APPLICATION OF ECONOMIC ORDER QUANTITY (EOQ) FOR INVENTORY MANAGEMENT OF A FOOD INGREDIENT IMPORTER
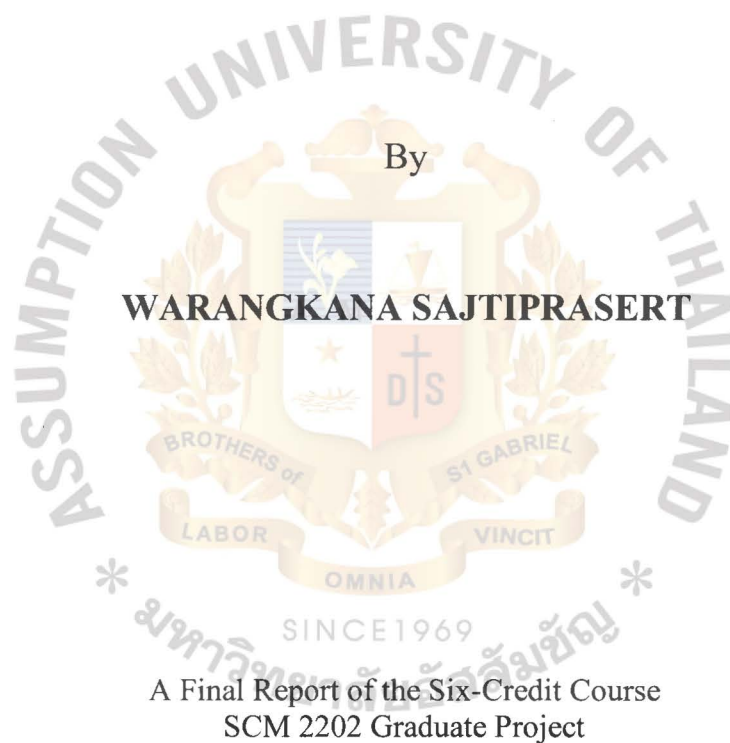
By

WARANGKANA SAJTIPRASERT

A Final Report of the Six-Credit Course
SCM 2202 Graduate Project

Submitted in Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE IN SUPPLY CHAIN MANAGEMENT

Martin de Tours School of Management
Assumption University
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August 2014

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Martin de Tours School of Management and Economics
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August 2014

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Assumption University
Martin de Tours School of Management and Economics
Master of Science in Supply Chain Management

Declaration of Authorship Form

I, Ms. Warangkana Sajtiprasert declare that this thesis/project and the work presented in it are my own and has been generated by me as the result of my own original research.

Application of Economic Order Quantity (EOQ) for Inventory Management of A Food Ingredient Importer

I confirm that:

1. This work was done wholly or mainly while in candidature for the M.Sc. degree at this University;

2. Where any part of this dissertation has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;

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Warangkana Sajtiprasert

Assumption University

August 2014

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ABSTRACT

The inventory management has become more and more important these days. Inventory requires storage space and encounters other carrying costs. Inventory is damaging to a firm's financial health and competitive edge. The use of models for inventory cost reduction is widespread. The cost of inventory consists of ordering costs and holding costs. The inventory holding costs are one of the most important in inventory models which is illustrated in the literature.

The economic order quantity system is used to find the optimal order size of each order. When the small item order is placed, the frequency is high and it causes high annual inventory costs. While the large order is placed, the frequency is low and the annual inventory cost is low accordingly. But when the order is large, the average inventory level for each item is high. This causes high expenses of inventory holding. Thus, this study focuses on the application of economic order quantity to identify the best quantity for each purchase order and a suitable reorder point for ABC Company. The primary data and secondary data of ABC Company in 2013 are collected for computing economic order quantity and comparing its possible inventory management efficiency with that of the current ordering system of ABC Company.

Applied to economic order quantity the results indicate the best order quantity of ABC Company in 2013. The comparison of the results of inventory cost after applied economic order quantity with the actual inventory cause is shown. ABC Company is successful in using economic order quantity for the company cost reductions.

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__MANAGEMENT OF A FOOD INGREDIENT IMPORTER_____

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__Ms. Warangkana Sajtiprasert_____

and hereby certify that the verbiage, spelling and format is commensurate with the quality `
of internationally acceptable writing standards for a master degree in supply chain
management.

Signed *Michael L. Welch*

(_____Michael L. Welch_____)

Contact Number / Email address ___michaelwelch21@gmail.com_____

Date: August 26, 2014

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CHAPTER I

GENERALITIES OF THE STUDY

In the world of competition, all firms are aware of how to be winners in business competitions, maintain their current customers, and also make the highest profit. He (2013) stated that "The main cost for supply chain management is inventory cost, high percentage for cost reduction can be increase profit greatly of just a part or the whole supply chain". Hence, many companies recently are looking at minimizing the management cost of inventory.

The role of inventory as a buffer against uncertainty has been established for a long time (Mangal & Chandna, 2009). Besides, many trading companies have to keep their products available in stock always in order to serve their customers' immediate need. However, if the companies are unable to manage their inventory, then the unnecessary cost for keeping it might be occurred. Therefore, the best inventory management is the best answer for their solution.

