COMPUTER UNIVERSITY (MANDALAY)

FINAL YEAR PROJECT REPORT

ON

INVENTORY CONTROL SYSTEM FOR ELECTRONIC SHOP USING MONTE CARLO SIMULATION TECHNIQUE

Bachelor of Computer Science

(B. C. Sc.)

Presented by Group (10)

2014-2015

Acknowledgements

First of all, we would also like to thank Dr. Win Aye, Rector of the Computer University (Mandalay), for overall supporting during our project. We appreciate her endless patience, positive outlook, ability to provide advice.

We respectfully thank to Dr. Aye Aye Chaw, Associate Professor, Head of Software Department at Computer University (Mandalay) for the invaluable guidance and expertisefor editing our project from technical point of view and Dr. Zarni San, Associate Professor, Head of Hardware Department at Computer University (Mandalay).

We would also like to express our special thanks toour supervisor Dr. Cho Cho Khaing, Lecturer, Software Departmentand she has provided not only helpful guidance but also a lot of inspiration, motivation and encouragement during our project.

We would like to express my respectful gratitude to U Thaung Kyaw, Head of English Department at Computer University(Mandalay) and Daw Wai Wai Myint, Tutor, English Department, for editing our project from English language point of view.

Finally, We also thank to all our teachers for their mentoring, encouragement, and recommending this project.

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Project Schedule

Project Proposal : **: March,2015**

First Seminar : **:13.5.2015**

Second Seminar : **:17.6.2015**

Third Seminar : **:22.7.2015**

Book Submission : **: September, 2015**

Time Schedule	March 2015	May 2015	June 2015	July 2015	September 2015
Project Proposal					
First Seminar					
Second Seminar					
Third Seminar					
Book Submission					

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Abstract

An inventory control system is a process for managing and locating objects or materials. Inventory control is important to ensure quality control in businesses that handle transactions revolving around consumer goods. A good inventory control system will alert the retailer when it is time to order. It can be used to make an estimate, forecast or decision where there is significant uncertainty. Monte Carlo simulation proved to be surprisingly effective at finding solutions to the problems. Monte Carlo methods have been applied to an incredibly diverse range of problems in science, engineering, finance and business applications in virtually every industry. The system will simulate the inventory control system to obtain the minimization of the total cost of the product ordering, holding and losses. Without proper inventory control, a large retail store may run out of stock on an important item. In order to control the inventory system, this system will be implemented by using Monte Carlo simulation technique for Electronic Shop. It is a technique that involves using random numbers and probability to solve problems. This system also analyzes the total costs depends on various reorder points, leading time and order quantity.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Inventory control may be used to automate sales order fulfillment process and also manage input and output materials. Inventory control is important to ensure quality control in businesses that handle transactions revolving around consumer goods. If an inventory control system is being simulated, then the problem may concern the determination of the size of order when inventory level falls up to reorder level. Keeping an inventory (stock of goods) for future sale is common in business. In order to meet demand on time, companies must keep on hand a stock of goods that is awaiting sale. The purpose of inventory theory is to minimize the costs associated with maintaining inventory and meeting customer demand. It is a list for goods and materials, or those goods and materials themselves held available in stock by a business. It is required at different locations within a facility or within multiple locations of a supply network to protect the regular and planned course of production against the random disturbance of running out of materials of goods. Maintaining inventories at their proper levels eliminates production shutdowns, from lack of raw materials and lost sales from lack of finished goods. Inventory information system provides information about inventory levels, stock out conditions, stock receipts, stock issues, stock damage and the location and distribution of stock within the organization [3].

This system describes a practical application of Monte Carlo Simulation technique in forecasting. A Monte Carlo application is a model that calculates the expected outcome of a system. This system calculates the minimum cost of the product ordering. This system also analyzes the total cost of various values such as reorder point, order quantity and lead time. Using Monte Carlo Simulation technique, the system can decide the best of inventory system depending on the various values.

1.2 Objectives of the Project

- To simulate the essence of actual operation.
- To obtain the minimum cost that depends on holding cost, ordering cost and shortage cost.
- To analyze large and complex real life problems which cannot be solved by usual quantitative methods.

1.3 Project Requirements

There are two types of requirements in project. They are hardware requirements and software requirements.

1.3.1 Hardware Requirements

- A computer that has at least P4 compactible
- At least 4GB memory (RAM)
- CD disk drive and other peripheral devices

1.3.2 Software Requirements

- Microsoft Office Word 2010 or higher
- Microsoft Visual Studio 2010 Ultimate
- Microsoft SQL Server 2010

CHAPTER 2

THEORY BACKGROUND

2.1 Simulation

Simulation is a powerful technique for solving a wide variety of problems. Simulation is an imitation of the operation of a real world processor system over time. Simulation involves the generation of an artificial history of a system and the observation of that artificial history to draw inferences concerning of the operating characteristics of the real system. Simulation is done either manually or using computers. Simulation is basically an experimental technique. It is a fast and relatively inexpensive method of doing an experiment on the computer. Simulation is a numerical solution method that seeks optimal alternatives (strategies) through a trial and error process. The simulation approach can be used to study almost any problem that involves uncertainty, i.e. one or more decision variables can be represented by a probability distribution, like decision making under risk. However, simulation approach requires an analogous physical model to represent mathematical and logical relationship among variables of the problem under study. After having constructed the desired model, the simulation approach evaluate each alternative (measure of performance) by generating a series of values of random variable on paper over a period of time within the given set of conditions or criteria. This process of generating series of values one after another to understand the behavior of the system (operational information) is called executing (running or experimenting) model on computers. Simulation is the fast and relatively inexpensive method of performing 'experiments' on the computers.

For example,

(1) In inventory control, the problem of determining the optimal replenishment policy arises due to the probabilistic (stochastic) nature of demand and lead time. Thus, instead of trying out in actual manually the three replenishment alternatives for each level of demand and lead time for a period of one year and then selecting the best one, we processed date (called experiment) on the computer and obtained the results in a very short time at a very small cost.

