

DEVELOPMENT OF A COMPUTERIZED INVENTORY  
MANAGEMENT SYSTEM (IMS) FOR  
INDUSTRY APPLICATION

OOI CHOON KHENG

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Faculty of manufacturing engineering  
UNIVERSITY MALAYSIA PAHANG

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## ABSTRACT

Inventory Management System (IMS) are widely used in industry nowadays to increase the efficiency of item flow. The traditional method of IMS involved a lot of paper work such as spreadsheet and order list which will be more difficult to manage as the storage grew bigger. Therefore, inventory management system can be computerized to further increase the efficiency of IMS. This project aim to develop IMS software can store a large amount item data. Moreover, it has check in/out function and search function that run using scan QR Code. Besides that, the software also has the feature of low stock warning function to warn the user if the item has low quantity. To develop the software, first the criteria of the software are determined followed by choosing the software development tools to develop the software that can achieve the criteria of the software. Next the software will be developed and debugged. This paper focuses on developing IMS software for SMEs and biomedical field company usage.

## ABSTRAK

Sistem Pengurusan Inventori (IMS) digunakan secara meluas dalam industri pada masa kini untuk meningkatkan kecekapan aliran item. Kaedah tradisional IMS melibatkan banyak kertas kerja yang akan menjadi lebih sukar untuk diuruskan sekiranya penyimpanan barang berkembang semakin besar. Oleh itu, sistem pengurusan inventori boleh berkomputer untuk meningkatkan lagi kecekapan IMS. Projek ini bertujuan untuk membangunkan perisian IMS yang boleh menyimpan item data yang berjumlah besar. Selain itu, ia mempunyai fungsi daftar masuk / keluar dan fungsi pencarian yang melibatkan menggunakan imbasan QR Kod. Selain itu, perisian ini juga mempunyai ciri fungsi amaran kiraan barangan rendah untuk memberi amaran kepada pengguna jika ada item yang mempunyai kuantiti yang rendah. Untuk membangunkan perisian IMS, pertama sekali, kriteria perisian akan ditentukan mengikuti pemilih alat-alat pembangunan perisian untuk membangunkan perisian yang boleh mencapai kriteria perisian. Seterusnya perisian IMS akan dibangunkan dan debugged. Thesis ini memberi tumpuan kepada membangunkan perisian IMS untuk penggunaan SMEs dan bioperubatan syarikat.

## TABLE OF CONTENTS

		<b>Page</b>
<b>EXAMINER’S DECLARATION</b>		ii
<b>SUPERVISOR’S DECLARATION</b>		iii
<b>STUDENT’S DECLARATION</b>		iv
<b>ACKNOWLEDGEMENT</b>		v
<b>ABSTRACT</b>		vi
<b>ABSTRAK</b>		vii
<b>TABLE OF CONTENTS</b>		viii
<b>LIST OF TABLES</b>		xi
<b>LIST OF FIGURES</b>		xii
<b>LIST OF ABBREVIATIONS</b>		xiv
<b>CHAPTER 1</b>	<b>INTRODUCTION</b>	
1.1	Introduction	1
1.2	Background	1
1.3	Problem Statement	3
1.4	Objectives	3
1.5	Scope of Research	3
<b>CHAPTER 2</b>	<b>LITERATURE REVIEW</b>	
2.1	Introduction	4
2.2	Method of Literature Search	4
2.3	Gap finding	5
	2.3.1 Literature Search Results	5
	2.3.2 The Technology Used	10
	2.3.3 The Software Development Tool Used	10
	2.3.4 The Software Features of the Previous Projects	11
2.4	Conclusion	11

### **CHAPTER 3            METHODOLOGY**

3.1	Introduction	12
3.2	Method to Develop IMS Software	12
3.3	Determine the Condition for the Software	13
3.4	Determine the Software Features	14
3.5	Determine the Software Development Tools to be Used	14
3.5.1	Coding Library Comparison	16
3.5.1.1	QR Code Library	16
3.5.1.2	Connect to MySQL (XAMPP) Library	20
3.5.1.3	Create GUI Library	20
3.5.2	Choice of Software Development Tools	20
3.6	Conceptual Software Flow Chart	21
3.7	Conceptual Software GUI	25
3.8	Design the Database	28
3.9	Debug Software	28
3.10	Conduct Survey	28

