathered the requirements by doing research through the background of automotive manufacturing and how they operate. We also discussed with supervisors about the ideas:

- Functions the software will need to address (Problems)
- Functions the software will resolve (Solutions)
- Function the users might also desire (Extra Features)

From the discussion, we were able to list down several points that will be able to satisfy the ideas above, which are:

1. Problems

- The ability to generate, edit scan and check information of item
- The ability to keep track of current location of a certain item

2. Solutions and extra features

- The ability to generate, edit and delete barcodes that contain information of item.
- The ability to view, edit and delete the information of warehouse.
- The option to view, edit and delete the information of suppliers and monitor supplies from around the world and track ongoing orders including invoice history.
- To monitor the transport of items that go into and out from the warehouse including the information on user who is current in possession of that item.
- Being able to keep track of current supply of items and the ability to place an order for items that are running low.
- The ability to manage the hierarchy of the users that will be able to access the system, user from a certain department will not be able to interfere with supplies of another department.

2.1.1.1 Framework of the System

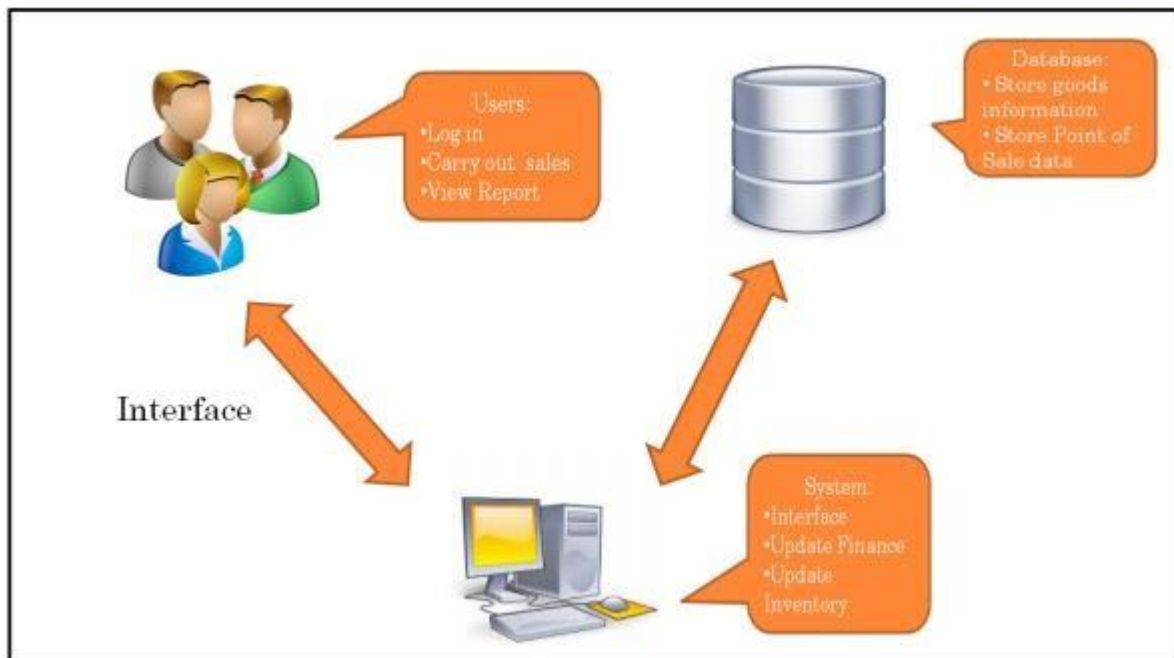


Figure 2.2. Framework of the system.

The users of the system include:

- Any employees of automotive manufacturing company who can access to this desktop system to modify information of goods.
- Any employees of automotive manufacturing company who can download the mobile application to scan barcode and browse inventory information, perform warehouse transfer.

The system includes:

- A user-friendly interface.
- A database to store all information.

User can interact with the system by using the provided interface. System will process inputs from user, prompt and store the inputs to database.

2.1.2 Design

Design phase include logical design and physical design. Logical design is the abstract representation of how data flow, inputs, and outputs. During this process all potential device specifications to be created are being sketched out using tools such as MindMeister for mind map, MySQL Workbench for Entity Relationship Diagram (ERD) and flow chart for overall system flow. The physical design such as data storage server and network hardware.

2.1.2.1 Mind map

A mind map is a schematic which is used to arrange knowledge visually. A mind map is bureaucratic and displays interspecies of the entire system. The center of the mind map is the main title of the project, followed by name of modules and functionality of each module. Refer to appendices for mind map.



Figure 2.3. Mind map of Warehouse Inventory Management System

2.1.2.2 Entity Relationship Diagram (ERD)

An entity-relationship model defines interrelated matters of concern in a specific information domain. An ER model is composed of types of entities and specifies the possible relationships between entities. An ERD contains entity and different cardinal relationships that represent different functions, which act as connectors to connect the entities together. The ER diagram for the project was drawn in Crow's Foot notation. Refer to figure 2.6 for complete ER diagram for the system.

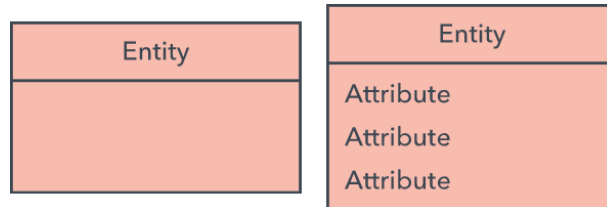


Figure 2.4. Entity

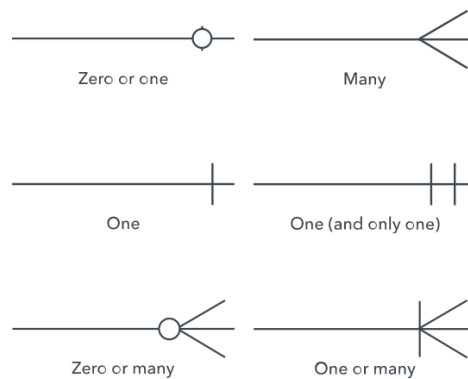


Figure 2.5. Cardinality

2.1.2.3 Devices

The devices used are PC which act as a main device that can access to all function of the software and smartphones which only used for scan barcode, review items information and perform warehouse transfer operation. To scanning barcode, a webcam was used during the development and a smartphone is used to test the system for application by user.

2.1.2.4 Flow Chart

A flowchart is a kind of diagram that shows a procedure or process flow. A flowchart can also be defined as a diagrammatic representation of algorithm, a process approach to resolving a task. The flowchart shows the steps as different types of boxes, and their arrangement by linking the boxes with arrowheads. This diagram showing a model of solution to a perceived task.

The flowchart is used to plan and log basic systems or processes. Unlike certain types of graphs, they also explain what is going on and therefore better clarify a procedure and may even reveal aspects that are less apparent in the design, such as defects and bottlenecks. Different styles of flowcharts exist, each style has its own collection and annotations. The flowchart below shows how each form works alongside with button function.

Desktop Application:

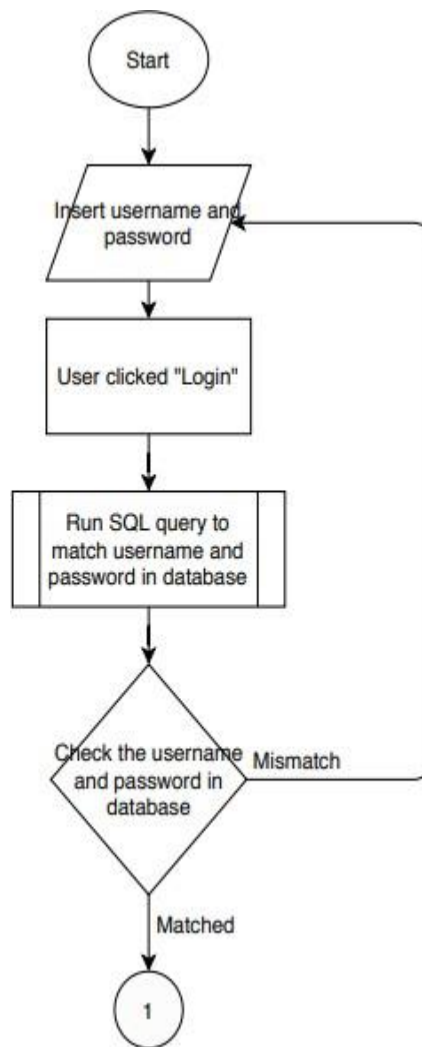


Figure 2.7. Flowchart of Login module

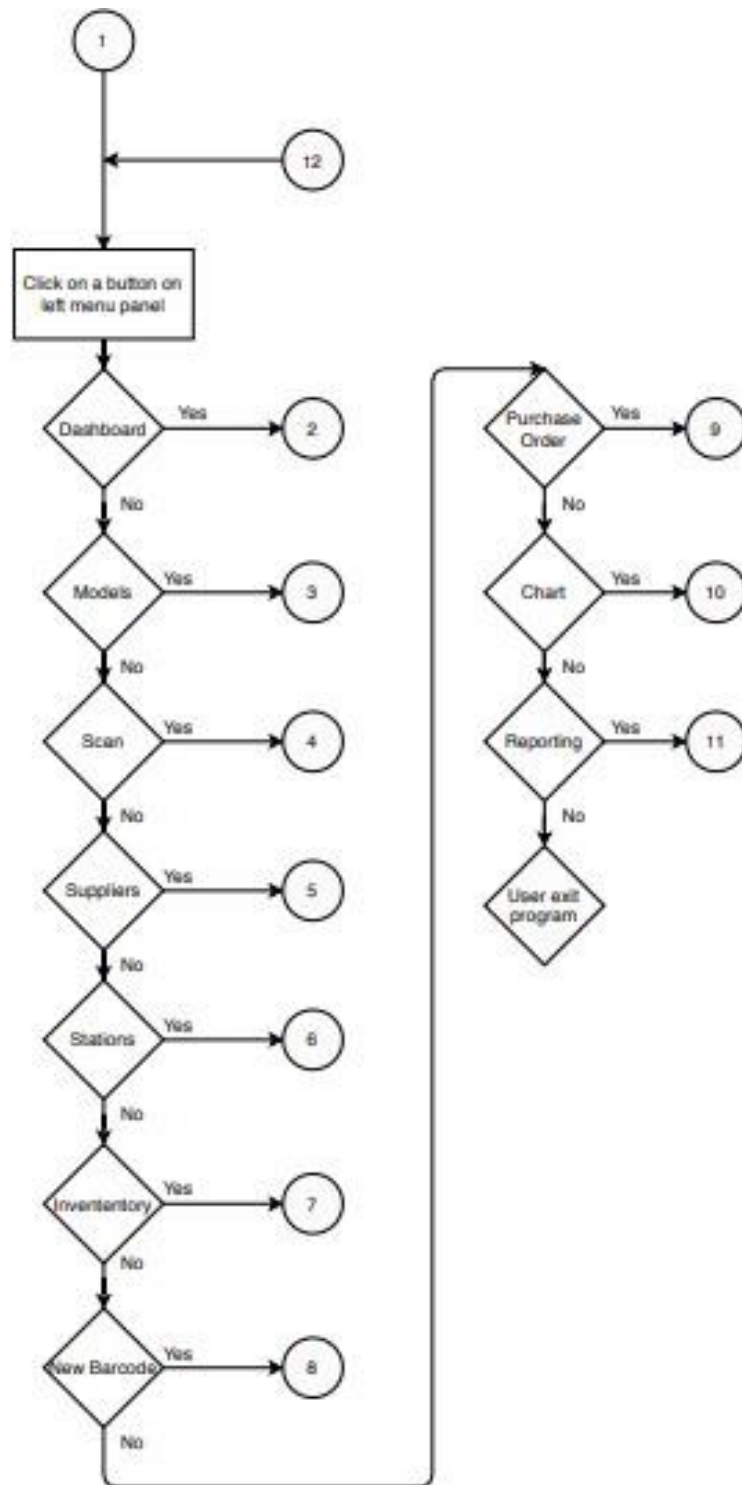


Figure 2.8. Flow chart of Main Page - Navigation

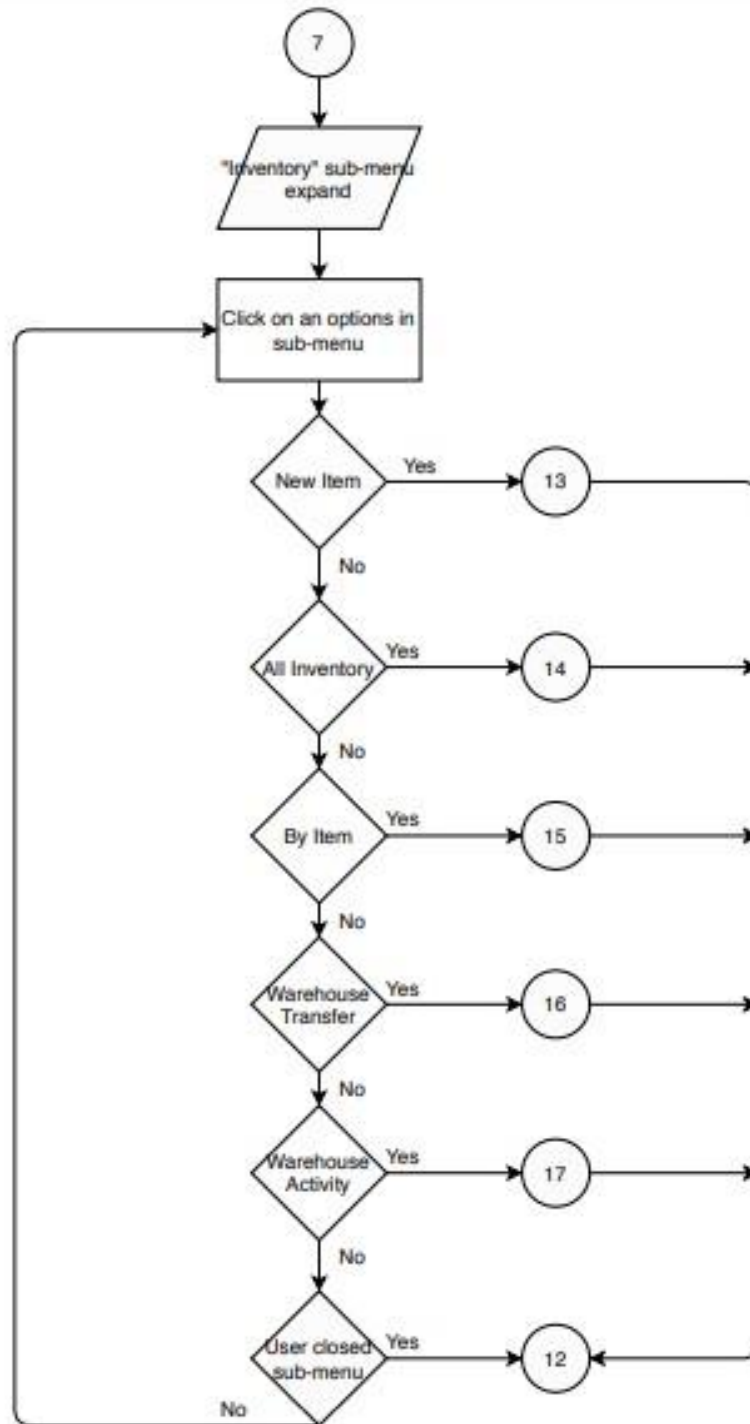


Figure 2.9. Flowchart of Inventory Sub Menu Navigation module

Mobile application:

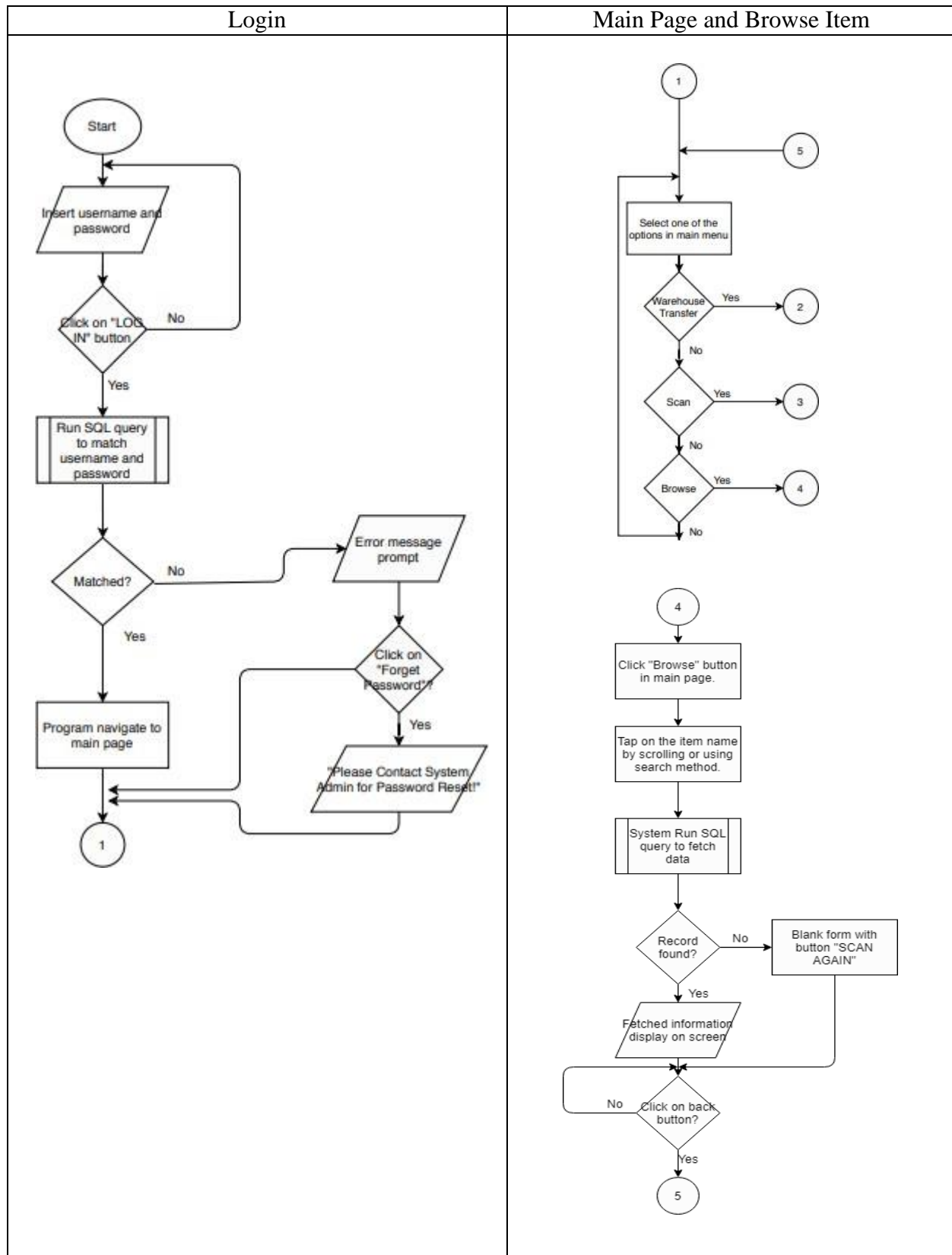


Figure 2.10. Flowchart of Login, Main Page and Browse Item modules for Mobile Application

2.1.3 Implementation

In contrary to the name, this phase is not where the software implemented into user environment rather the implementation phase is building the system into actual software, which is the devices that we specified in design phase. The software is coded according to the design document. The programming languages used is C# (c sharp) which is a language that developed by Microsoft that runs on .NET framework.