(2) In queuing theory the problem of balancing the cost of waiting against the cost of idle time of service facilities, in the system arises due to the probabilistic nature of the inter-arrival times of customers and the time taken to complete service to the customer. Thus, instead of trying out in actual manually data to design a single server queuing system, we processed the data on computers and obtained the expected value of various characteristics of the queuing system such as idle time of severs, average waiting time, queue length, etc [1].

The basic idea behind simulation include :

- Model the given system by means of some equations.
- Determine its time dependent behavior.

The simplicity of approach when combined with the computational power of the high speed digital computer makes simulation a power full tool

Simulation is mostly used when :

- An exact analytic expression for the behavior of the system under investigation is not available
- The analytic solution is too time consuming or expensive.

Simulation modelling can be used as :

- An analysis tool: To predict the effect of changes to the effect of changes to existing system.
- A design tool: To predict the performance of new systems under varying set of circumstances.

2.1.1 Examples of simulation applications in services

- Simulation aircraft delay absorption
- Runway schedule determination by simulation optimization

2.1.2 Steps Of Simulation Process

The process of simulating a system consists of following steps:

Step1: Identify the problem

If an inventory system is being simulated, then the problem may concern the determination of the size of order, number of units to be ordered) when inventory level falls reorder level (point).

Step2: (a)Identify the decision variables

(b) Decide the performance criterion (objective) and decisions rules. In the context of the above defined inventory problem, the demand (consumption rate),time and safety stock are identified as decision variables. These variables shall be responsible to measure the performance of the system in terms of total inventory cost under the decision rule_ when to order.

Step3: Construct a numerical model so that it can be analyzed on the computer. Sometimes the model is written in a particular simulation language which if suited for the problem under analysis.

Step4: Validate the model to ensure whether it is truly representing the system being analyzed and the results will be reliable.

Step5: Design the experiments to be conducted with the simulation model by listing specific values of variables to be tested (i.e. list courses of action for testing) at each trial (run).

Step6: Run the simulation model on the computer to get the results in the form of operating characteristics.

Step7: Examine the results in terms of problem solution as well as their reliability and correctness. If the simulation process is complete, then select the best course of action otherwise make desired changes in model decision variables, parameters or design, and return to Step3[1].

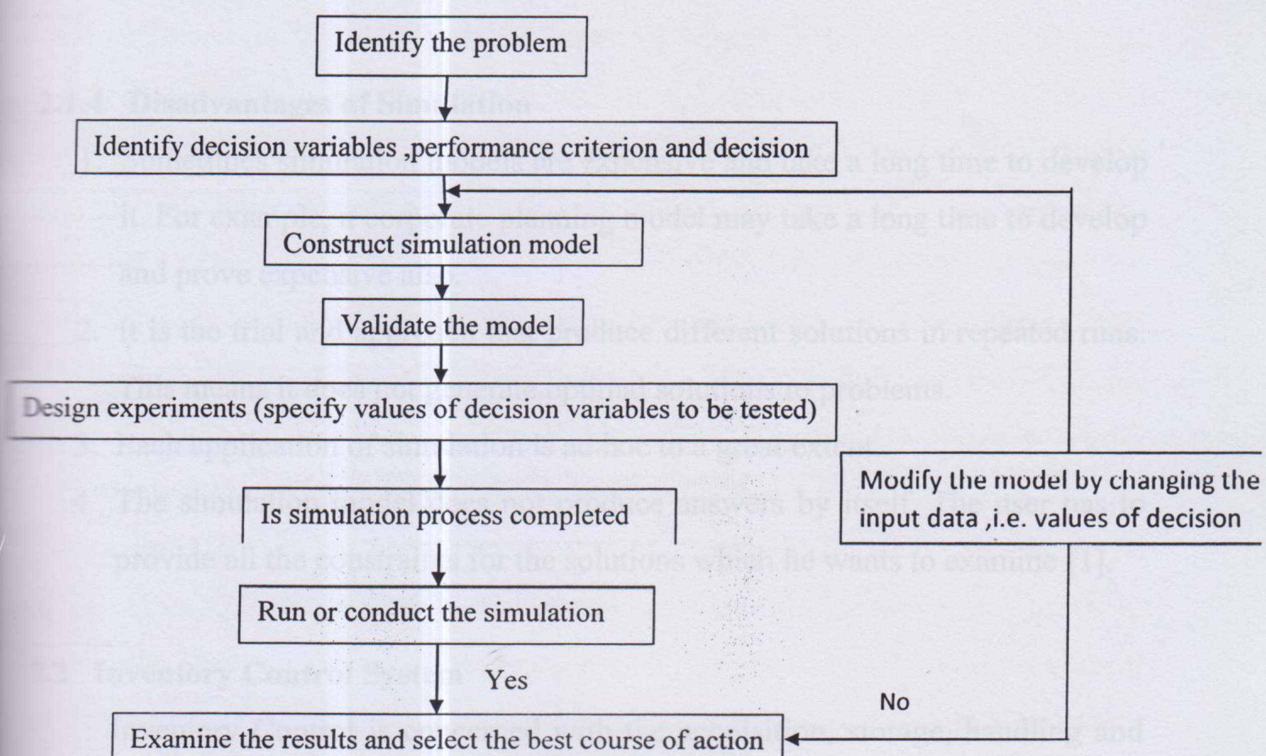


Figure 2.1 Steps of Simulation Process

2.1.3 Advantages of Simulation

1. This approach is suitable to analyze large and complex real life problems which cannot be solved by usual quantitative methods.
2. Simulation allows the decision maker to study the interactive system variables and the reflect on changes in these variables on the system performance in order to determine the desired one.
3. Simulation experiments are done with the model, not on the system itself. It also allows to include additional information during analysis that most quantitative models do not permit.
4. Simulation can be used as a pre-service test to try out new policies and decision rules for operating a system before running the risk of experimentation in the real system.

2.1.4 Disadvantages of Simulation

1. Sometimes simulation models are expensive and take a long time to develop it. For example, a corporate planning model may take a long time to develop and prove expensive also.
2. It is the trial and approach that produce different solutions in repeated runs. This means it does not generate optimal solutions to problems.
3. Each application of simulation is ad hoc to a great extent.
4. The simulation model does not produce answers by itself. The user has to provide all the constraints for the solutions which he wants to examine [1].