### **CHAPTER 4            RESULTS AND DISCUSSION**

4.1	Introduction	29
4.2	Overview of IMS Software	29
4.3	Developed Database	30
4.4	Developed GUI	31
4.5	Survey Conducted	38

### **CHAPTER 5            CONCLUSION AND RECOMMENDATION**

5.1	Introduction	39
5.2	Conclusion	39
5.3	Recommendation	40

<b>REFERENCES</b>	41
<b>APPENDICES</b>	
A        IMS Software Coding	43
B        Example of Survey Form	59
C1       Final Year Project 1 Gantt Chart	60
C2       Final Year Project 2 Gantt Chart	61

**LIST OF TABLES**

<b>Table no.</b>	<b>Title</b>	<b>Page</b>
2.1	Summary studies comparing the methods and technology used to develop an Inventory Management System	9
3.1	List of current IMS software available in market	15
3.2	List of supported Module by ZXing library	17
3.3	List of Code supported by ZXing library	18
3.4	List of Code supported by BARCODE IMAGE GENERATION library	19
3.5	Summary of coding library	19
4.1	Survey result	38

## LIST OF FIGURES

<b>Figure no.</b>	<b>Title</b>	<b>Page</b>
2.1	Flow Chart of method used for literature search	5
3.1	Method to develop Inventory Management System (IMS) Software	13
3.2	Software Flow Chart Part 1	21
3.3	Software Flow Chart Part 2	22
3.4	Software Flow Chart Part 3	23
3.5	Software Flow Chart Part 4	24
3.6	Software Flow Chart Legends	25
3.7	Login Tab Conceptual Design of GUI	26
3.8	Itemview Tab Conceptual Design of GUI	26
3.9	Add item Tab Conceptual Design of GUI	27
3.10	QR code identification method	27
4.1	Overview of IMS	29
4.2	Overview of the database	30
4.3	Login_data data table example	30
4.4	ims_test data table example	31
4.5	000002 data table example	31
4.6	User selection form	32
4.7	Register form	32
4.8	Login form	33
4.9	Mainpage form	34
4.10	Notification form	34
4.11	Item box form	35
4.12	Add item form	35



4.13	Photo Taker form	36
4.14	QR Code scanner form	36
4.15	Check out form	37

**LIST OF ABBREVIATIONS**

IMS      Inventory Management System

GUI      Graphical User Interface

QR Code    Quick Response Code

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 INTRODUCTION**

This chapter is written on the background of Inventory Management System (IMS), problem statement, objectives to be achieved and scope of research of “Development of a computerized Inventory Management System (IMS) software for industrial application”.

#### **1.2 BACKGROUND**

To keep business running at a good pace, a good management is required to constantly maintains a good balanced between the items keep in storage and the items going in and out. In order to achieve a good management, inventory management system as the tool to monitor the inventory level and items status is used.

Before the era of technology, Inventory Management System was a system involving paperwork to record down all the item status. It was widely used by companies to manage their storage. However as the company grow bigger and the storage increase in size where sometimes the storage has to be divided to a few location, thus the Inventory Management System would use up a lot of spaces and money to keep track of the item as it used more paper to keep track of the item and at the same time the papers need more spaces to stored. It will become less efficiency as longer time is needed to arrange the information from all the storage and find the information about a certain item within that huge pile of papers.

To overcome this, computerized Inventory Management System has been introduced to increase the efficiency despite having a large storage and making possible to search the information or a specific item in a short time. Nowadays, the computerized Inventory System has been further improved by the technology we have today and even real time item monitoring is possible for the user can make modify or view the storage status and item status with a few clicks by their fingertips.

Computerized Inventory Management System involved a computer loaded with a software capable of interacting with user using Graphical User Interface and capable of registering new items, deleting items, modifying items details, generate a label for each item, categorizing each item accordingly and store the data in a database and display it in the Graphical User Interface for the user to view or modify it. The labels are later on being used to label the items and a scanner is used to scan the labels to identify the item and view its detail on the Graphical User Interface.