2.1.3.1 IDE

An integrated development environment (IDE) is a software framework which offer extensive software development environment. An IDE usually consists of at least one source code editor, a debugger and automation tools. The IDE used for this project is Visual Studio 2019 from Microsoft.

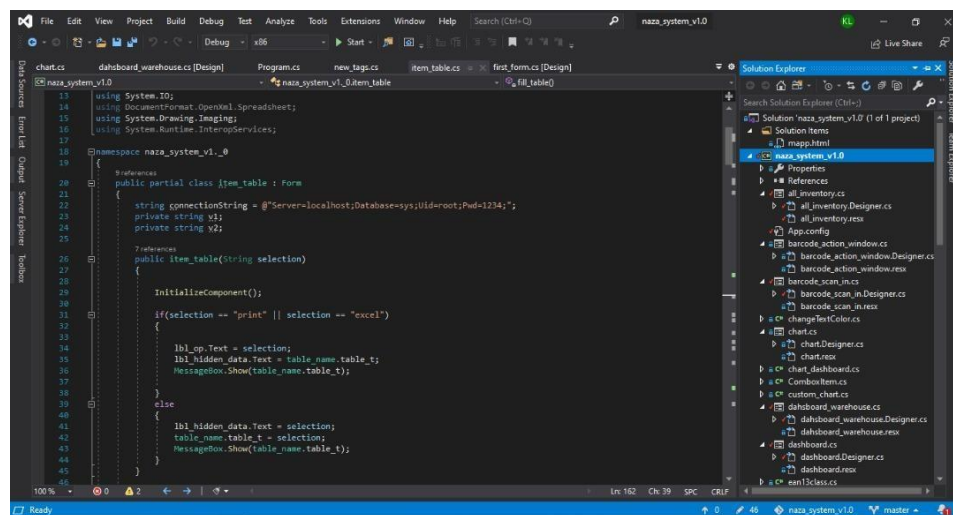


Figure 2.11. Visual Studio Community IDE 2019

2.1.3.2 Framework and Tools

The framework used for developing desktop application is .NET framework which programmed with C# language, and Xamarin which is a cross-platform app development tools by Microsoft. Although both mobile and desktop use same programming language but their structure is different. Since desktop application is developed with .NET framework therefore it is not allowed to use on operating system other than Windows. While Xamarin can in different platform such as Android, iOS, Linux, et cetera. Since it is implemented by Mono. The software application is primary used in Android system.

2.1.3.3 Database

MySQL is an open-source relational database management (DBM) system based on structured query language (SQL). MySQL is the most popular query language and has vast range of purpose on warehousing, e-commerce, logging application, et cetera. The database management and design tool used is MySQL Workbench which used for database design and development.

There are two types of database used which is local and online. The database does not fully available online is due to the connection speed is very slow and it often failed to connect since the online database is free. Mobile application is fully online but not on desktop application.

The reasons that we choose MySQL over another powerful database such as Oracle is because:

- Cost

Since MySQL is an open-source software and provide free relational database management system (RDBMS) software under terms of GNU General Public License.

- Space and flexibility

MySQL require less storage to run the server compare to other database. Which makes it more efficient to implement on small scale of system such as the start-up software that we are doing for this project.

- Management

Database administration is easier due to auto-management features such as automatic space expansion, auto-restart, and dynamic configuration changes, et cetera.

2.1.3.4 Barcode

The barcode is a technique for representing data in a visual way, machine-meaningful structure which able to read by computer. At first, the barcode defined by changing the width and spacing between parallel lines. The barcode generator we implemented can generate one-dimensional (1D) barcode, which consisting of lines and spaces with varying widths that made up of explicit and complex patterns. The two-dimensional (2D) barcode is usually referred as QR code. EAN-13 format barcode is being chosen as our primary generate barcode although our barcode reader can reader wide range of one-dimensional (1D) barcode. "EAN" stands for European article number and 13 in it refers to the number of digits that are in the barcode. However, only the first 12 digits contain information that is transmitted by the barcode.




The final digit of the code is known as the check digit. The final digit number does not contain information, but it is used to confirm that the barcode is correctly scanned. The 13th digit is the mathematical result of a formula dealing with the other 12 digits. The formula used in this process is known as the modulo 10 algorithms. To calculate an EAN-13 barcode is by determining the 13th digit of the code by applying this modulo 10 algorithms to the other 12 digits.

These are the steps to perform the modulo-10 algorithm:

- 1) First, locate the 13th digit in the barcode. If the check digit is not yet placed, this is the last digit from the left. If the check digit is in place, this is the 2nd to last digit from the left. For example, if the EAN-13 was 9 735940 564824, the 13th digit is '2'.
- 2) Starting with this 12th digit, move from right to left across the code adding every second digit to it. Using our example code of 9 735940 564824, this means starting with the '2' and adding to it the numbers 4, 5, 4, 5 and 7, giving a total of 27.
- 3) Multiply the sum that is obtained in Step 2 by 3. Using our example above, this means the multiplying of 27 by 3, giving a total of 81.
- 4) Locate the 11th digit in the code. Using the example code of 9 735940 564824, this would be the '8'.
- 5) Starting with the 11th digit, move from right to left of the code adding every 2nd digit to it. Using the example of 9 735940 564824, this means starting with the '8' and adding to it 6, 0, 9, 3 and 9, giving a total of 35.
- 6) Add the results from Step 3 and Step 5. In the example this means adding 81 and 35, giving a total of 116.
- 7) Round the result of Step 6 up to the nearest multiple of 10. In the example, this means rounding 116 up to 120.
- 8) Subtract the result of Step 7 from the result of Step 6. In the example, this is 120-116, giving us a difference of 4. Hence 4 should be the 13th digit in the EAN-13, otherwise known as the check digit.

For the inventory system, we have several types of barcode that hold data for different types of data to scan:

Table 2.1. Barcode Descriptions

Type	Starting number	Barcode	Description
Item	0		Contain the data for single item.
Car	1		Contain data for single car model.
Car manufacturing batch	2		Contain data for car manufacturing by batch.

2.1.3.5 Barcode Reader

Both desktop and mobile application can scan barcode with camera. Desktop use webcam to scan barcode while smartphone use built-in camera to scan. Both devices use ZXING (“zebra crossing”) package, which is an open-source, multi-format 1D/2D barcode image processing library.

2.1.3.6 NuGet Packages

NuGet is a Visual Studio’s Package management system. It makes adding, upgrading, and deleting external library within our application simple. We can easily build our own packages using NuGet and make them accessible to others. The packages contain codes that wrote by other developers. Package consumers can install the packages from NuGet packages manager and call the functionality of a package into project code.

There are several packages implemented in this project, the list of packages is in the table below.

Table 2.2. NuGet packages

NuGet Package	Description
BUNIFU framework	A DLL driven tools that provides greater user interface experience and reduce development time for Visual Studio. Used for desktop application.
Synfusion	.NET based product which used as template for mobile application
Gmap.NET	Used to display maps with pinpoint location.
LiveCharts	Used to display an array of data in chart such as pie chart or line chart.
Newtonsoft.JSON	Serialize received JSON. The JSON data are obtained from URL and used to perform geocoding of address.
RestSharp	An open source HTTP library, used before Newtonsoft. RestSharp create HTTP request, add parameters to the request, execution, and handle response, deserialization, and authentication.
ZXing	Used to decode barcode by capturing through camera.
iTextSharp	Used to convert data into PDF
Interop	Used to convert data into Excel

2.1.3.7 User Interface Design

User interface (UI) design is the method of designing interfaces with an emphasis on appearance of software interface. Designers aim to build projects that will be easy to use and efficient. The icons and color of the interface are specially picked by using other application. The application Metro Studio by Syncfusion contain vast library for icons and we can customize the icon's color, background, and size. To pick the right color, Just Color Picker for color matching.

2.1.4 Verification

System verification is the phase where a completed and integrated is tested by potential users or by professional tester. They usually test the system in terms of design or behaviors and the expectations and requirements. If the system does not fulfil the requirements, it will be sent back to design phase for programmer.

2.1.5 Maintenance

In the final stage of the software development life cycle, the system has met the expectations and requirements, ready to be deployed in industry. This phase also known as stabilization period. User provides feedback for programmer to investigate and programmer provide information for user to learn how the system works.

2.2 Technologies Involved

2.2.1 Hardware Requirement

The hardware and software requirement to run the system are:

Table 2.3. Requirement to run the system

Item	Description
Processor	x86, 1.6GHz or faster
Memory	512MB or higher
Hard Disk	1GB of available hard disk space
Resolution	1024 by 768 or higher resolution
Windows (desktop app)	Windows 10
Android (mobile app)	Android 9 (Pie) or above

The hardware required to develop the system are:

Table 2.4. Requirement to develop the system

Item	Description
Processor	x86, 1.6GHz or faster
Memory	1GB RAM or higher
Hard Disk	1GB of available hard disk space
Resolution	1024 by 768 or higher resolution
Windows	Windows 10

3.0 Result and Discussion

3.1 User Manual (Desktop Application)

3.1.1 Login

1. User must login to system with recorded username and password.
2. Key in username and password then click on button “LOG IN” or “EXIT” to exit the application.



Figure 3.1. Login screen.

3. If username and password mismatch, the following error message will prompt, and user need to insert username and password again.