2.2 Inventory Control System

Inventory Control is concerned with the acquisition, storage, handling and use of inventories so as to ensure the availability of inventory whenever needed, providing adequate provision for contingencies, deriving maximum economy and minimizing wastage and losses.

Hence Inventory control refers to a system, which ensures the supply of required quantity and quality of inventory at the required time and at the same time prevent unnecessary investment in inventories. It is one of the most vital phase of material management. Reducing inventories without impairing operating efficiency frees working capital that can be effectively employed elsewhere. Inventory control can make or break a company. This explains the usual saying that "inventories" are the graveyard of a business. Designing a sound inventory control system is in a large measure for balancing operations. It is the focal point of many seemingly conflicting interests and considerations both short range and long range. The aim of a sound inventory control system is to secure the best balance between "too much and too little." Too much inventory carries financial rises and too little reacts adversely on continuity of productions and competitive dynamics. The real problem is not the reduction of the size of the inventory as a whole but to secure a scientifically determined balance between several items that make up the inventory. The efficiency of inventory control affects the flexibility of the firm. Insufficient procedures may result in an unbalanced inventory. Some items out of stock, other overstocked, necessitating excessive investment. These inefficiencies ultimately will have adverse effects upon profits. Turning the situation round, difference in the efficiency of the inventory control for a given level of flexibility affects the level of investment required in inventory. The less efficient is the inventory control, the greater is the investment required. Excessive investment in inventories increase cost and reduce profits, thus, the effects of inventory control of flexibility and on level of investment required in inventories represent two sides of the same coin.

Control of inventory is exercised by introducing various measures of inventory control, such as ABC analysis fixation of norms of inventory holdings and reorder point and a close watch on the movements of inventories [2].

2.3 Monte Carlo Simulation

A Monte Carlo method is a stochastic technique that involves use of random numbers and probability statistics to solve the problems. The term Monte Carlo Method was coined by S. Ulam and Nicholas Metropolis in reference to games of chance, a popular attraction in Monte Carlo, Monaco (Hoffman, 1998; Metropolis and Ulam, 1949). This method can be used in many areas from economics, nuclear physics to regulating the flow of traffic. To call something a "Monte Carlo" experiment, all you need to do is use random numbers to examine some problem. The Monte Carlo method is just one of many methods for analyzing uncertainty propagation, where the goal is to determine how random variation, lack of knowledge, or error affects the sensitivity, performance, or reliability of the system that is being modeled. Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple of uncertain parameters.

The principle behind the Monte Carlo simulation technique is replacement of the given system under analysis by a system described by some known probability distribution and then drawing random samples from probability distribution by means of random numbers. In case it is not possible to describe a system in terms of standard probability distribution such as normal, Poisson, exponential, gamma, etc., an empirical probability distribution can be constructed.

The Monte Carlo simulation technique consists of following steps:

1. Setting up a probability distribution for variables to be analyzed.

2. Building a cumulative probability distribution for each random variable.
3. Assign an appropriate set of random numbers to represent value or range (interval) of values for each random variable.
4. Conduct the simulation experiment by means of random sampling.
5. Repeat Step4 until the required number of simulation run has been generated.
6. Design and implement a course of action and maintain control [1].

2.4 Computer Generator

The random numbers that are generated by using computer software are uniformly distributed decimal fractions between 0 and 1.The software works on the concept of cumulative distribution function for the random variables for which we are seeking to generate random numbers.

For example, for the negative exponential function with density function $f(x) = \omega e^{-\omega x}, 0 < x < \infty$, the cumulative distribution function is given by

$$F(x) = \int_0^x \omega e^{-\omega x}\, dy = 1 - e^{-\omega x} \tag{2.1}$$

Or

$$e^{-\omega x} = 1 - F(x)$$

Taking logarithm on both sides, we have

$$-\omega x = \log[1 - F(x)]$$

Or

$$x = -\frac{\log[1 - F(x)]}{\omega}$$

If $r = F(x)$ is a uniformly distributed random decimal fraction between 0 and 1, then the exponential variable associated with r is given by

$$x_n = -\frac{\log[1 - r]}{\omega} = -\frac{\log r}{\omega}$$

This is an exponential process generator since $1 - r$ is a random number and can be replaced by r[1].

2.5 Method Description

Lead Time: Lead time is the number of minutes, hours or days between the placement of an order and delivery.

Shortage Cost: Shortage cost is the costs that incurred when an item is out of stock.

Loss: An amount of money lost by a business.

Reorder Point: Inventory level of an item which signals the need for a replenishment order.

Ordering Cost: Ordering costs are the incremental costs of processing an order of goods from a supplier.

Order Quantity: The number of pieces ordered to replenish the inventory.

Holding Cost: Holding costs are the additional costs involved in storing and maintaining goods of inventory.

CHAPTER 3

DESIGN AND IMPLEMENTATION

This system is implemented by Monte Carlo Simulation Technique. The flow of the system is depicted in figure. First of all, the customer searches the goods that he or her likes among electronic devices. And then, the system checks the amount of item quantities at database. If the goods have the required quantity at warehouse, the system calculates the total amount of the goods and replies the customers the costs of goods.