There are many type of methods that can be used to label and identify an item. One of the oldest methods is barcode system. By generating unique barcode through the computer after registering a new item and its details and label the item with the generated barcode, user will be able to identify all the status of the specific item and search the item more efficiently at the computer by simply scanning the barcode using a barcode scanner. Besides that, QR code system is also one of the favourite systems used to identify the item status and it works similiarly to the barcode system which require user to input the data to generate a code unique to a specific item and scan the code to obtain the item information.

This project aims to develop and validate an user-friendly Inventory Management System (IMS) software capable of storing large amount of data on items for usage in biomedical field, Small-Medium-Entrepreneurs companies and any other organization or company with a low cost.

### **1.3 PROBLEM STATEMENT**

Inventory management has been practiced by many companies to increase efficiency of item flow. Nowadays, Small and Medium Entrepreneurs (SMEs) still practice inventory management using traditional method such as spreadsheet and order list although they are in the era of technology. Hence, Inventory Management System can be computerized to further increase the efficiency of item flow and easier to manage.

### **1.4 OBJECTIVES**

- I. To identify the most suitable software development tool to design Inventory Management System (IMS).
- II. To design and develop a low cost Inventory Management System (IMS) software.
- III. To validate and verify the Inventory Management System (IMS) software.

### **1.5 SCOPE OF RESEARCH**

- I. The software will be used in field of biomedical to organize the storage.
- II. The software will be used by SMEs companies to organize their storage.
- III. The software can be used by University Malaysia Pahang to organize university property.
- IV. The software can be used by the laboratory in Faculty of Manufacturing Engineering, University Malaysia Pahang.

## **CHAPTER 2**

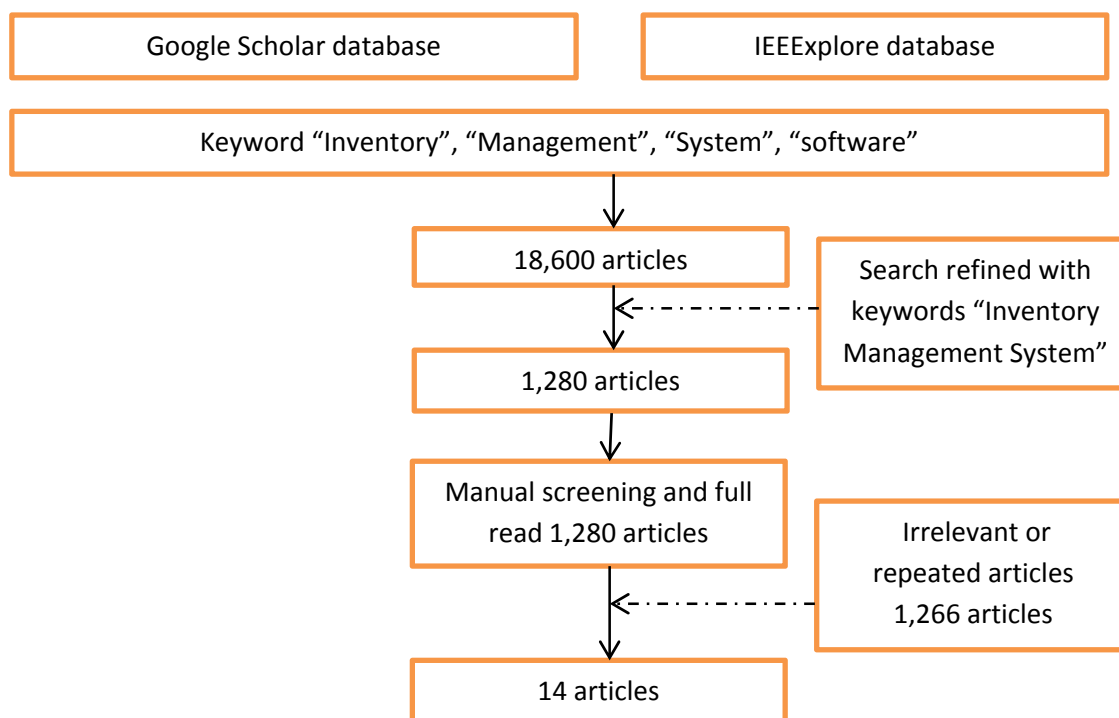
### **LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