1.1 Background of the Study

ABC Company is a food ingredient importer with more than 30 years of experience and who imports products in order to supply the customers and demand in the Thai market. ABC's business is divided based on customer industries, and material supplied to the customers into three categories which are meat processing, dairy processing, and flavour. The meat processing category supplies the products for the manufacturers of sausage, meat balls, fish balls, pork balls, and frozen food. The dairy processing category supplies the products for manufacturing the dairy products, bakery and ice cream. The flavour category supplies the products for the manufacturer of beverages, functional foods and snacks.

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ABC is not only supplying ingredients, but also sharing technical know-how with customers. In terms of technical service, ABC has been accredited by laboratory standard; ISO/IEC 17025: 2005 at the end of 2009 by the Bureau of Laboratory Quality Standards, Department of Medical Science, Ministry of Public Health. In terms of warehouses, ABC offers the best services with the highest standards of AS/RS systems both in supply chain management and logistics. With the space of 16,000 square meters, it will ensure that the storage and product movement is at least 4,000 metric tons daily. Also with the high technology of services, ABC completely delivers to all customers for their great satisfaction.

Presently, intense competition is pressuring the company to develop efficient operation within the firm. The best product quality, cost competitive, and on time delivery are key factors to fulfill customer satisfaction and establish competitive advantages for the firm. Inventory management is an element that plays an important role on the cost competitiveness of the firm. Sometimes, appropriate inventory is hardly predicted due to the fluctuation of demand. Thus, inventory management is significant for both purchasers and marketers in the supply chain.

Inventory is the core factor of a trading business, not only classified as current assets for the business but also company 'must have' for productivity or for selling to move the business a step forward smoothly. Too high of inventory means capital is sunk which the cause of illiquidity in the company. On the contrary, insufficient inventory would cause a stock shortage and lose the opportunity to sell the products. Consequently, it would affect the image of the company in the future. Hence, the company should manage inventory to be at a suitable level which is not too high or too low. This study is emphasizing the planning and controlling inventory which will lead to an efficiency in inventory management. ABC, as a food ingredient import company and is selected to be a case study because most of the imported products have a high cost and long lead time due to transportation by sea freight. Likewise, the inventory management is essential to this kind of business.

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The following Table 1.1 presents the sale quantity of ABC Company during 2011 to 2013.

Table 1.1: Sale Quantity of ABC Company in Each Product Category during 2011 to 2013.

Product Category	2011 (Metric Tons)	2012 (Metric Tons)	2013 (Metric Tons)
Meat Processing	1,870	1,984	2,528
Dairy	692	784	716
Flavour	150	117	126

Source: ABC Company

Table 1.1 shows the demand in 2011, 2012 and 2013 where there is growth of demand in every year. Hence, the researcher intends to analyze the latest data from 2013 as it is closest to the present. The following Table is showing the purchase value of the three categories in 2013.

Table 1.2: Purchase Value of ABC Company in Each Category in 2013

Categories	Value in Thai Baht (Overseas Purchase)
Meat Processing	176,881,905
Dairy	36,258,061
Flavour	. 4,380,050

Source: ABC Company

From Table 1.2, the meat processing category had the highest of purchase value among the three categories. Hence, the researcher selected the meat processing category in this research.

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Table 1.3: Type of Product in Meat Processing Category from Each Supplier

Product type	Country of Suppliers	Lead time in week	Purchasing Quantity in 2013 (KG)	Frequency of Purchase per year	Average price per unit (Baht)	Sum of Amount in Thai Baht
Phosphate	Australia	3	311,485	9	159.31	49,623,518
Starch	France	4	797,600	5	37.91	30,238,294
Starch	Australia	3	1,287,500	6	23.36	30,076,545
Preservative	Canada	6	263,760	8	95.46	25,179,094
Soy Protein	China	2	239,000	6	93.86	22,431,752
Smoke Oil	USA	6	39,230	3	406.48	15,945,948
Calcium Lactate	China	2	17,306	1	135.23	2,340,319
Spice	Finland	4	52,310	2	20	1,046,436
Grand Total						176,881,905

Source: ABC Company

From Table 1.3, the product type that is shown in the tables are the raw material used in meat processing industries which is categorized under the meat processing category. The industrial categories that these products go to are sausages, frozen food and meat ball etc. These products are specialty products which can be ordered one product per times and not necessary combined with other products. The price of these products is fixed throughout the year. These products need close monitoring and quick response to potential stock outs.

1.2 Statement of the Problem

Like other trading companies, ABC Company is facing insufficient warehouse space for keeping its stock. The ordering quantity is not relevant to actual demand, uncertainty of demand, and the delay of delivery from suppliers affects customer service levels. The rapid transition of price caused the refusing of products from customers and decreased the benefit as well. All mentioned problems are leading to stock shortages or over inventory.

The main problem of ABC is on the high inventory level which resulted from the excessive orders from the suppliers that are done based on the inaccurate sales forecasts. Therefore, the sales forecast is done based on the purchasing plan given by customers. When customer demand is much less than the sales forecast, ABC has to carry more inventories. In such a case, it costs two times the expenses to ABC.