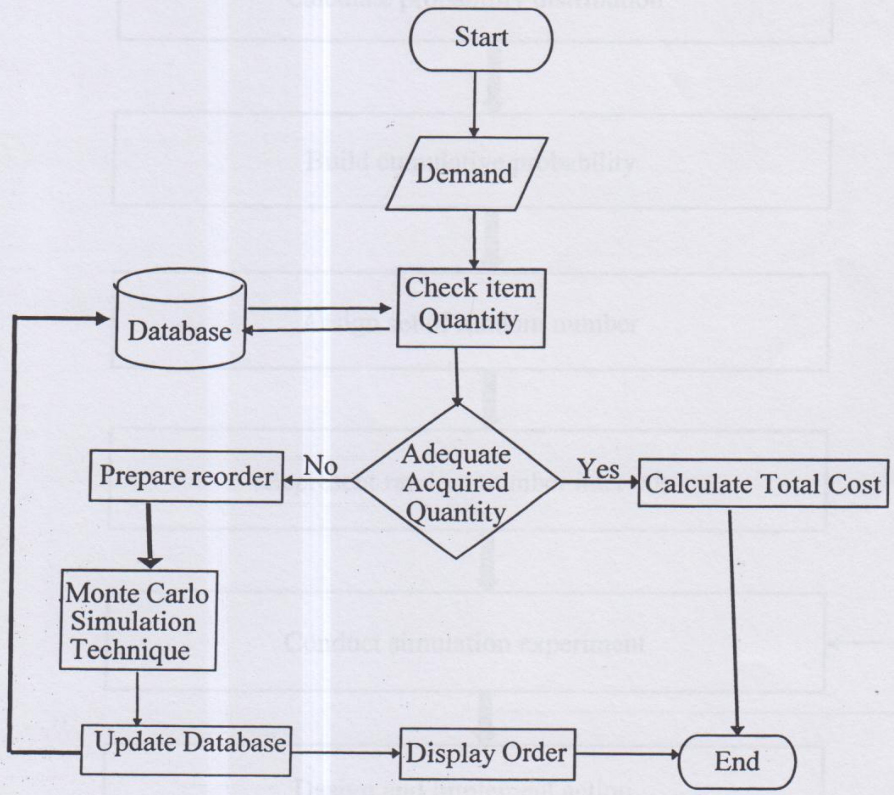


Figure 3.1 System Flow of Inventory Control System

Secondly, if the goods haven't the required quantity at warehouse, the system prepares for the reorder. At that time, the system uses Monte Carlo Simulation Technique in order to reduce the total costs including ordering costs, holding costs and shortage costs. And then, the system updates at database. Eventually, the system displays the order report.

3.1 Monte Carlo Simulation Technique

Monte Carlo Simulation Technique consists of six steps in Figure 3.2.

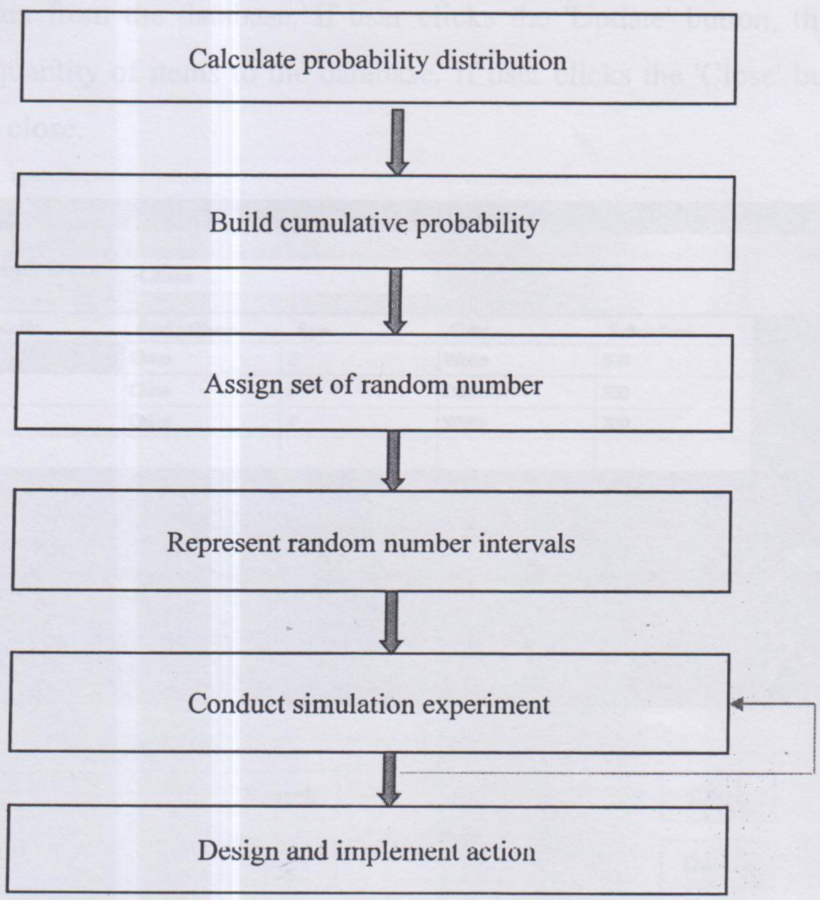


Figure 3.2 Steps of Monte Carlo Simulation Technique

3.2 Design and Implementation of the system

User enters product name to search his or her required material. And then user clicks the 'search' button. After clicking 'search' button, the system shows about this product from the database as shown in Figure 3.3.

After the user enters data to the form, user can click 'check' button. And then the system will show the amount of the data. User enters new data to the form. If user clicks 'Insert' button, the system shows new data at the database. When user enters the form, user can click 'Delete' button. And then the system will delete about this data from the database. If user clicks the 'Update' button, the system updates the quantity of items to the database. If user clicks the 'Close' button, the program will close.