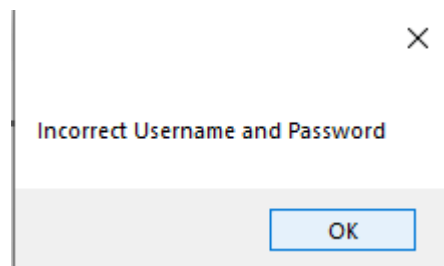


Figure 3.2. Error message for Login Form

4. If username and password are matched, program navigate user to main page of the system.

3.1.2 Dashboard

1. The dashboard page will appear every time after user login or click on “Dashboard” button on left menu panel

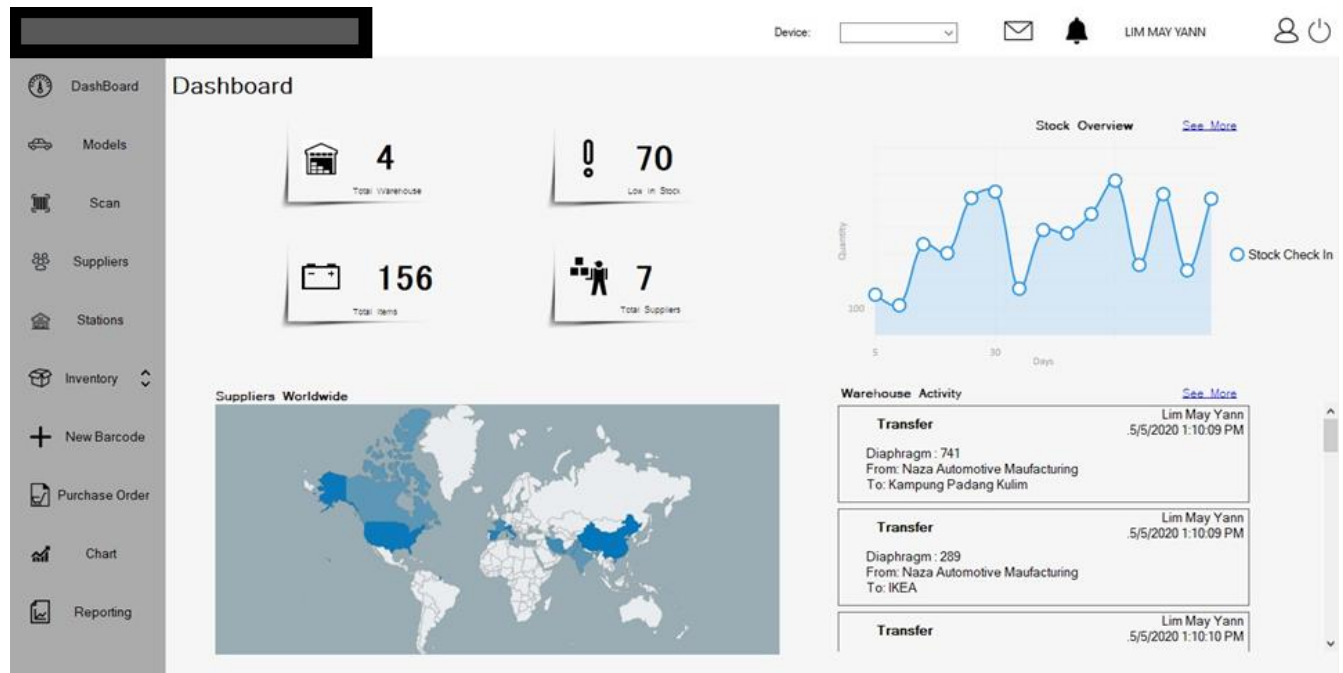


Figure 3.3. Dashboard.

- Upper left: total warehouse, low in stock, in transit, suppliers
- Upper right: check in and check out of items over the past 10 warehouse activity recorded.
- Lower left: suppliers around the world
- Lower right: warehouse check in, check out and transfer activity from 10 of the latest record.

3.1.3 View and Print

1. Click on the “Inventory” button which is located on the left-hand side to expand. Then, click on “All Inventory” button.

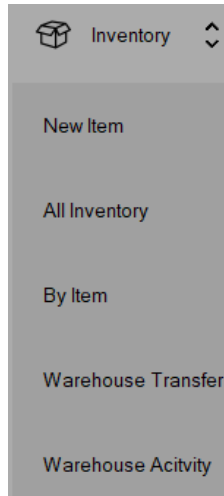
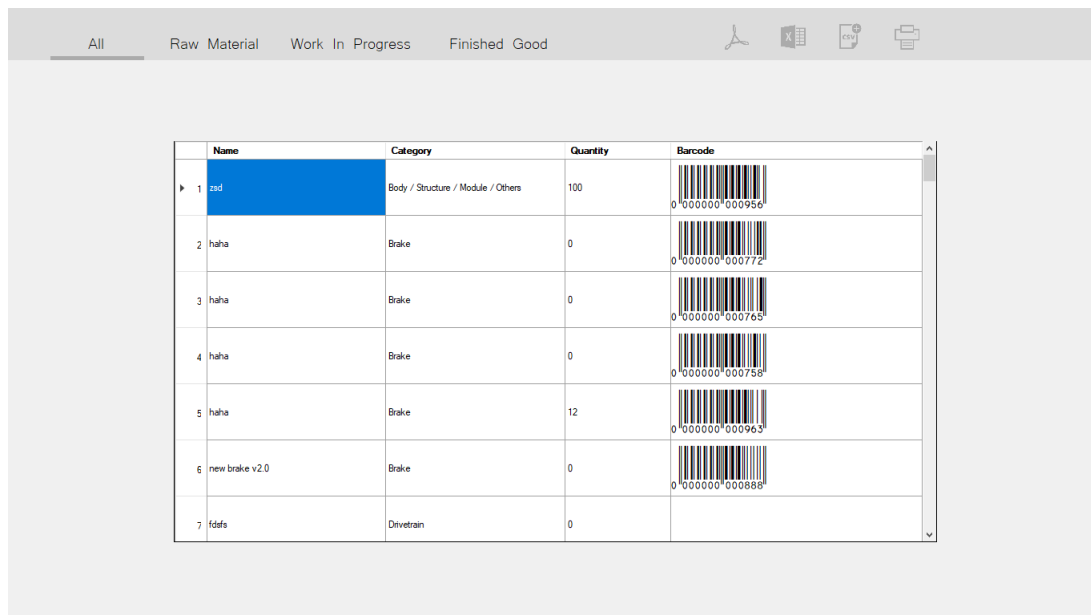


Figure 3.4. Inventory options

2. The following form will appear.

A screenshot of a web application interface. At the top, there is a navigation bar with tabs: "All", "Raw Material", "Work In Progress", and "Finished Good". To the right of the tabs are icons for download, print, and other functions. Below the navigation bar is a table with the following data:







	Name	Category	Quantity	Barcode
1	asad	Body / Structure / Module / Others	100	 0 000000 000950
2	haha	Brake	0	 0 000000 000772
3	haha	Brake	0	 0 000000 000765
4	haha	Brake	0	 0 000000 000758
5	haha	Brake	12	 0 000000 000963
6	new brake v2.0	Brake	0	 0 000000 000888
7	fdafa	Drivetrain	0	

Figure 3.5. All Inventory Barcodes

3. There are four types of views in total, click the desired panel to view the table.

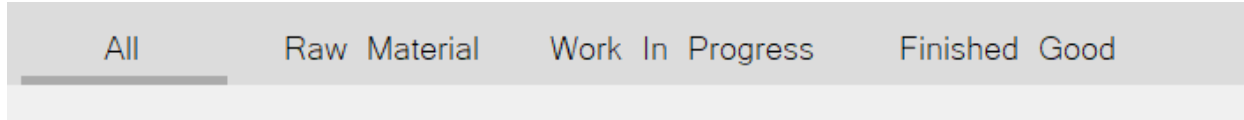


Figure 3.6. Inventory category options

4. There are 4 clickable icons on top right. The tables can be generated in forms of PDF, Excel, CSV, or print directly (format same as PDF).

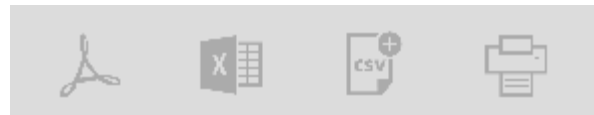


Figure 3.7. Save table format icons

5. Click on the PDF icon to export the table to a pdf file. A dialogue box will pop out. Change name of file then click on “Save”.