In this section, the researches and studies done on article with previous similar projects which is to develop an Inventory Management System (IMS) software will be discussed. In addition, method of doing the literature research will also be discussed. The studies done are mainly to determine the software development tool used and technology used to create the IMS software in the previous projects and also the features of the IMS software. Then the knowledge gained from this section will be used as references to determine the direction of this project to create an unique Inventory Management System software.

#### **2.2 METHOD OF LITERATURE SEARCH**

By using the keyword “Inventory Management System Software”, a search on the literature is conducted on the studies published between year 2005 and 2014, in the Google Scholar database and IEEExplore database. Then the search was refined by adding keywords “Inventory Management System”. Then the result is further filtered using the criteria. The criteria included were: (1) Development of Inventory Management System and (2) Designing and analysis of Inventory Management System. The criterion excluded was: (1) Simulation of Inventory Management System.



**Figure 2.1:** Flow Chart of method used for literature search

## 2.3 GAP FINDING

This part will focus on discussing the literature search results and the literatures found. The literatures will be further analyzed to identify the technology and software development tool used to develop the Inventory Management System software in the previous projects and determine the gap of the previous projects. Then, the technology and software development tool of this project and features of this software will be determine based on the summary make from the literature analysis.

### 2.3.1 LITERATURE SEARCH RESULTS

The study shows that a total of 16800 articles that fitted the criteria words: "Inventory", "Management", "System", and "Software" were retrieved from the online database used. A refined search using the keyword "Inventory Management System" was made and retrieved 1280 articles. Then 1266 articles were excluded according to the criteria set, and only 14 articles were being analyzed further. The method is as shown in figure 2.1. In the table 2.1, the studies are done using Google scholar and

IEEEExplore. From number 1 to 12, the papers are found in Google Scholar with the exact keyword “Inventory Management System” and for number 13 to 14, the papers are found in IEEEExplore with the exact keyword “Inventory Management System”.



No.	Years	Title	Software Used	Technology used	Objective	Methodology	Focus	Author
1	2014	AN RFID based supply chain Inventory Management Solution for the petroleum development industry: A case study for Shell Nigeria [1]	Not mentioned	RFID	To show that an RFID supply chain inventory management system can be a viable solution to the infinite challenges faced in the operation of the storage in the petroleum development industry	Design solution architecture with management application as the center connected to inventory database and to mobile RFID reader within store and Fixed RFID reader at store exit > the tag readers will be linked to ERP system database to detect and trace the items movements	enhance the operational efficiency of the logistic and warehouse organization	Inalegwu Adoga and Raul Valverde
2	2014	Development of Mobile Enterprise Inventory Management System Application with CBD [2]	Android software, AppGyver, HTML5, SQL server	Barcode/QR code enabled smartphone	To design a mobile application intended for enterprise used, run in mobile devices with the CBD software engineering technique	Identify the components of the system > Break down functions > develop the system using SDLC methodology (planning > analysis > design > implementation)	high security data server, mobility (smart phone apps used in real time), increase efficiency, accuracy, software stability, understandability	Yvette E. Gebogo and Haeng-Kon Kim
3	2013	Application of RFID on equipment parts readiness management system of semiconductor packaging plant [3]	Visual Basic 6.0	RFID tags	To apply RFID on equipment parts readiness management system of semiconductor to decrease production time	Design system hardware based on operation procedure of REPE-MS > Design the RFID operation procedure > Design the system > Design the software > Compare the performance of the gadgets now and before	Enhance gadgets performance and efficiency	Wei-Ling Wang, Chia-Tzu Huang, Shi-Jen Wang and Chia-Pao Chang
4	2011	An Intelligent Warehouse Stock Management and Tracking System based on Silicon Identification Technology and 1-wire Network Communication [4]	Microsoft .Net, TIMEX C API, and Microsoft MySQL	Silicon Identification Technology (One-wire Network Communication)	To develop a wide variety Intelligent Warehouse Stock Management and Tracking system by introducing iButtons run on one-wire network protocol for various application	1-wire communication protocol and iButtons enhance with chain function communication concept > Conditional Read ROM function is added > Design GUI	Low cost, iButtons has high reliability and durability, Technological Acceptability, Rapid Development Time	Kai-Xin Tee
5	2011	The Application of Wi-Fi RTLS in Automatic Warehouse Management System [5]	Not mentioned	PIC16C73, RFID tags, bar code, wireless modules	To solve the management of warehouse related information by applying Wi-Fi RTLS technology	Design system hardware using MCU PIC16C73 as controller > system software design based on system functions	Increase item transfer capacity within one day, automatic item identification and item data tracing, verify and supervision function, cost reduction	Xiangguo Ma
6	2012	Design of an RFID-based Inventory Control and Management System: A case study [6]	Not mentioned	RFID	To enhance product life cycle management by collecting accurate real-time transactions of physical stock items data.	Identify the current management problem > Identify the work flow in and out > Design the system > Assess the workplace compatibility with RFID > Implement system >	Enhance the system's capability of identifying transactions and locations of tagged stock items reduce cost and increase efficiency	Jacky S.L. Ting and Albert H.C. Tsang