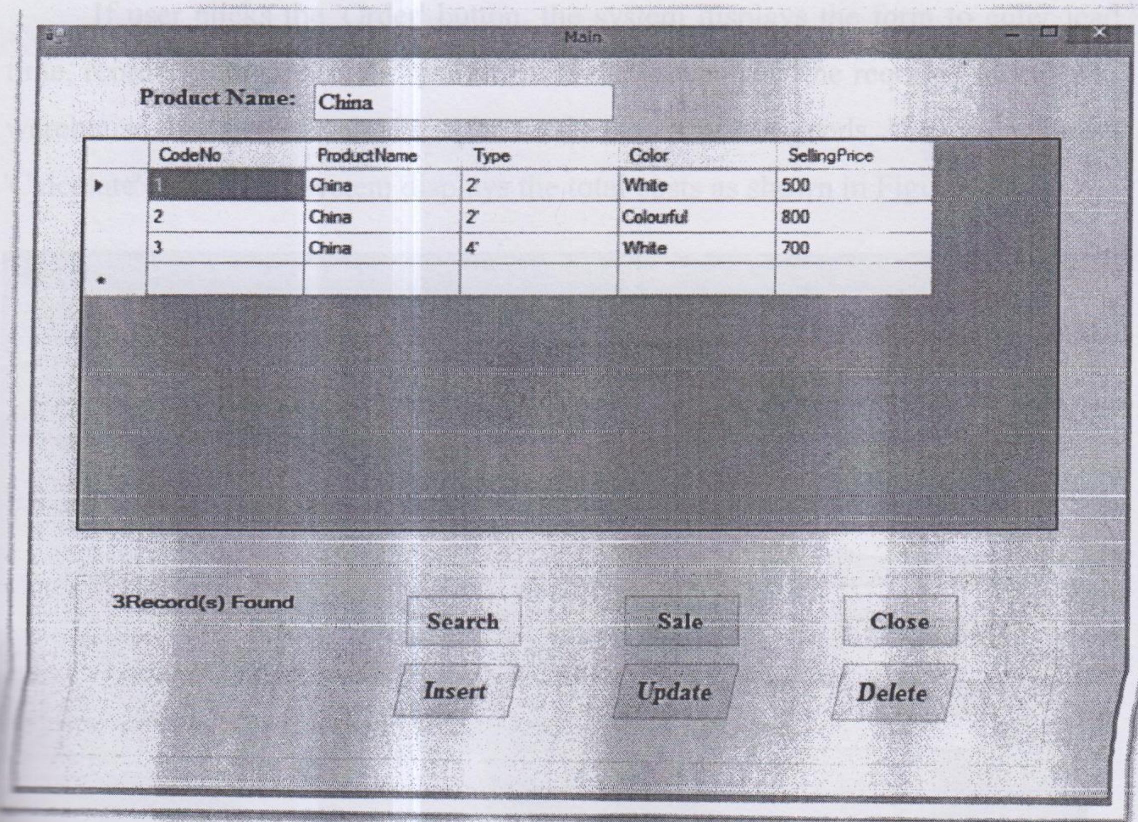


Figure 3.3 Searching items from warehouse

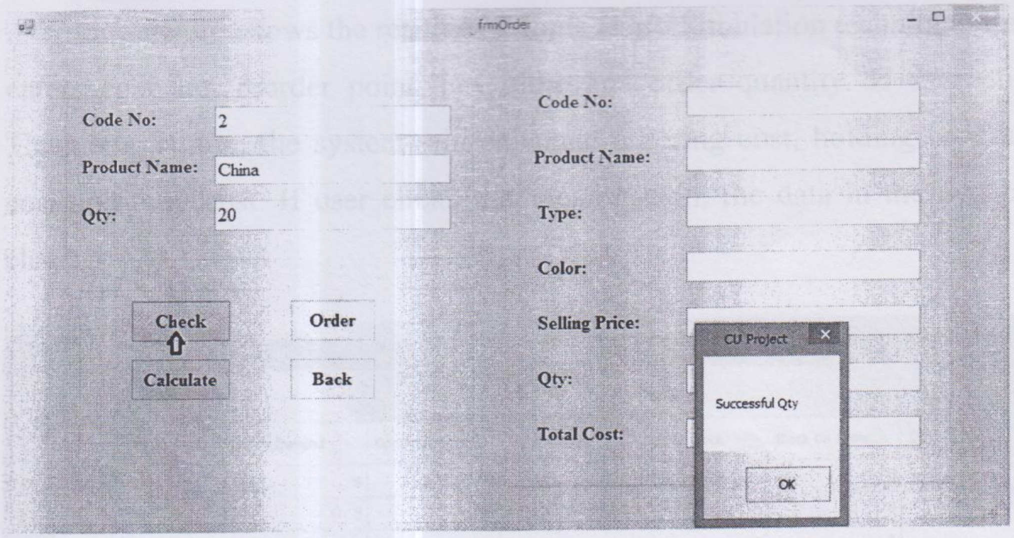


Figure 3.4 Check required items from warehouse

If user clicks the 'Order' button, the system displays the form to enter lead time, reorder point and order quantities. If the goods have the required quantity at warehouse, the system calculates the total amount of the goods. If user clicks the 'Calculate' button, the system displays the total costs as shown in Figure 3.5.