Firstly, the Company should reserve a large amount of money to pay for the product which causes the decrease of cash flow. Secondly, the excessive amount of inventory would require a large warehouse space that causes the Company to pay for the cost of renting the warehouse as well as the warehouse management cost. Practically, if the warehouse space is not sufficient ABC has to outsource the warehouse so then the Company has to pay for another rental charge.

Figures: 1.1: Historical Data of Inventory VS Forecast VS Sales Volume in Metric Ton during 2011 to 2013 of ABC Company
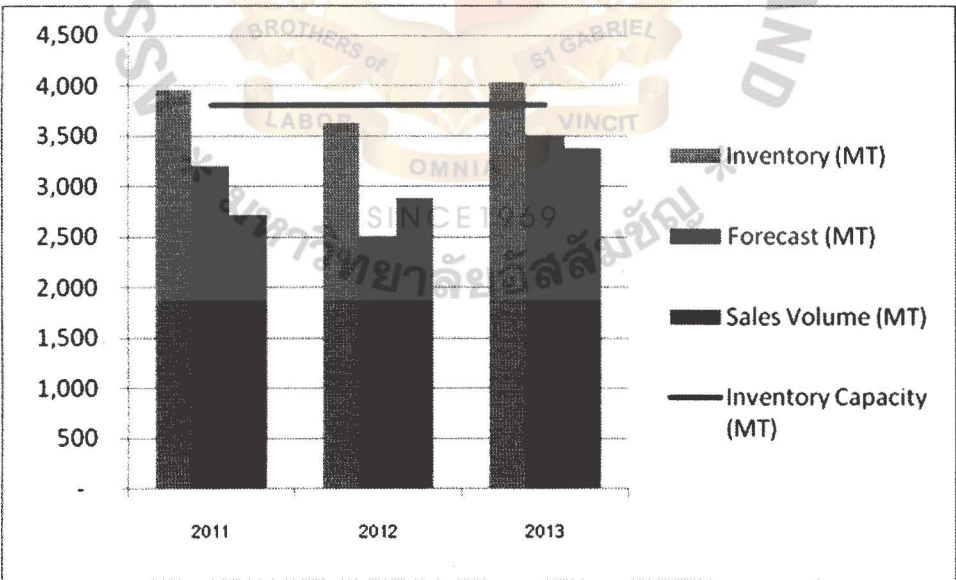
Source: ABC Company

From Figure 1.1, it shows the comparison of forecast, sales volume and inventory and the inventory capacity during 2011 to 2013 of ABC Company. In 2011, the forecast was higher than demand and inventory was over the inventory capacity. In 2012, the

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forecast was lower than demand and inventory was under the inventory capacity. In 2013, forecast is not much different to demand but inventory is very much over the inventory capacity.

Other problems are when the specification of the products is revised by the customers, the company has to return those products to the suppliers. In that case, the Company has to be responsible for the transportation expenses. Sometimes, customer demands are higher than the sales forecast; the Company has to place an urgent order to support them otherwise the Company may lose the customer to competitors. Regarding the mentioned problems, planning and controlling inventory of ABC Company is important to ABC. Thus, the question, *"How would ABC Company apply Economic Order Quantity to manage inventory and purchasing plan?"* is emphasized in this study.

1.3 Research Objectives

1.3.1   To identify the inventory problem and the root causes of the problem of ABC Company.

1.3.2   To identify the best quantity for each purchase order and suitable reorder point of ABC Company.

1.3.3   To determine the possible advantages to gain from the Economic Order Quantity (EOQ) by comparing its possible inventory management efficiency with that of the current ordering system of ABC Company.

1.4 Scope of the Research

The concerned departments of this research are the purchasing department, marketing department, accounting department and warehousing department. The selected database is from the most affected to the company and cost driven. A database of eight items is selected from ABC Company, from which all the items came from meat processing category. The researcher determines the criteria to set up the scope area of

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the research. Only items that need buffer stock and need space in the warehouse for storage are selected. The annual order quantity of the selected items is not lower than ten metric tons per year. Also the annual order value is not less than one million baht. Each item is independent to each other in the order and able to be ordered one item at a time. The database comes from the ABC Company from January 2013 to December 2013. The researcher determined the working day of year 2013 is 250 days. Determining the study company is using its own warehouse.

1.5 Significance of the Research

This research aims to propose the guideline to improve efficient inventory management to improve the efficiency of ABC Company. This research does not only benefit in cost reductions but it also helps the company drive the business smoother with the availability of products on time needed for customers. ABC Company they can extend the practice of using economic order quantity to all items in the company not only just for the particular items.

1.6 Limitations of the Research

This study uses the actual data from the study company which cannot reveal the name of the company in this research. In order to have a result closest to the actual situation the researcher intended to collect the data in 2014 but with a limited database, the researcher used the data from 2013 instead. The research needs to calculate the economic order quantity for all three categories that is the meat processing category, dairy category and flavor category but only the meat processing category is selected because the meat processing category has the highest value of purchase and with a clearer picture of the result.