7	2011	The use of RFID and web 2.0 Technologies to Improve Inventory Management in South African Enterprises [7]	Web 2.0 tool	RFID	To introduce the use of a Web 2.0 tool such as twitter fuse with RFID technology to update the inventory manager on the inventory status anytime and anywhere.	Design and propose architecture for inventory management where internet is the center of the control which connect the local server to a remote server, QNS server and to user cellphone for user to access	Increase efficiency, mobility and real time update	Sizakele Mathaba, Nomusa Dlodlo, Andrew Smith and Mathew Adigun
8	2013	Wireless Infrastructure for Oil and Gas Inventory [8]	XML	RFID, Wireless Sensor Network	To develop an online inventory management system which enables monitoring the essential events in oil and gas offshore environment using a user intuitive web interface application	Design the system includes 5 modules (RFID system, weight measurement system, wirelessHAART compliant node for communication, WirelessHART compliant gateway for network management and co-ordination and Total Inventory Web server application enable remote access)	Increase efficiency, long range management	Shanthi Yellingri, Apala Ray, Maalikarjun Kande
9	2010	Intelligent service-integrated platform based on the RFID technology and software agent system [9]	Not mentioned	RFID, Software Agent	To design an intelligence platform with framework based on software agents to build an integrated information system mechanism integrated with RFID technology act as the trigger point for commodity message receiver as smart shelf to enhance performance of the sales outlets, customer service and identify popular commodity	Design the system architecture > determine the types of software agents to be used and its function > Determine the type of RFID to be used and its function > Design the architecture of the intelligent service-integrated platform	real time customers demand and product status control, increase accuracy of forecast of inventory data, decrease issues on shortage and replenishment, enhance product and customer support	Kun-Chieh Yeh, Ruey-Shan Chen and Chia-Chen Chen
10	2010	The Design and Implementation of the Integrated Supply Chain Management System Based on UML and J2EE Technology [10]	J2EE	UML, J2EE	To plan, build and apply Integrated Supply Chain Management System (SCMS) based on J2EE and UML	Plan the Architecture of the system based on J2EE technology > Design and apply integrated supplychain management system	optimize the supply chain performance	Yongchun Wu, Zhenjian Jiang, Na Han
11	2009	A RFID-based Material Supply Management System in Automatic Vehicle Assembly Streamline [11]	MySQL server, Sun Java System RFID, J2EE	RFID, J2EE	To build a RFID-based item source management in automatic vehicle assembly streamline for control over the material consumption of each work space in real time	Plan the system architecture > prototyping > Implement the System	enhance efficiency and accuracy of item supplement in the workshop	Wexing Su, Kunyuan Hu, Lei Zhang, Lianbo Ma
12	2008	Development and Implementation of Radio-frequency Identification (RFID) technology for inventory management system: A case study [12]	Visual Basic 6.0, Microsoft Access data base packages	RFID	To develop and implement RFID technology for supply store inventory management system	Analysis the data of previous system > Determine the flow of data > Design and develop system hardware > Design and develop software	increase efficiency and effectiveness of the system	Wan Harun Wan Hamid and Loh Chee Hong