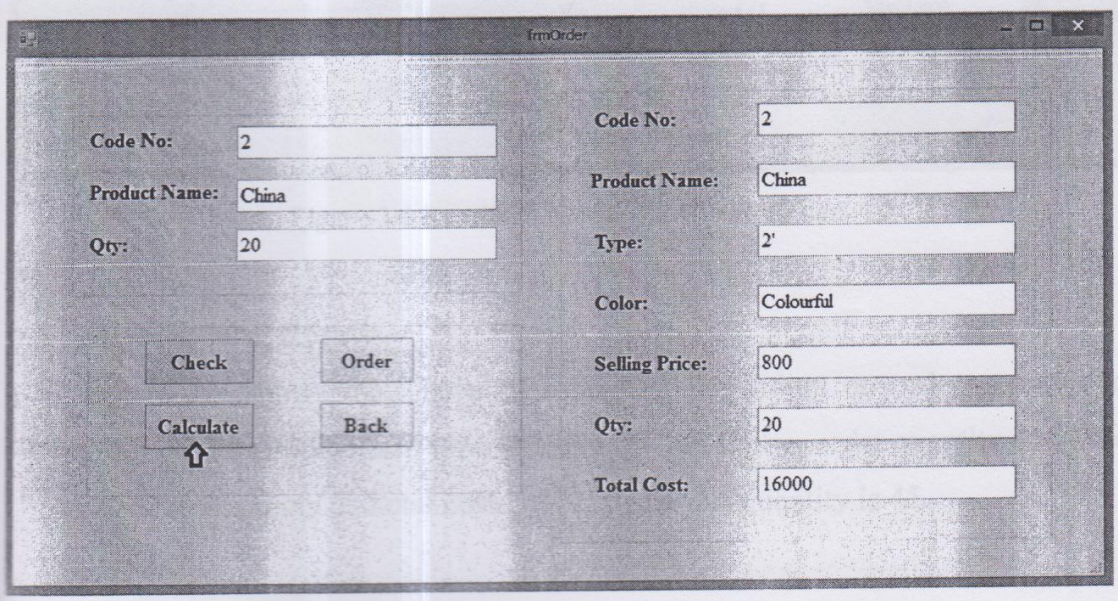
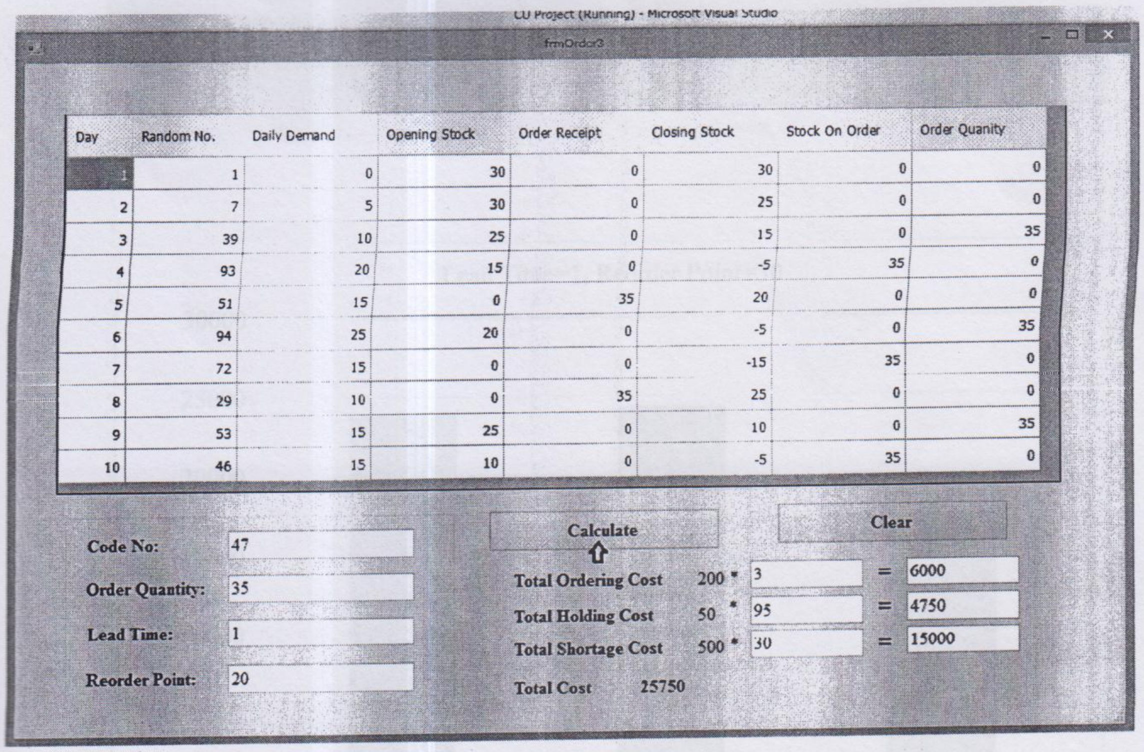


Figure 3.5 Calculate total cost

Figure 3.6 shows the result of Monte Carlo Simulation technique. First, user enters code no, reorder point, lead time and order quantity. If user clicks the 'Calculate' button, the system will calculate ordering cost, holding cost, shortage cost and total cost. If user clicks the 'clear' button, the data in the text box will clear.



Day	Random No.	Daily Demand	Opening Stock	Order Receipt	Closing Stock	Stock On Order	Order Quanity
1	1	0	30	0	30	0	0
2	7	5	30	0	25	0	0
3	39	10	25	0	15	0	35
4	93	20	15	0	-5	35	0
5	51	15	0	35	20	0	0
6	94	25	20	0	-5	0	35
7	72	15	0	0	-15	35	0
8	29	10	0	35	25	0	0
9	53	15	25	0	10	0	35
10	46	15	10	0	-5	35	0

Figure 3.6 Results of Monte Carlo Simulation

3.3 Experimental Results

Figure 3.7 shows the results of total cost depending on order quantity at reorder point is 30 and lead time is 1 day. In this figure, order quantity 45 is the best solution among 3. Total cost is 17250 at order quantity is 45.

Table 3.1 Result for Lead Time 1 day and Reorder Point 30

Order Quantity	Total Cost
35	23750
40	24250
45	17250

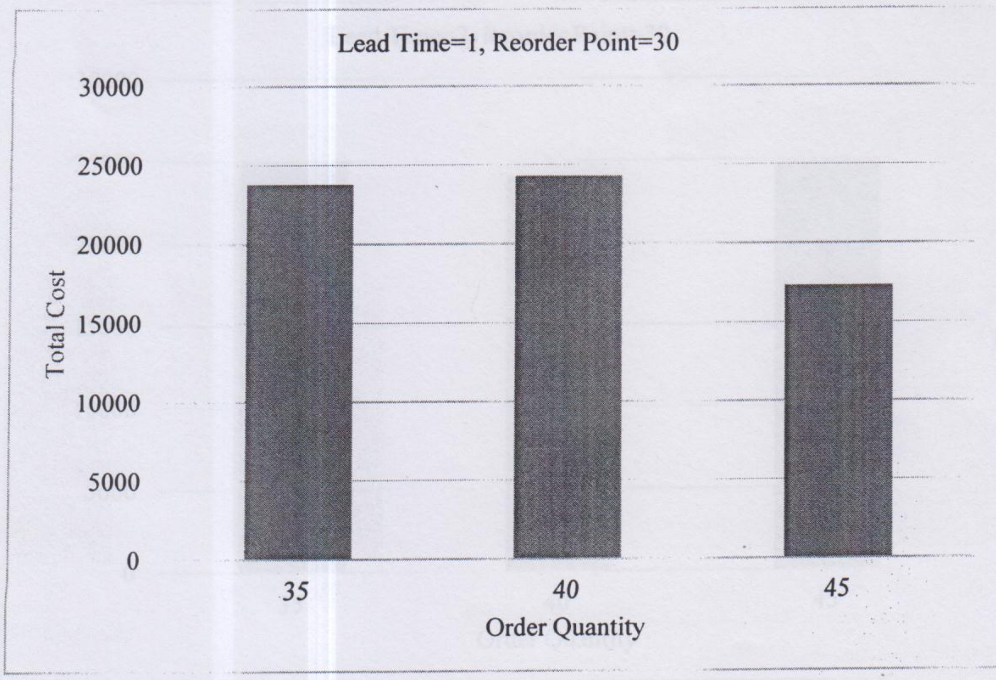


Figure 3.7 Result for Lead Time 1 day and Reorder Point 30

Figure 3.8 shows the results of total cost depending on order quantity at reorder point is 30 and lead time is 2 day. In this figure, order quantity 40 is the best solution among 3. Total cost is 24000 at order quantity is 40.