1.7 Definition of Terms

Carrying Cost	Costs for storage facilities, handling, insurance,

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(Holding Cost)	pilferage, breakage, obsolescence, depreciation, taxes, and the opportunity cost of capital. (Jacobs & Chase, 2013)
Csmile program	The program software used to help to generate all business jobs within ABC Company. This program records all the data such as sales data, purchasing data, accounting data and delivering data.
Economic Order Quantity (EOQ)	The optimal order quantity by minimizing the sum of certain annual costs that varies with order size (Stevenson & Chuong, 2014).
Inventory	Inventory is the stock of any item or resource used in an organization. (Jacobs & Chase, 2013)
Ordering Cost	These cost refers to the managerial and clerical costs to prepare the purchase or production order. Ordering costs include all the details, such as counting items and calculating order quantities. (Jacobs & Chase, 2013)

CHAPTER II

REVIEW OF RELATED LITERATURE

The role of inventory management at present is very important. The number of products stored in the warehouse is money that the company must spend. Not only are they necessary for operations, but they also contribute to customer satisfaction. The nature and importance of inventories can be explained as inventories may represent a significant portion of total assets; a reduction of inventories can result in a significant increase in return of investment (Stevenson & Chuong, 2014). Moreover, inventory also serves many functions, of which the most important are as follows:

i. To meet anticipated demand because they are held to satisfy expected demand.

ii. To smooth productivity requirements.

iii. To continue the operations for any business.

There are two systems of inventory control, which consist of Economic Order Quantity System or EOQ and Periodic Review System. The researcher selects Economic Order Quantity System, which in this research is called EOQ system, for analysis. The first reason to use this system is because of the order quantity for ABC Company is constant with quantity and each order replacement are the same, and also there is no season for ordering whereas the Periodic Review System is used for variable quantity. The second reason is the EOQ system is used to replace the order when the inventory level is reached at the reorder point but the Periodic Review System will be used to place orders as per period consideration. The last reason is there some risky products such as the meat processing category that is difficult to manage which is necessary for more monitoring, so the EOQ system is more suitable for this category than the Periodic Review System.

Therefore, the right inventory management is very important for all kinds of businesses. Wallin, Rungtusanatham and Rabinovich (2006) stated that across firms, the right inventory management is not an approach for a particular purchase item but there are another factors to consider like cost of planning, storing and handling.

In regards to the trading company of food ingredients, the competitive price is the heart of this kind of business. The inventory management is the one that influences the cost of goods. Thus, this research focuses on finding the possible method to decrease the cost of goods. The concept and theory that are relevant to the study with the scope in inventory management and relevant literature. Inventory is the beginning of several major costs such as interest cost, real estate costs follow-on from the need for space to store it, costs of obsolescence and product degradation, material handling costs; inventory labor costs and costs of security services (Finkin, 1989).

In studies from many literature, the most pervasive method for inventory management is economic order quantity and reorder point. The Economic Order Quantity formula is one of the most popular formulas in business and engineering literature (Roach, 2005). Finkin (1989, p. 52) also stated that "Firms use a variety of criteria for selection order quantities for goods that go into inventory. These include a fixed number of units, or the level at which one obtains a vendor's price break. The most methodical way is to use the economic order quantity. This is the quantity that provides the minimum cost from manufacturing/purchasing and a carrying cost point of view".

The inventory management is not only trying to keep lowest the inventory but tries to find the most suitable level for storage. To keep the inventory expenses as low as possible; the analyst should consider all the expenses that occur such as ordering cost and carrying cost. The objective of inventory management is not always to reduce inventory levels. It is therefore necessary to take a broad view of the purpose of inventory (Howard, 1984). However, the main importance of inventory management is to minimize the costs related with inventory decisions. The researcher focused on

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considering analytical procedures and methods of control which will allow the main objective to be achieved by the reductions in costs directly related to inventory.

2.1 Inventory Management

Inventory is a kind of the asset which the Company must have available for sale or manufacturing or something that is kept for use in future activities. There are three major types of stock which all have appropriately different roles. There are process or in-transit stocks, lot-size or cycle stocks and safety stocks (Howard & Lancioni, 1978). It depends on the type of business the inventory is. Inventories can be divided into four areas, following on the stage in the manufacturing process.

Firstly, the inventory for a company making products is called raw materials. Secondly, the inventory of a component of item being manufactured and which requires further processing is called a component. Thirdly, the inventory of items in production process, or waiting to be produced in the next step, is called work-in-process. Lastly, the inventory of items that have been completed in the manufacturing process and are ready for sale are called finished goods.

2.1.1 Advantage of Inventory

The inventory is usually kept available for service to customers when there are immediate requirements. Inventory helps to protect the firms from price fluctuations caused by inflation when there is high demand in the market or speculation in the market. Purchasing in big volumes gets discounts. It also prevents from stock shortages by safety stocks in case of shipment delays. Firms cannot operate without inventories. They need inventory as a protection against uncertainty. Uncertainty of demand is a force to build a safety stock. These are also called "buffer stocks" (Chavan, 2010). The greater the uncertainty of demand and supply; the larger will have to be the amount of buffer stock. Inventories protect the firms from unforeseen failures in supply or an increase in demand. With an uncertainty in lead-time, sometimes the supply of goods of suppliers do not arrive per their promised dates.

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The delay of transportation causes the lead time to change and also forces the building of inventories.