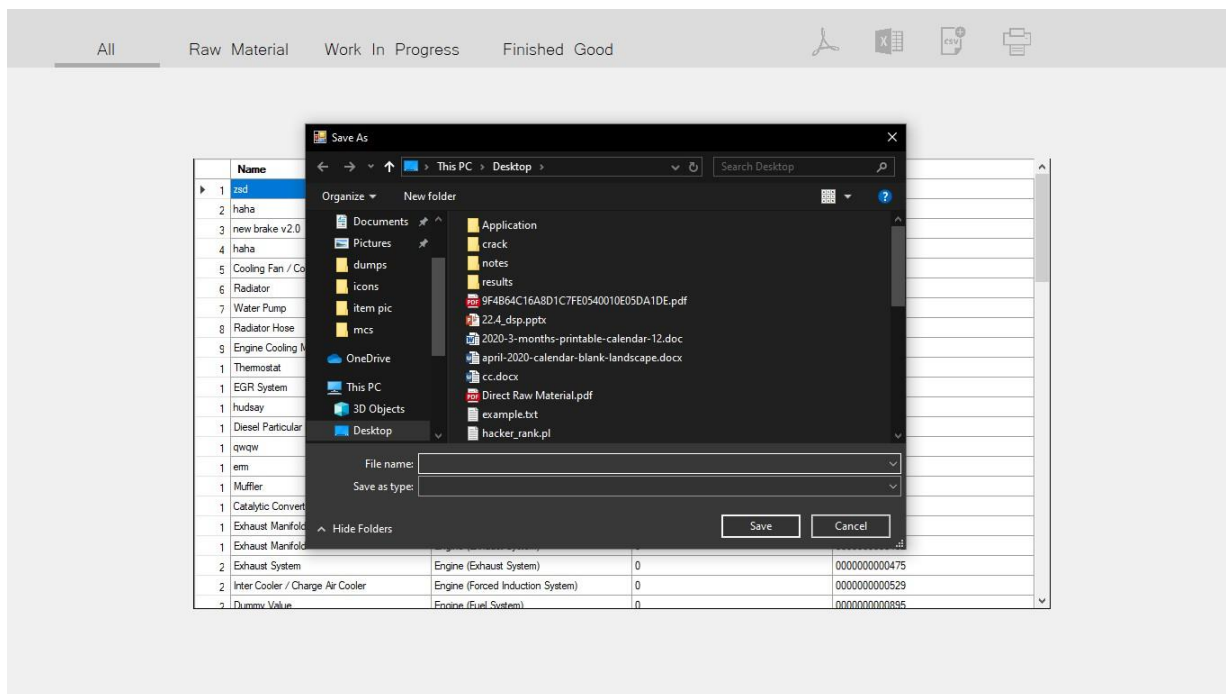


Figure 3.8. Save option

6. The saved pdf should have contents like figure 3.9.

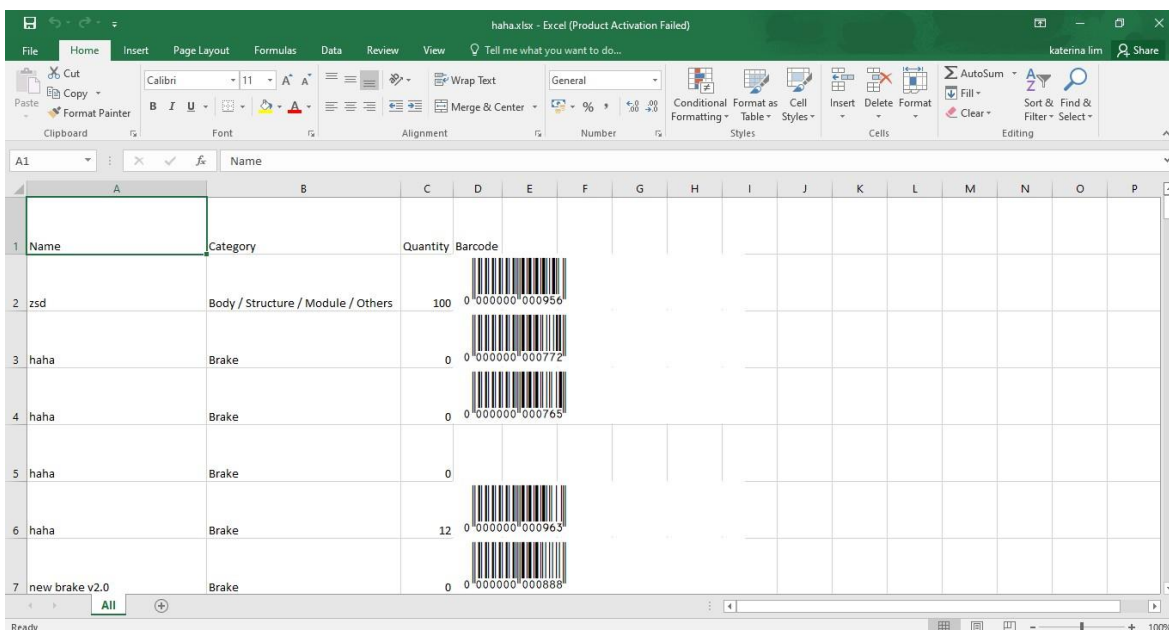


Diesel Particular Filter	Engine (Exhaust System)	0	0 000000 000451
Inter Cooler / Charge Air Cooler	Engine (Forced Induction System)	0	0 000000 000529
Carbon Canister	Engine (Fuel System)	0	0 000000 000253
Fuel Filter	Engine (Fuel System)	0	0 000000 000260
Fuel Hose	Engine (Fuel System)	0	0 000000 000277
Fuel Pump	Engine (Fuel System)	0	0 000000 000284
Engine Management System	Engine (Fuel System)	0	0 000000 000291
Fuel Filter (Diesel)	Engine (Fuel System)	0	

Figure 3.9. View PDF

5. To download the form in excel format, click on the Excel icon to export the table to an excel file. A dialogue box will pop out like figure 3.8. Change name and path of file as desired then click on “Save”.

6. The saved excel file should have contents like figure 3.10.



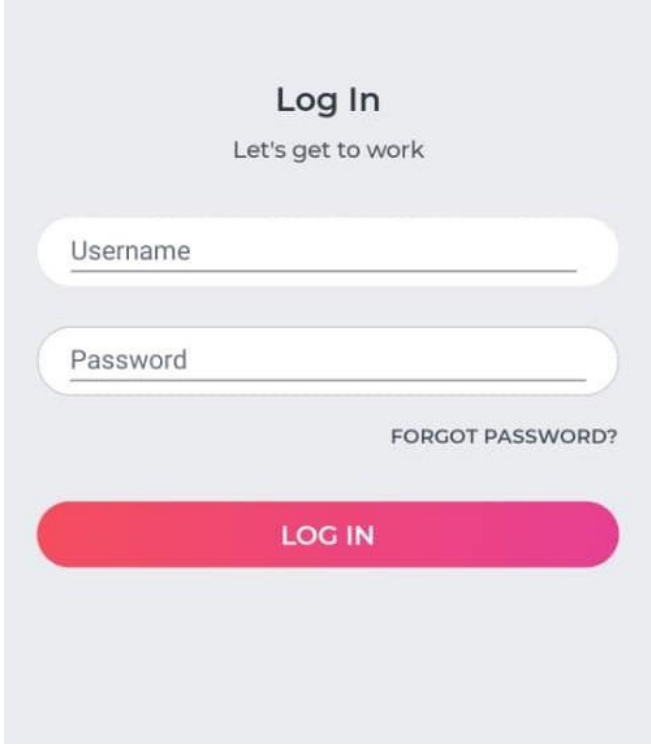
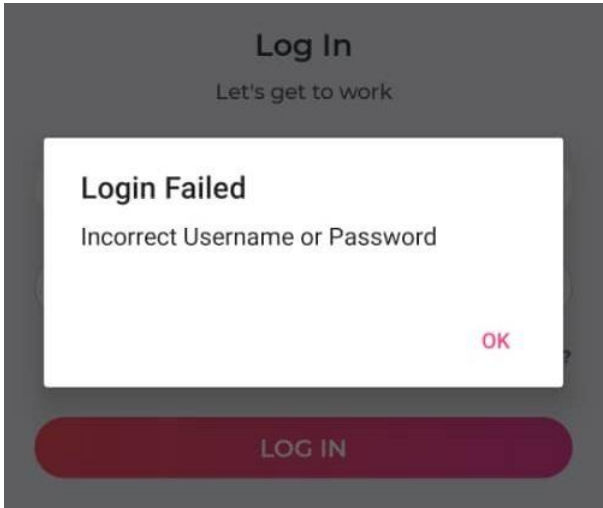
Name	Category	Quantity	Barcode
zsd	Body / Structure / Module / Others	100	0 000000 000956
haha	Brake	0	0 000000 000772
haha	Brake	0	0 000000 000765
haha	Brake	0	
haha	Brake	12	0 000000 000963
new brake v2.0	Brake	0	0 000000 000888

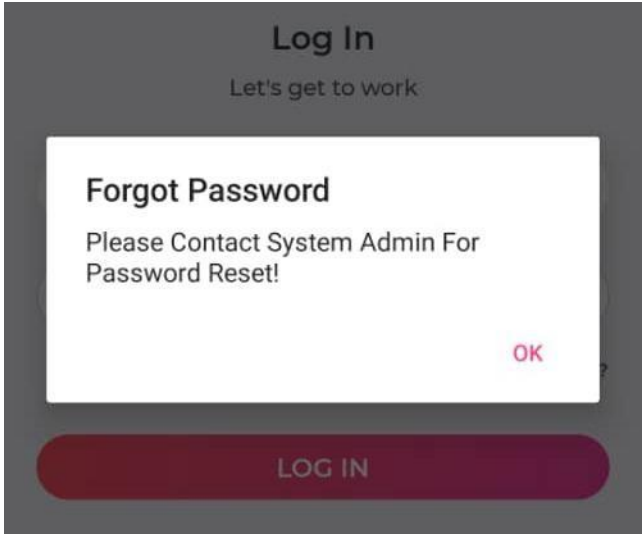
Figure 3.10. View Excel

3.2 User Manual (Mobile Application)

3.2.1 Login

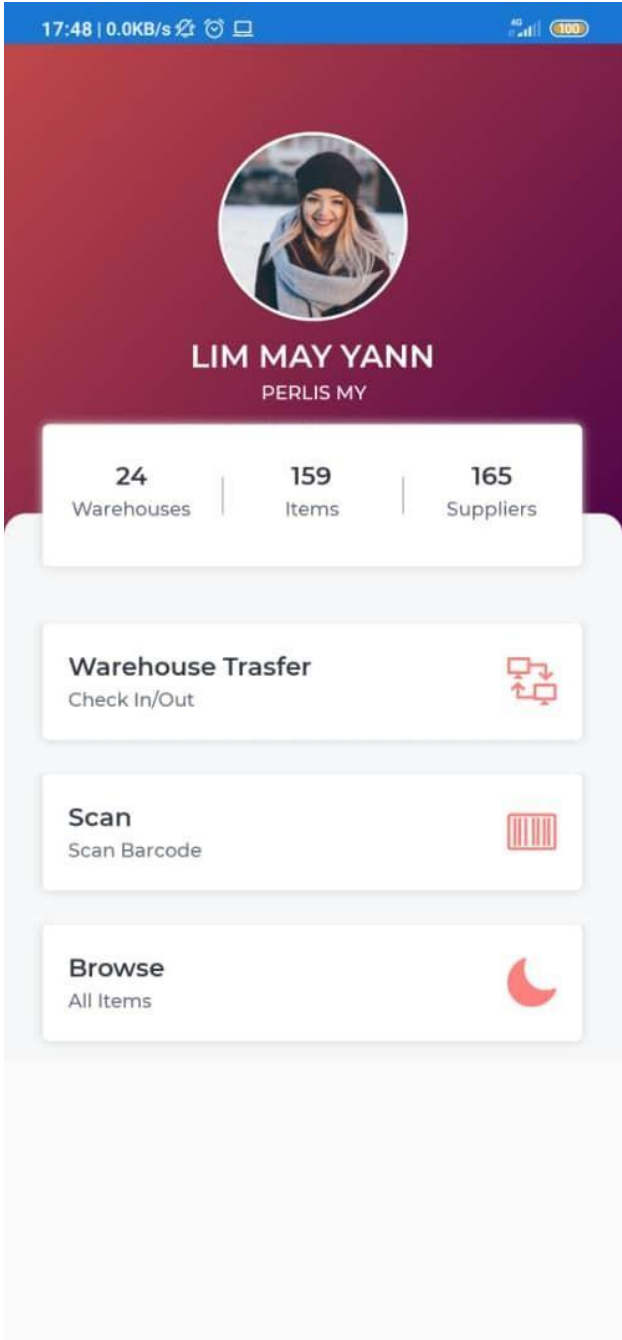
Table 3.1. Mobile user manual (login)

	<ul style="list-style-type: none">• Insert username and password as provided from system admin, then click button “LOG IN”.• The application shall navigate user to main page of the application with successful login.
	<ul style="list-style-type: none">• If user insert incorrect username or password, the above message should prompt.