Table 3.2 Result for Lead Time 2 days and Reorder Point 30

Order Quantity	Total Cost
35	25000
40	24000
45	24750

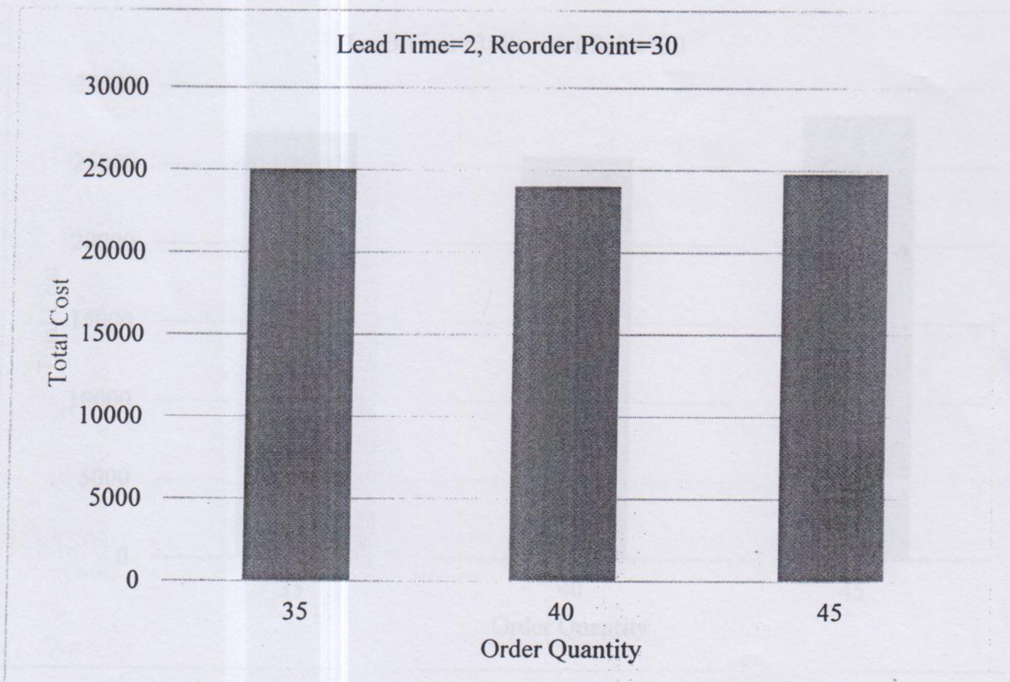


Figure 3.8 Result for Lead Time 2 days and Reorder Point 30

Figure 3.9 shows the results of total cost depending on order quantity at reorder point is 30 and lead time is 3 days. In this figure, order quantity 40 is the best solution among 3. Total cost is 25500 at order quantity is 40.

Table 3.3 Result for Lead Time 3 days and Reorder Point 30

Order Quantity	Total Cost
35	27000
40	25500
45	28250

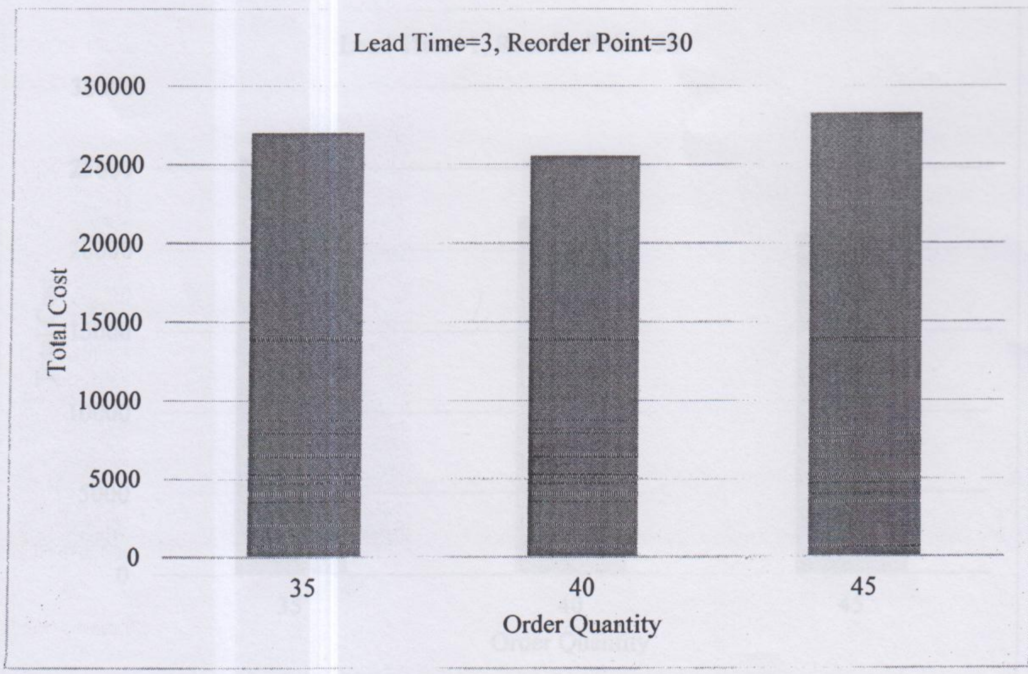


Figure 3.9 Result for Lead Time 3 days and Reorder Point 30

Figure 3.10 shows the results of total cost depending on order quantity at reorder point is 20 and lead time is 1 day. In this figure, order quantity 45 is the best solution among 3. Total cost is 21000 at order quantity is 45.

Table 3.4 Result for Lead Time 1 day and Reorder Point 20

Order Quantity	Total Cost
35	25750
40	22000
45	21000

Figure 3.10 Result for Lead Time 1 day and Reorder Point 20

Figure 3.11 shows the results of total cost depending on order quantity at reorder point is 20 and lead time is 2 days. In this figure, order quantity 40 is the best solution among 3. Total cost is 25500 at order quantity is 40.