2.1.2 The Importance of Inventory Management

The importance of inventory management to the organization can be raised in three elements:-

i. The stock ready to be sold to customers is an important factor of providing better service to customers. This is significant to increasing customer service levels and also an important factor that enables the company to compete in the market. Thus, an effective inventory management becomes a key to business success for all industries.

ii. Most firms give priority to the effective management of capital investment in inventory, which is considered one of the key elements.

iii. Most of the firms need the flexibility and support the customer's needs. Hence, the efficient inventory is essential.

It is usually better to experience some loss of business than to pay the price of overstocking, giving up the potential profit through incursion of inventory costs of approximately 24-28 percent per annum (Finkin, 1989).

There are two systems to control inventory which appear in many literary reviews. Periodic system or Periodic review systems or fixed-time period models. Another system is the fixed-order quantity model also called economic order quantity system or EOQ.

The basic distinction is that the economic order quantity systems are "even triggered" and the periodic review systems are "time trigger". This is an economic order quantity system which initiates an order when the event reaches a specified reorder level. This event may take place at any time, depending on the demand for the items considered.

In contrast, the Economic order quantity system is restrictive to placing orders at the end of a set time period; only the passage of time triggers the model.

2.2 Periodic Review System

The periodic review system of inventory is counted only at particular times, such as every week or every month. After counting the inventory, the order is placed to fulfill a maximum target level.

The periodic review systems generate order quantities that vary from period to period, depending on usage rates. Generally, this system requires a higher level of safety stock than economic order quantity (Jacobs & Chase, 2013).

In 2012, Wisner, Tan and Leone emphasized on safety stock for periodic review systems that should add more safety stock to buffer against uncertainty in demand over a longer planning horizon.

2.3 Economic Order Quantity or EOQ

To use the Economic order quantity system which places an order when the remaining inventory drops to a set order point the inventory remaining must be continually monitored. Thus, the economic order quantity system is a perpetual system, which requires that every time a withdrawal from inventory or an addition to inventory is made, reports must be updated to affect whether the reorder point has been accomplished. In economic order quantity, counting takes place only at the review period (Jacobs & Chase, 2013).

In 2012, Mangan, Lalwani, Butcher and Javadpour explained the theory for inventory management systems where the economic order quantity must be continuously monitored, and orders are issued when the inventory is depleted past a set level which can be called the reorder point, but the periodic review system's orders are reviewed

by period. There is no reorder point concerned. However, each period to review the orders must be determined by the right quantity for target stock keeping.

In 2013, Jacobs and Chase compared the difference between the Economic order quantity and Periodic review system as per the Table 2.1.

Table 2.1: The Differences between Economic Order Quantity System and Periodic Review System

Feature	Economic Order Quantity	Periodic Review System
Order quantity	The same amount ordered each time.	Varies each time order is placed.
When to place order	When inventory position drops to the reorder level.	When the review period arrives.
Record keeping	Each time a withdrawal or addition is made.	Counted only the review period.
Size of inventory	Less than Periodic Review System.	Larger than Economic Order Quantity.
Time to maintain	Higher due to perpetual record keeping.	Efficient, since multiple items can be ordered at the same time.
Type of items	Higher-priced, critical, or important items.	Typically used with lower-cost items.

Source: Jacobs and Chase, 2013

Moreover, Wisner, Tan and Leone (2012) had explained the economic order quantity system as a classic independent demand inventory that provides many useful ordering decisions. The basic order decision is to determine the optimal order size that minimizes total annul inventory costs.

In 1989, Chyr, Lin and Ho had pointed out that the goal in economic order quantity is to minimize the costs of inventory, set-ups and production. Attempts to approximate holding and set-up cost inputs for EOQ, and highlight the fact that financial accounting does not identify these costs.

2.4 Inventory Cost

When mentioning inventory, no matter that for manufacturing or for sale it has its own cost of operation. There are four types of inventory cost, which may be involved in balancing the contradictory objectives for inventory.

The first cost is the ordering cost, and includes for purchase in items of the following:

i. The cost of actual purchase demand by inventory control.

ii. The cost of issuing a purchase order and any follow-up time. This cost is from the Purchasing Department.

iii. The cost of the receiving department's order processing such as the cost of generating the manufacturing demand by inventory control. The cost of planning, loading, scheduling and expediting the item by production control.

The second cost is the inventory carrying cost, and includes all the expenses required to maintain a volume of inventory. This can be expressed as a per cent of the dollar value of the inventory per unit of time. The inventory carrying cost consists of obsolescence, deterioration, taxes, insurance, storage and cost of capital. Obsolescence is referring to cost of the item that is no longer of use due to design changes, customer desires, etc. Deterioration is referring to cost of material that has been spoiled or damaged, and is no longer of use. Taxes are referring to cost of holding inventory. Storage cost is the costs of storing the inventory such as rent, maintenance, material handlers, equipment, etc. Lastly, the cost of capital is the current cost of borrowing the investment, or the opportunity cost of any other investment possibilities.

The third cost is shortage cost or stock out cost. This cost occurs when the inventory in insufficient for manufacturing or for sale. This is caused by the cancellation of customer's orders. The firms will lack profits that ought to gain.

The forth cost is setup cost which will occur when the product changes machines from one to another.