	<ul style="list-style-type: none">• If click on “FORGOT PASSWORD”, the following message will pop out.• Note that the current mobile application does not support changing yet.
---	--

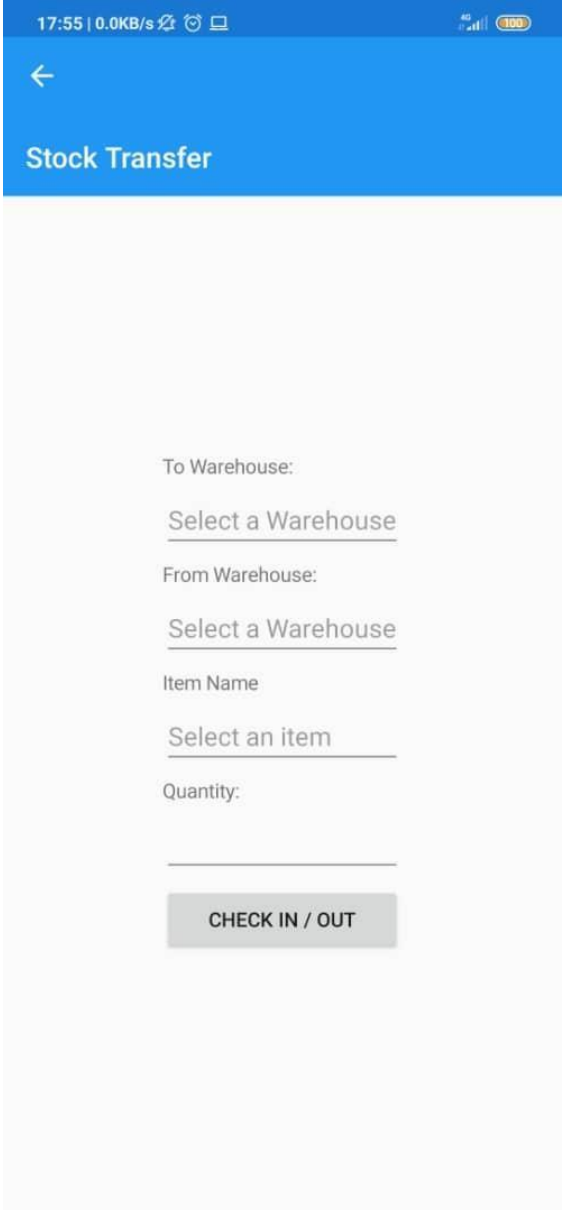
3.2.2 Main Page

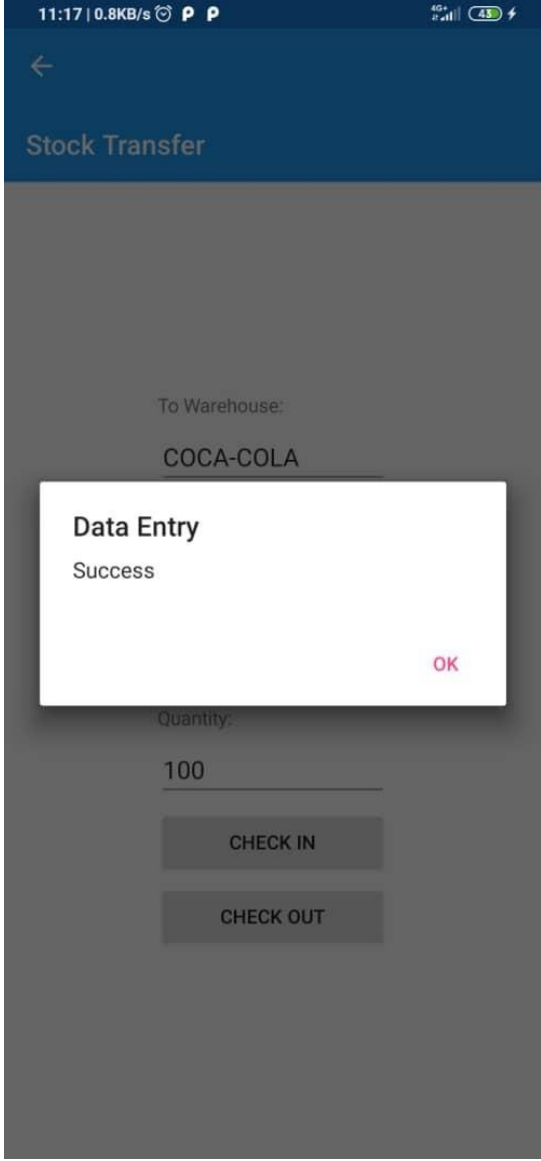
Table 3.2. Mobile user manual (main page)

	<ul style="list-style-type: none">• Main page of the application act as navigation for user. It usually appears after login page.
--	---

3.2.3 Warehouse Transfer

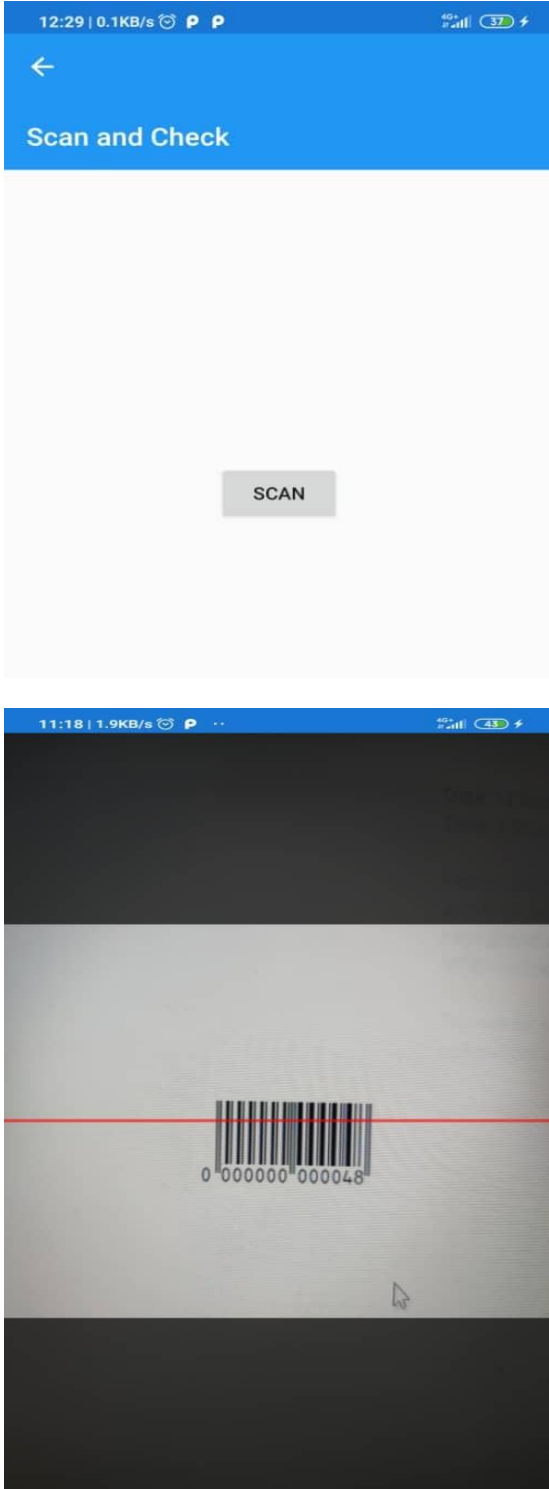
Table 3.3. Mobile user manual (Warehouse Transfer)