13	2013	Research and design of the intelligent inventory management system based on RFID [13]	SQL server 2005, web server	GSM, RFID	To analyses the data flow of intelligent inventory system from the perspective of business and function and design and develop a specific framework program and function modules of intelligent inventory management system based on IOT RFID technology.	Design network structure > Design system function and structure > Design system database	Saving logistics costs, reducing labors costs, improving operation accuracy and storage efficiency	XiaoJun, Jing and Peng Tang
14	2011	The Design and Implementation of Distributed Inventory Management System Based on the Intranet Architecture [14]	SQL server 2005, Web server, ASP.NET + C# language	Non	To investigates and plans the distributed inventory management system function model, and propose system design and implementation methods, and implement the valid management and retrieve distributed inventory information fast and accurately	Functional model based on analysis on all of the products status is build > Develop the system software	increase information efficiency, reduce cost and time consumption, increase production varieties, increase income, assist in decision making, enhance communication platform for optimal material reserve	Liling Xia

**Table 2.1:** Summary studies comparing the methods and technology used to develop an Inventory Management System

### 2.3.2 THE TECHNOLOGY USED

Most of the studies (Wan Hanun Wan Hamid and Loh Chee Hong (2008); Xiaojun Jing and Peng Tang(2013); Weixing Su et al.(2009); Kun-Chieh Yeh et al.(2010); Sharthi Vellingiri et al(2011); Sizakele Mathaba et al.(2011); Jacky S.L. Ting and Albert H.C. Tsang(2011); Wei-Ling Wang et al. (2013); Inalgewu Adoga and Raul Vaverde (2014)) used RFID as the medium to identify and track the items in the inventory[1,3,4,6,7,8,9,11,12,13]. Whereas the studies by Kai-Xin Tee (2011) used Silicon Identification Technology to identify and track the items [4] and Yvette E. Gelogo and HaengKon Kim (2013) used Barcode and QR-code to identify and track the item [2]. Besides that, Xiangguo Ma (2011) has used combine technology of RFID and barcode to identify and track the item [6].

### 2.3.3 THE SOFTWARE DEVELOPMENT TOOL USED

For developing the Graphical User Interface (GUI), Wan Hanun Wan Hamid and Loh Chee Hong (2008) and Wei-Ling Wang et al.(2013) used Visual Basic 6.0 [3,12]. As for Xiaojun Jing and Peng Tang(2013); Liling Xia (2011); Sizakele Mathaba et al.(2011); Kai-Xin Tee (2011) they used Microsoft .NET Framework to create the Graphical User Interface [7,13,14]. Weixing Su et al.(2009); Yongchun We, Zhenjian Jiang, Na Han(2010) used J2EE to create the Graphical User Interface [10,11]. Yvette E. Gelogo and HaengKon Kim (2013) used Android software development tools, AppGvyer to create the GUI for mobile phone and HTML5 for computer [2]. On the other hand, Sharthi Vellingiri et al.(2011) used XML to develop GUI [8].

As for database server, most of the studies (Yvette E. Gelogo and HaengKon Kim (2013); Kai-Xin Tee (2011); Weixing Su et al.(2009); Xiaojun Jing and Peng Tang(2013); Liling Xia (2011) ) used SQL server to build the database [2,3,4,11,14]. Wan Hanun Wan Hamid and Loh Chee Hong (2008) used Microsoft Access to create the database[12].