2.5 The Basic Elements of Inventory Management

To be effective, inventory management must rely on schemes of both stock recording and stock control. The former can exist without the latter but the reverse cannot be applied (Howard, 1984).

Top management must decide the method of calculating the cost of capital. It may be done with assistance of financial management and the inventory controller, but never by the inventory controller alone.

2.5.1 Demand

Demand is a measurement of the total requirement for a given item on a specific time period. However, inventory demand should be differentiated from sales or usages. For example, sales only measures orders satisfied on a specific time period but it does not include demand lost because of stock-outs. The importance of this difference is readily observed in the preparation of demand forecasts. The accuracy of this forecast requires data be based on the total historical demand, which includes both the amount supplied and the amount back ordered or lost. While the actual differences between demand and sales or usages for most firms are small, the examination of the historical data must be made to determine if the difference is significant.

2.5.2 Lead Time

The length of lead time directly affects the size of the capital investment in inventories. Inventory lead time can be broken into four periods: review, order, manufacturing or purchasing, and receiving.

The review period starts from the last order placed to the review. The order period is starting from review to placing the order. The manufacturing or purchasing period includes order processing, schedule time, any queue time, machine set-up time, plus the actual manufacturing and transportation time. The receiving period starts from when the goods arrive and includes inspection and storage time, plus the time entering orders into the inventory control system.

2.6 Summary

In this literature review, the researcher has researched the systems for inventory management. Many literatures refer to inventory systems; there are two systems commonly used for inventory management that are the Economic Order Quantity and Periodic Review System. Both systems are used in different manners which follow the nature of the products. The Economic Order Quantity system is used for the products that need close monitoring, high price and are sensitive to be out of stock; whereas the Periodic review system is used for the products that have lower costs than the Economic Order Quantity and do not need to be closely monitored. Hence, the nature of the meat processing category of ABC Company is suitable for the use of the Economic Order Quantity rather than the Periodic Review System which the researcher has adopted to use in this study.

CHAPTER III

RESEARCH METHODOLOGY

This research explains research which starts from design to the collection of data of each source used for the study of the research. The data analysis procedure follows with calculating the total annual cost, calculations of the economic order quantity and calculations of the reorder point are described. Then, lastly the expected results and evaluations and conclusion are explained.

3.1 Research Design

This research is a case study of ABC Company; the data required are from both primary data and secondary data.

Primary data is collected by interviewing the purchaser and warehouse staff. The area of data is about procedures and practices in ordering food ingredients. The obstacles when import goods from overseas and problem inventory that affect the Company financially.

Secondary data is collected from the historical data which is related to sale quantities; order quantities, actual costs of products, transportation costs which use the real data of the ABC Company from January 1, 2013 to December 31, 2013. This data is exported from Csmile program. The Csmile program is used to record the data such as sales data, purchasing data, accounting data and delivering data.

3.2 Data Collection Methodology

The following table is indicating the data required, the source of data and the data collecting method.

Table 3.1: Data Collection Method

Sources of Data	Data Required	Data Collecting Method
Purchase Department	Order Quantity	Export data from Csmile
	Custom Clearance Expenses	Export data from Csmile
	Duty for Each Product	Interview with the Purchaser
	Wage of Purchaser	Interview with the Purchaser
	Frequency of Purchase	Interview with the Purchaser
	Delivery Lead Time of Each Product	Interview with the Purchaser
Sale Department	Sale Quantity	Export data from Csmile
Warehouse Department	Rental Space Expenses	Interview with the Warehouse staff
	Wage of Warehouse Staff	
	Product Insurance	

From Table 3.1, the data required in this research is mainly from the purchase department, sales department and warehouse department. From the purchase department the area of interest is the order quantity of each particular product, frequency of purchase and total value of purchase. The data from the purchase department also includes import duties of each product, clearing expenses and wages of purchasers.

All the data from the purchase department is for calculating purchase cost and ordering cost. From the sales department the area of interest is the quantity of the product that were sold in 2013. This data is used to find the quantity of products that are for sale or demand of the particular year. The last data is from the warehouse department where the area of interest is the rental space expenses, wage of staff in the warehouse and product insurance. The data from the warehouse department is used to calculate inventory holding cost.

3.3 Data Analysis Procedure

After completing the data collection, the excel program will be used to calculate EOQ. Details of the calculation and formula are explained as follows:

3.3.1 Calculating the Total Annual Cost

According to Mangan et al (2012) the first step is to develop a functional relation between the variables of interest and measures of effectiveness, the following equation is considered;

Total annual Cost = Purchase cost + Holding cost + Order processing cost

or

$$TC = DC + (Q/2)H + (D/Q)S$$

where

TC = Total annual cost

D = Annual demand

C = Cost per unit

S = Setup cost or cost of placing an order

H = Annual holding and storage cost per unit of average inventory

Q = Quantity to ordered in one purchase order

L = Lead time

R = Reorder point

From the equation on the right side, DC is the annual purchase cost for the unit, $(Q/2)H$ is the annual holding cost, $Q/2$ is the average inventory and H is the cost per unit for holding and storage and $(D/Q)S$ is the annual ordering cost where D/Q is

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actual number of orders placed and S is times the cost of each order. These costs have a relationship shown in Figure 3.1.