Table 3.5 Result for Lead Time 2 days and Reorder Point 20

Order Quantity	Total Cost
35	27000
40	25500
45	28250

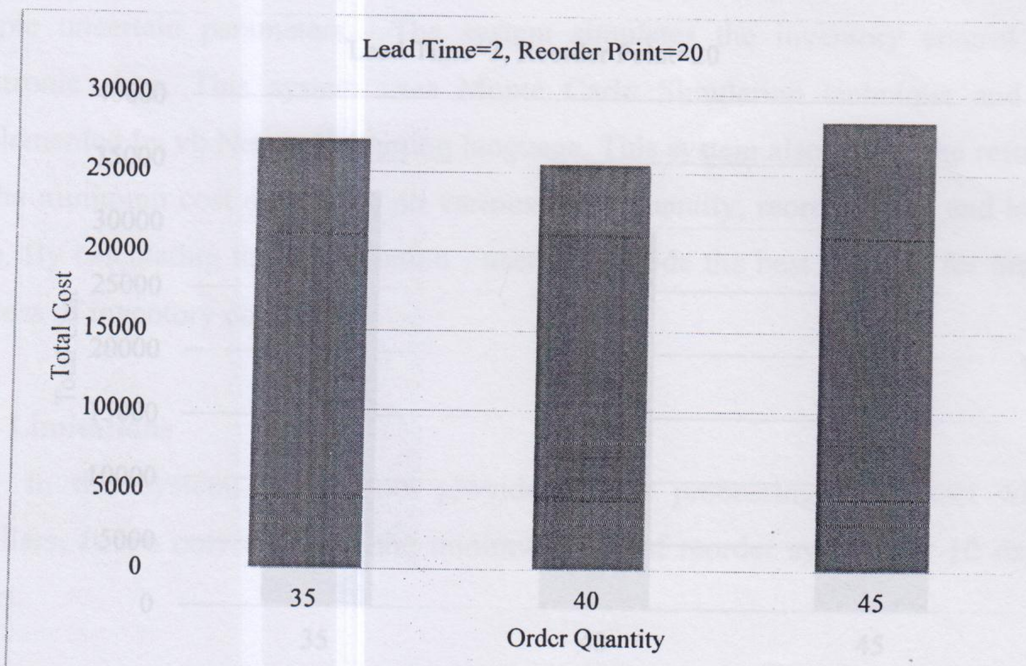


Figure 3.11 Result for Lead Time 2 days and Reorder Point 20

Figure 3.12 shows the results of total cost depending on order quantity at reorder point is 20 and lead time is 3 days. In this figure, order quantity 40 is the best solution among 3. Total cost is 29650 at order quantity is 40.

Table 3.6 Result for Lead Time 3 days and Reorder Point 20

Order Quantity	Total Cost
35	32500
40	29650
45	35150

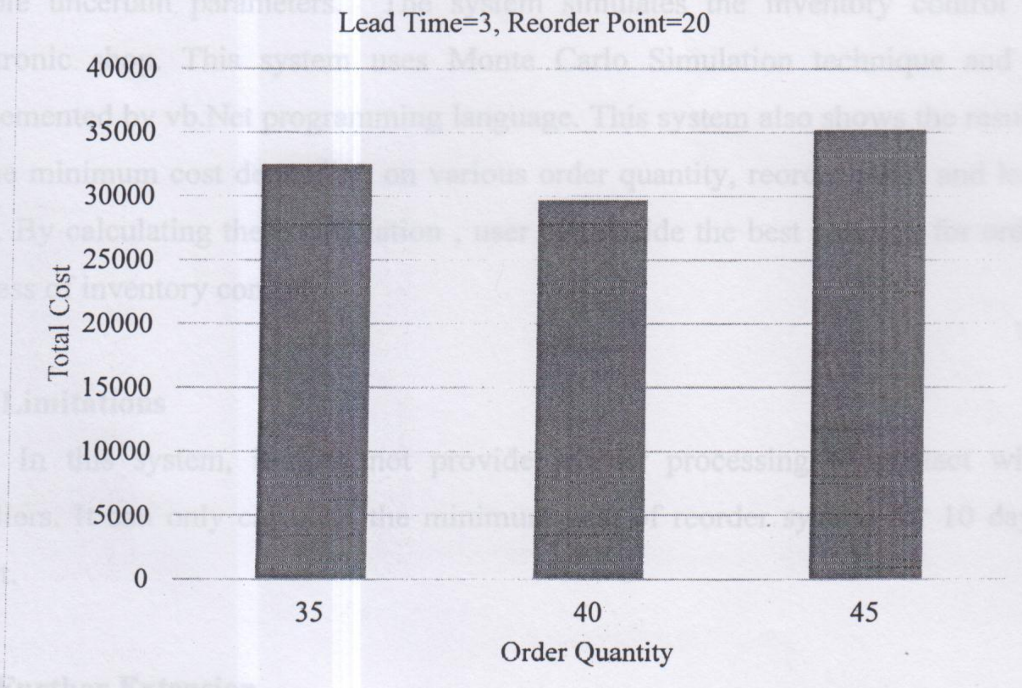


Figure 3.12 Result for Lead Time 3 days and Reorder Point 20

CHAPTER 4
CONCLUSION

4.1 Conclusion

Monte Carlo simulation is a specialized probability application that is no more than an equation which the variables have been replaced with a random number generator. A Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple uncertain parameters. The system simulates the inventory control of electronic shop. This system uses Monte Carlo Simulation technique and is implemented by vb.Net programming language. This system also shows the results of the minimum cost depending on various order quantity, reorder point and lead time. By calculating these simulation , user can decide the best solution for order process of inventory control.

4.2 Limitations

In this system, it does not provide reorder processing to contact with suppliers. It can only calculate the minimum cost of reorder system for 10 days report.

4.3 Further Extension

The system will be extended the reorder process to contact with suppliers. It will also calculate the minimum cost of reorder process for monthly and yearly report instead of 10 days.

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