### 2.3.4 THE SOFTWARE FEATURES OF THE PREVIOUS PROJETS

One of the aims of all of the articles except Kai-Xin Tee (2011) is to improve the efficiency of inventory management [1,2,3,5,6,7,8,9,10,11,12,13,14]. Liling Xia (2011); Xiaojun Jing and Peng Tan (2013); Kai-Xin Tee (2011) have additional aim to reduce the costs for inventory management system [4,11,13]. Moreover, Yvette E. Gelogo and Haeng-Kon Kim (2013) has others aims that are increase mobility, software accuracy, stability and understandability and high security data server [2]. While Kai-Xin Tee (2011) mainly focus on introducing new technology “iButtons” and its acceptability with its rapid development time and high reliability and durability features [4]. In addition, Sizakele Mathaba et al.(2011) has aim to provide real time update besides its focus to increase efficiency and mobility [7]. Kun-Chieh Yeh et al.(2010) has aim to provide real time customer demand and merchandise status control to improve product service and customer supports [9].

## 2.4 CONCLUSION

Based on the studies done on all 14 articles, it is discovered that the usage of software development tool such as Visual Studio, Code Block and Dev C++ and android software development tools such as Eclipses and Unity have not been tried. GUI which enable the user to access the database from the main server and also from mobile phone. Most of the projects adapt Microsoft .NET to make GUI. The database is made using SQL server and only one project used Access to create the database. There is no attempt on using excel to create a database or create a cloud database. As for the technology, RFID is used in most of the projects to identify and track the item and barcode/QR-code is rarely used. As for focus of the projects, overall aim to improve efficiency of the Inventory Management System. There are only 2 articles paid extra attentions on providing real time control or monitoring. In addition, only 1 article paid more attention on increase mobility, software accuracy, stability and understandability and high security data server.

As a conclusion, the features of this software will be to increase efficiency, real time control and monitoring, increase understandability and low stock alarm feature.