Figures 3.1: Costs Relationship
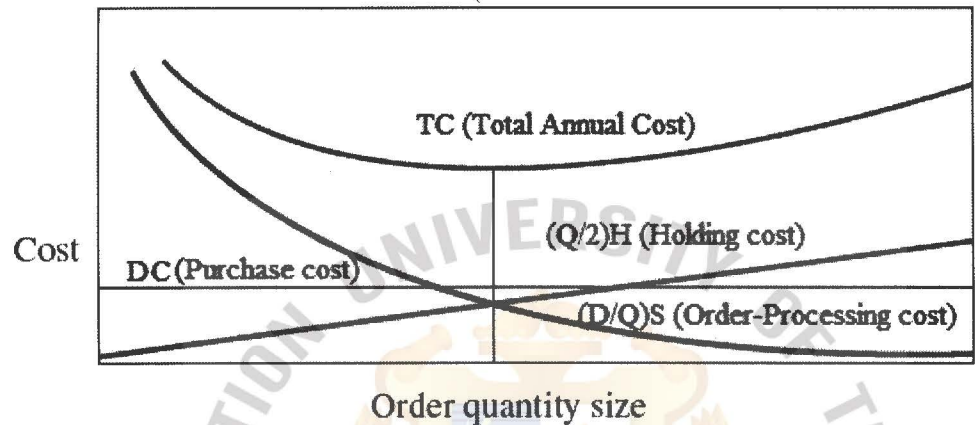
Source: Jacobs and Chase, 2013

3.3.2 Calculating the Economic Order Quantity

Apart from the above step, the EOQ system is to find the order quantity at the minimum total cost. From Figures 3.2, it is straight forward to derive the EOQ formula. Differentiating the TAC and setting it to zero for minimization:

$$\frac{d(TC)}{dQ} = 0$$

$$\frac{d\{DxC + \{\frac{Q}{Q2}\}H + \frac{D}{Q}\}S}{dQ} = 0$$

$$\frac{H}{2} - \frac{DxS}{Q^2} = 0$$

Assuming that the cost is constant and no bulk discount, you can also assume that the safety stock remains fixed as order quantity is changed.

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$$Q = \sqrt{\frac{2DS}{H}}$$

Figures 3.2: EOQ Model
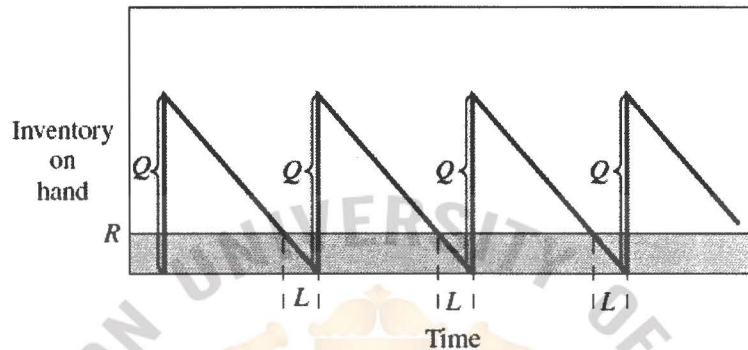
Source: Jacobs and Chase, 2013

From Figures 3.2, Q shows the relation between Q and R when the inventory position drops to point R, a reorder is placed. For computing the EOQ of ABC Company where demand is unknown because the demand is vary up to customers' requirement. In this case, safety stock is important to maintaining protection levels against stock outs.

3.3.3 Calculating the Reorder Point

The EOQ is the system that frequently monitors the level of inventory and places every new order when stock meet the point, R. The risk for out of stock for this system can happen when the demand for using the product from a customer is increased or fluctuates from the forecast.

Hence, to compute the EOQ or Q_{opt} is done using a formula concerning demand, ordering cost and holding cost. Then reorder point is set to cover the demand that is expected during the lead time plus a safety stock which is determined by the desired service level of ABC. The reorder point is

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ROP = D x L

where

ROP = Reorder point in units

D = Annual Demand

L = Lead time in days, starting from placing an order until receiving the items

3.4 Expected Results

After computing EOQ and reorder point using excel, the right quantity for placing orders is able to reduce the cost for inventory management in order to increase more benefit for company.

3.5 Evaluation and Conclusion

After getting the results from computing the data, the researcher compares the actual inventory cost for 2013 with the results after using EOQ. In order to see the success of the EOQ system, the total inventory cost will be compared with the actual cost spent in 2013 the reorder point and the warehouse space as well as warehouse rental costs, with and without EOQ will also compared.

3.6 Summary

In this chapter, the researcher described the methodology used in this research. In order to reach the objectives of the research, the economic order quantity is selected to analyze the actual data of ABC Company in 2013 and compared the result of use and not using EOQ. The primary data and secondary data are selected to collect the data from ABC Company. The excel program is used to calculate the results.

CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

This chapter presents the results of the data analysis. The primary data and secondary data were collected and analyzed as planned. In regards to the research question, the inventory problems and their root causes were analyzed based on the collected data.

The first section describes details of the primary data that were collected from the interviews. The second section describes the calculation of the actual cost of inventory of ABC Company in 2013. The computation of the actual inventory cost using the EOQ concept is shown in the third section. The forth section presents the application of economic order quantity. The last section is the summery of the results.