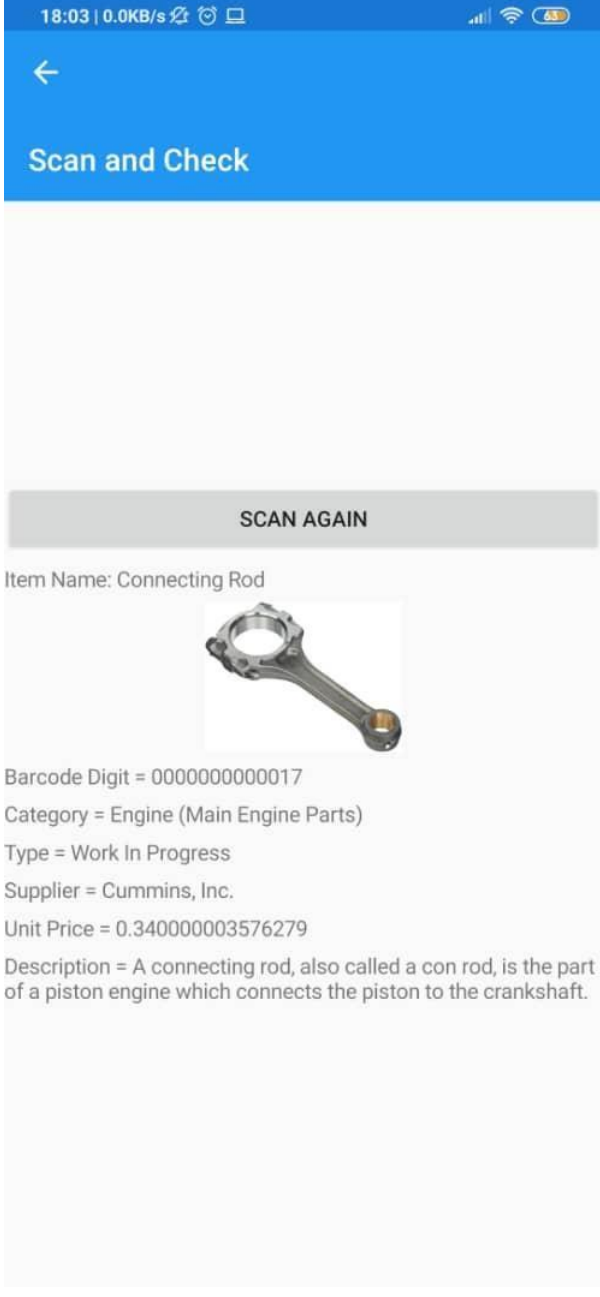

	<ol style="list-style-type: none">1. To perform warehouse transfer, click on “Warehouse Transfer” tab at main page.2. Fill in all required fields, then click on “CHECK IN / OUT” button.3. “Form Warehouse” and “From Warehouse” fields are optional.<ul style="list-style-type: none">• If you wish to check in the stocks to warehouse, then leave “From Warehouse” blank.• If you wish to check out the stocks from warehouse permanently, then leave “To Warehouse” blank.
--	--

	<p>4. The following message will prompt if data are inserted successfully in database.</p> <p>5. If data does not record by database, the “Success” word will be replaced by “Failed”.</p>
--	--

3.2.4 Scan Barcode

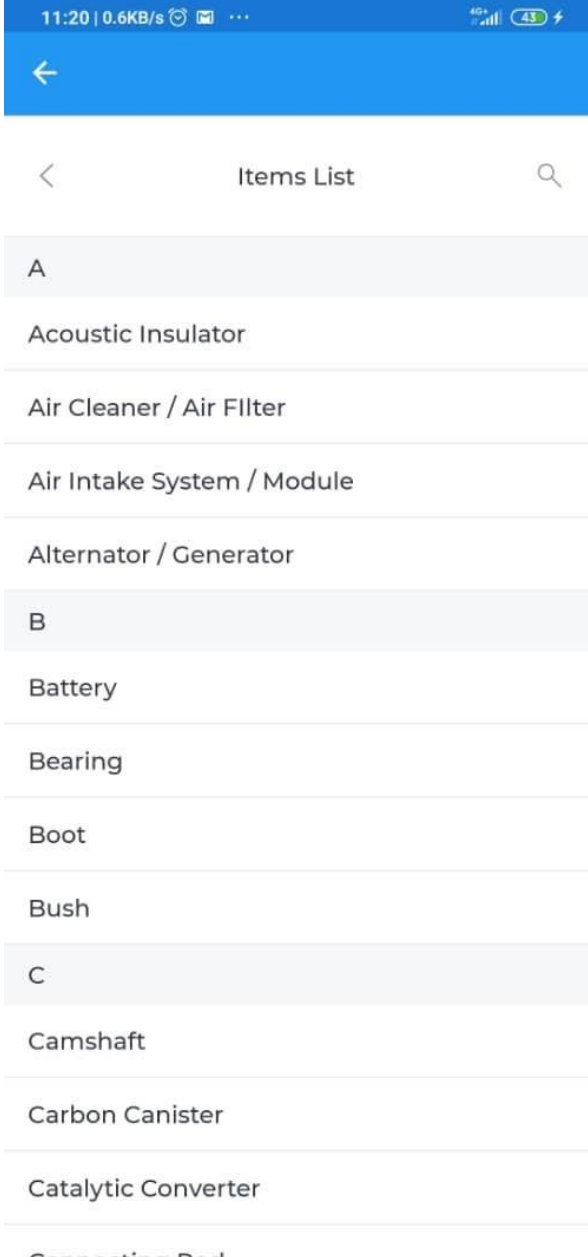
Table 3.4. Mobile user manual (Scan barcode)

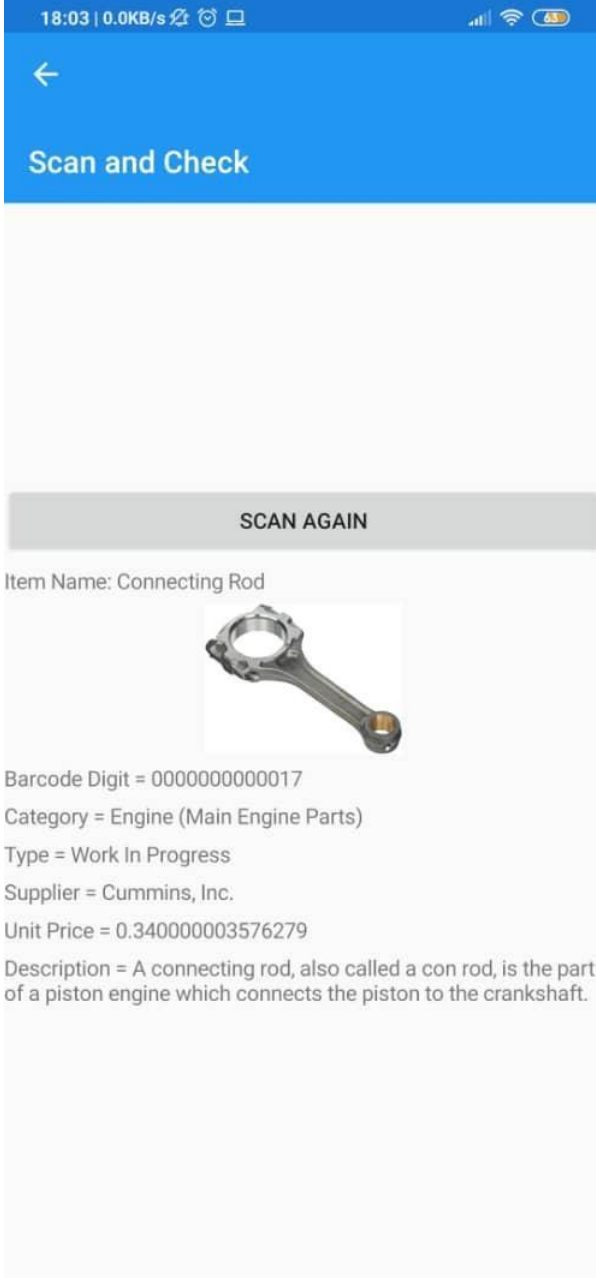
	<ol style="list-style-type: none">1. To scan item's barcode, click on "Scan" tab at main page.2. User shall be navigated to the following page.3. Click on "SCAN" button to activate phone camera.4. After the camera has been activated, place the barcode on red horizontal line.5. It is advised that user ensure only one barcode is being scanned by camera to avoid unnecessary error.
--	--

 <p>18:03 0.0KB/s</p> <p>←</p> <p>Scan and Check</p> <p>SCAN AGAIN</p> <p>Item Name: Connecting Rod</p>  <p>Barcode Digit = 0000000000017 Category = Engine (Main Engine Parts) Type = Work In Progress Supplier = Cummins, Inc. Unit Price = 0.340000003576279 Description = A connecting rod, also called a con rod, is the part of a piston engine which connects the piston to the crankshaft.</p>	<p>6. If barcode were found in database, the messages of items will display as following screenshot.</p> <p>7. If barcode record does not find in database, it will show only empty screen with “SCAN AGAIN” button.</p> <p>8. Click on “SCAN AGAIN” to repeat steps from step 4 and onwards.</p>
---	---

3.2.5 Items List

Table 3.5. Mobile user manual (Items List)

	<ol style="list-style-type: none">1. To browse item's information by name, click on "Browse" tab at main page.2. User shall be navigated to the following page.3. User shall scroll down the list to find the item name or tap on magnifying class icon which located on right side of "Items List" to type the item name.
--	--

	<p>4. Tap on the item name, then it shall navigate to “Scan and Check” page which is also used to display scanned barcode result.</p>
--	---

4.0 Project Design Consideration

4.1 Health and safety

By implement this system, it reduces labor-intensive to operate manually. This reduce of human error caused by manually tracking inventory. Inventory management system do not require nonstop monitoring to verify that each transaction is accounted for and that products are preserve at the appropriate stocking level. By this inventory management system also it will keep an accurate item supply count, as well as to make sure the goods in and out of the warehouse are recorded. It will ensure the security of data and the safety of employees when they just must do business only through the inventory system.

This system use barcode to controlling inventory. Using barcode in inventory system will ensure the safety and quality. Barcodes afford tightly quality control and more accurate inventory tracking. Tight control is also a safety feature where theft or loss can be easily identified and followed up to reduce the impact further down the chain. Plus, by using barcode will be useful when affixed to equipment so that the locations of equipment, especially small items which tend to go ‘missing’ frequently, can be ascertained quickly and accurately reducing the amount of time employee spend looking for them. Each lost item also can be identified because the system can detect each location change with the correct storage unit and the right quantity transferred. It ensures the safety of the goods. Besides, to minimize the data entry errors when there is more product to manage at one time, a check digit is used. A check digit known as a checksum character; it is the number located on the far-right side of a barcode is used to verify that the information on the barcode has been entered correctly. If an error is made during intake, the likelihood of being caught is relatively small. Besides that, this system used C# language. C# is a type-safe object-oriented language that enables developers to build a variety of secure and robust applications that run on the .NET Framework. C# is easier and secure to develop application based on the C# language and the .NET Framework. This system also use MySQL stored procedure to increase security in database. The database administrator can grant convenient permission to applications that only access specific stored procedures without giving any permission on the underlying tables. Stored procedure limit direct access to tables via defined roles in the database.