## **CHAPTER 3**

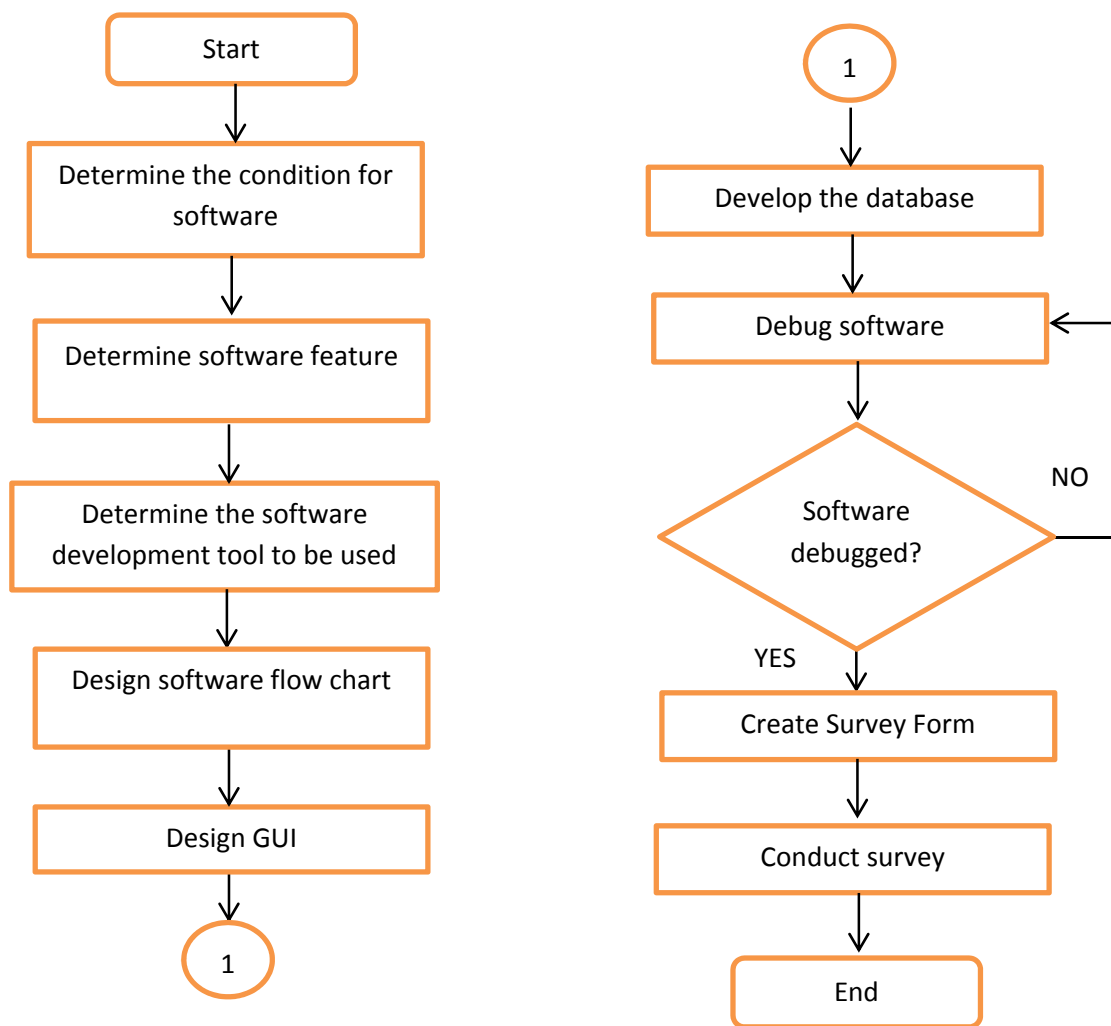
### **METHODOLOGY**

#### **3.1 INTRODUCTION**

In this section, the method and software development tool used to develop the Inventory Management System (IMS) will be discussed. The method used to develop the software will be explained in details together with figures and flow charts.

#### **3.2 METHOD TO DEVELOP IMS SOFTWARE**

First, a condition will be set on the software based on the usage of the software. Then, the features of the software are determined based on the needs. Next, a data flow diagram is created to determine the flow of data from server to user. The software development tools is chosen based on the limitation and features. Then, the software flow chart is created based on the limitation and features. Next, the conceptual design of the GUI is created to visualize how the software will looks like when it is done. Next the GUI will be built with the full function including the QR Code Encoder and Decoder follow by the creation of database. The software will be debugged until it can run smoothly. Lastly, a survey form is created to gather data on user satisfaction and the software will be tested by 10 persons and then fill up the survey form.



**Figure 3.1:** Method to develop Inventory Management System (IMS) Software

### 3.3 DETERMINE THE CONDITION FOR SOFTWARE

A condition is set to act as the boundary of the software so that it will only function within the boundary based on the usage of the software. According to the objective of this project, the software will be used within companies of SMEs and biomedical field. Hence, it is assume that the software will be used locally, within the company and there is only one storage area since the company is not too large. Next the software will be made available only on the server computer to register the check in/ out of the item and check the status of items to prevent multiple access at the same time which will causes data to overload.

### **3.4 DETERMINE SOFTWARE FEATURE**

The features of the software are determined based on the expected outcome and the result of the research done in chapter 2 literature review. First, the software have to be user friendly so that it is easily understand and can be used by the user without the needs of training. Next, the basic feature of the software is to register item for both check in and check out. Besides that, user can add in description to help user to recognize the item. The database will be updated in real time. In addition, users will able to scan the QR code on the item to determine and extract the item information and status at any time from the server computer. The database is MySQL database that will be hosted by a free software XAMPP. Moreover, there is a low stock reminder function to remind the user that the item quantity of the certain item is lower than the 5 so that the user can restock accordingly.

### **3.5 DETERMINE THE SOFTWARE DEVELOPMENT TOOLS TO BE USED**

A research have been done on the current IMS software in the market, and the following table 3.1 is a list of IMS software available in current market. Based on table 3.1, it can be concluded that the language used to develop the software is normally separated into two group C programming(C, C++, C#) and JAVA programming. As listed in table 3.1, most of the software is windows based which means that they are developed using C, C++, or C# language that runs on windows platform. There are a few of the software is developed using JAVA which can be website based or android based. JavaScript can be added in PHP to run on website and JAVA language can be used to develop Android apps or even to make windows based apps.