4.2 Environmental Consideration

The inventory management system will allow you to keep an accurate record of item still has stock. Besides, using barcode in inventory represent a generalized yet clever way of accurately storing information. You will be better equipped to accurately predict changes in supply and demand needs, and this way you will avoid over-producing and inevitable wastage that can be devastating to the environment over time which leads to less packaging which leads to less waste and contribute to environmental advantage.

In addition, the system uses a MySQL database that stack terabytes of data, which will reduce the use of paper if data is recorded manually using paper. The use of paper will impact the globe at every stage in its lifecycle. Many trees are being cut down for the paper and pulp industries. There will be loss in the ecological balance, increased rate of greenhouse gases, giving rise to severe global warming and climatic changes. By switching to MySQL database to store data instead of manually store data using paper, it will save tree and our environmental.

4.3 Cultural and Benefit to the Society

This project is designed to provide a better inventory management system of with authorized person in charge in monitoring the system. Inventory management system using is the controlling of industry supply or controlling the movement of items and services following their demand. Inventory management enhances industrial operations with the effective flow of items and services. Inventory management system are highly beneficial in today's industry world as it makes a vital part in any industry success/failure by having intense competition with its competitors. Inventory management plays a vital part in enhancing product quality, improving competitiveness, reducing carrying cost of inventory by reducing inventories, service enhancement, and operational flexibility through pull systems. Inventory Management and control provide actions and strategies that are integrated into all management controlling, planning, and processes which are crucial to enhancing and making successful management.

The use of barcodes in inventory management makes it more an efficient way of tracking inventory throughout the production process all the way to a sale, making it so much easier for employee to store items in a sensible way, locate them and make ordering decisions based on more accurate inventory levels. This project uses mobile application, and it is more convenient because employee can use smartphones, which they already have in their pockets, to process inventory and asset transactions. They can process inventory transactions or change asset status now it happens, with one scan of barcode. They also can access accurate inventory count or asset status in the field with one scan of barcode.

5.0 PROJECT MANAGEMENT AND COSTING

5.1 Project Gantt Chart

TASK	SEMESTER 2																			
	FEB				MAR				APR				MAY				JUNE			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Discussion with Supervisors																				
Information Gathering																				
Determination of System Requirement																				
Analysis & Design																				
Database Development																				
Software Development																				
Testing and Debugging																				
System Optimization																				
Project Documentation																				

5.2 Project Costing

Project costing is the structure of the project task to make decision and demonstrate how the task deal with the cost income as well as the process of handling the billing. Project cost management is the technique used by calculating the payment cost of development needed. The aim of software costing is to accurately predict the cost of developing the software so that it can help with the planning process and the effective use of resources. For this project of inventory system there are few software and tools that need to be analyzed in terms of their cost as shown in table below.

Table 5.1 Project costing

No.	Software / Tools	Description	Price (RM)	Quantity
1.	Visual Studio 2019 Community	This software is a free, fully featured, and extensible solution for developers to create applications for Android, iOS, Windows and the web.	0	1
2.	MySQL Workbench	Software tool used to access MySQL using a friendly user interface. It is free for download and installation.	0	1
3.	MySQL Database	An open-source online MySQL server that allows to store data in tables, create indexes on the data, and query the data.	0	1
4.	PC	A PC was used to access the system. It also used to scan the barcode via the webcam.	2500	1
5.	Smartphone	Smartphone was used for the mobile app that also able to access the system and for barcode scanning.	800	1
6.	Electricity	The estimate average cost for electricity used for the system development.	200	
TOTAL			RM 3500.00	

The total cost for the project is RM 3500 that included the cost of tools and software. However, the software used in this system do not cost any to the system as those all are an open-source software that are free for download and installation.

5.2.1 Cloud Storage

A cloud database is a storage system that allows to save files and data on a server that is connected to the internet. With a cloud database service provider, all the info stored in the company's computers is transferred to the database and can be access through the internet. It also able to keep a backup data in case of any crashes that might be happened. With this option, if the data was lost, we can just log in to the account and retrieve back the data.

Database used in this inventory system is MySQL that the most popular open-source database. It has evolved and is known to be the best database for system that allows to store data in tables, create indexes on the data, and query the data. This database was chosen as it is available for free download and installation and a secure and reliable database management system.

Other than MySQL there are other types of cloud database that can also offer a better performance. One of it is Oracle database. Only Oracle Express Edition is free of cost, but Oracle Express Edition has very limited features when compared to MySQL. For extensive features, either Oracle Standard Edition or Oracle Enterprise Edition must be purchased. For Standard Edition, the license cost is 17,500 USD per unit and 47,500 USD for Enterprise Edition. Although the license price is high, it provides enhanced database security and can performs well even when handling huge amounts of data.

Besides, as a start-up developer that require a flexible database solution, Azure SQL database should have been listed as one of the cloud databases. It can easily be scaled without the need for more memory or new servers. With Azure, clients can use the services purely on the cloud or it can be combined with any existing applications, data center or infrastructure.

6.0 Conclusion

6.1 Future Enhancement and Limitations

First, the online MySQL server does not support stored procedure. The reason we preferred using stored procedure over writing the query along with C# coding is because it is easier to maintain the system. Sometimes a particular query function will be used by more than one function in C# therefore instead of editing each same part separately we can access it all at once with stored procedure. As the inventory system control all the inventory, which is an asset for the company, the security of the system should be emphasis in the future. The security vulnerable such as SQL injection can be critical. Unlike web application which hacker can perform injection through user input, hacker should have obtained the desktop application since the application can directly connect to database. Hence, stored procedure is also considering as an intermediate layer to prevent hacker directly access to the database tables.

Other than stored procedure, since the online database is free, we may expect some time delay when fetching the data which may cause connection timeout when applications are attempted to connect with it. Performance of application are slowed down due to the slow database connection speeds which limits the use of online database in desktop application. In near future, a better and faster paid online database should be considered or maybe switch to more powerful cloud computing service such as Microsoft Azure.

There are more limitations in desktop application. Since desktop application is using .NET framework instead of .NET core, it is unable to run on operating system other than Windows. Although .NET core allows cross-platform on application, as we are not computer science student and most of us are not very fluent in programming, .NET framework is much easier to learn and implement. In future, we can migrate system from .NET framework to .NET core for more scalable application.

Besides from the limitations that we mentioned above, there are more improvement that can be done in future. Some solutions like cloud storage might be costly but the features they provided is totally worth it and we can see it as an investment. The system with good cloud server would be able to speed up activities in inventory activities and perhaps it is more than just inventory but the entire activities in industry.

6.2 Summary

Thus, a comprehensive inventory management system was developed that might help NAM manage their stocks, car model information, and also car manufacturing process using the barcode inventory system. It would minimize the worker's efforts to maintain the track of each object manually, and their hassle of maintaining the log as it will be stored in the database.

The project also has the potential to notify the company if any products fall below the level of the recorder and the products in-store as well as the amount available in the store. The project has an efficient security system by using stored procedure in MySQL, among other achievements, which makes the documents highly confidential using an effective password program.

Good inventory system often because of the system has proper maintenance from programmer from time to time. Although the system has a lot of improvement now, but it should be always maintained by programmer and update the best possible features for company to deal with changing technical and management environment. There is no perfect inventory but best inventory that fits the environment of the company and therefore lead to more organized warehouse with minimum cost.

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Appendix A

```
//c# class that used to generate ean13 barcode
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Text.RegularExpressions;
using System.Threading.Tasks;
namespace naza_system_v1._0
{
    class ean13class
    {
        public static string Barcode13Digits = "";
        public static string ean13(string chaine)
        {
            int i;
            int first;
            int checkSum = 0;
            string Barcode = "";
            bool tableA;
            if (Regex.IsMatch(chaine, "^\\d{12}$"))
            {
                for (i = 1; i < 12; i += 2)
                {
                    System.Diagnostics.Debug.WriteLine(chaine.Substring(i, 1));
                    checkSum += Convert.ToInt32(chaine.Substring(i, 1));
                }
                checkSum *= 3;

                for (i = 0; i < 12; i += 2)
                {
                    checkSum += Convert.ToInt32(chaine.Substring(i, 1));
                }
                chaine += (10 - checkSum % 10) % 10;
                Barcode13Digits = chaine.ToString();
                Barcode = chaine.Substring(0, 1) + (char)(65 + Convert.ToInt32(chaine.Substring(1,
                first = Convert.ToInt32(chaine.Substring(0, 1)));
                for (i = 2; i <= 6; i++)
                {
                    1))));
```

```

tableA = false
switch (i)
{
    case 2:
        if (first >= 0 && first <= 3) tableA = true;
        break;
    case 3:
        if (first == 0 || first == 4 || first == 7 || first == 8) tableA = true;
        break;
    case 4:
        if (first == 0 || first == 1 || first == 4 || first == 5 || first == 9) tableA = true;
        break;
    case 5:
        if (first == 0 || first == 2 || first == 5 || first == 6 || first == 7) tableA = true;
        break;
    case 6:
        if (first == 0 || first == 3 || first == 6 || first == 8 || first == 9) tableA = true;
        break;
}
if (tableA)
{
    Barcode += (char)(65 + Convert.ToInt32(chaine.Substring(i, 1)));
}
else
{
    Barcode += (char)(75 + Convert.ToInt32(chaine.Substring(i, 1)));
}
}
Barcode += "*";
for (i = 7; i <= 12; i++)
{
    Barcode += (char)(97 + Convert.ToInt32(chaine.Substring(i, 1)));
}
Barcode += "+";
}
return Barcode;
}
}
}

```