4.1 Major Operating Processes of the ABC

To identify the inventory problems of the ABC Company, the production, selling, and storage processes of the ABC Company were observed. The cost of each procedure was also collected and analyzed. The data were collected from both primary and secondary sources as follows:

4.1.1 Ordering Procedures

Data regarding the ordering procedure were collected from the interviews with salespersons from the sales department and purchasers from the purchasing department. The data gathered from the interviews indicated that the ordering procedure starts when the salesperson requests for the purchasing plan from the customers who are the meat processing factories, which are called "customers" hereafter.

After receiving purchasing plan from their customers then salespersons were able to perform the sales forecast. Purchasing requisition or PR was issued by a salesperson

when they found that the products are possible to be reordered. A purchasing requisition is then passed to the purchasing department to perform the purchasing. Purchasers, then contact the suppliers to deal on the price, quantity and delivery lead time. After receiving the confirmation from the suppliers, the purchasers generate a purchasing order by using the CSmile program and sent it to the suppliers. Supplier would then confirm the order quantity and the delivery date. Purchasers prepared the estimated incoming shipment plan and sent it to the warehouse department to arrange the storage space in the warehouse.

4.1.2 Selling Procedures

The details of the selling procedure were gathered from the interviews with the product manager, sales team and warehouse staff. The selling procedure starts when the salespersons received the purchase order from the customers. The purchase orders from customers come in the form of fax or e-mail. Salespersons confirmed the order and send it back to customers. The order was keyed in the CSmile program and the system passes the details of the order to the accounting department to generate invoices. After that the accounting department generates the invoice, in the CSmail System the CSmile program automatically sends the order to the warehouse for delivering process. Warehouse staff the arranged the shipment according to order gathered from the CSmile and load the product into the truck for delivery.

4.1.3 Storage Procedures

Storage procedure data were gathered from the interviews with the managers and the employees of the warehouse department. The storage procedure begins after the department receives the estimated incoming shipment plan from the purchasing department. The warehouse department arranges the space to store the product. When the products arrived, the warehouse department issues the report of the condition of the product when it arrives at the warehouse, whether it is in good condition or not. This report is submitted to the purchasing department to inform the suppliers later. As the FIFO system is utilized in the warehouse, the product is classified by the

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manufacturing date of the product. Major operating processes of the ABC Company can be concluded graphically in Figure 4.1 as follows:

Figures 4.1: Major Operating Processes of the ABC Company
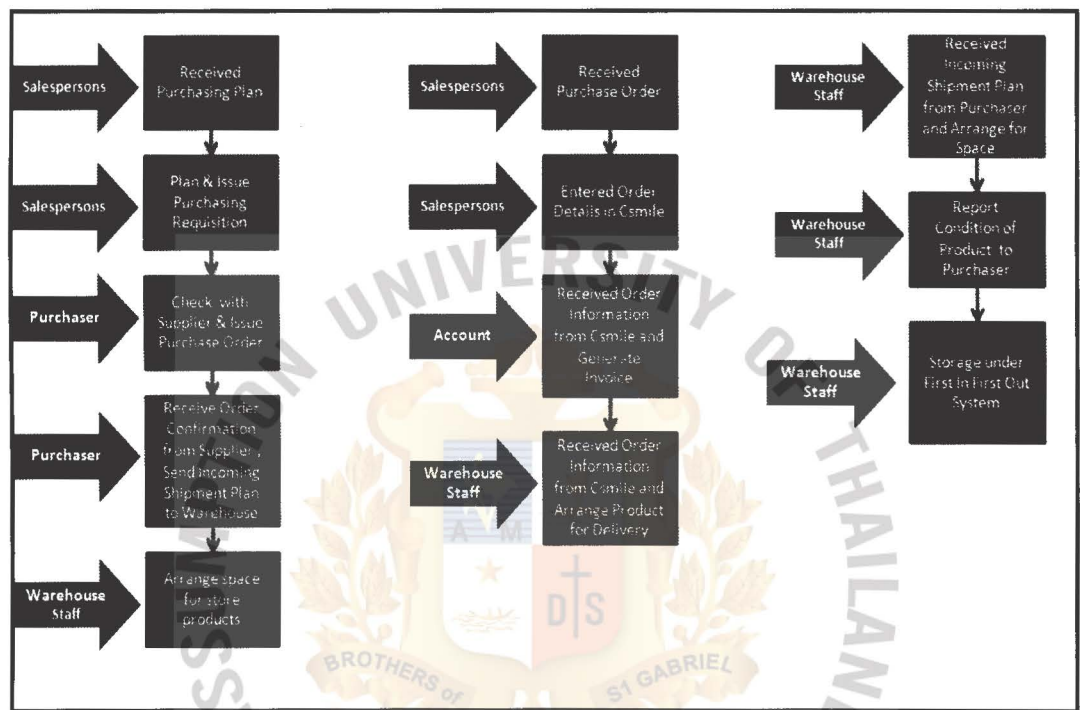
Source: ABC Company

Figures 4.1, shows the flow of three procedures. The ordering procedure is involved with salespersons, purchasers and warehouse staff. The selling procedure is involved with salespersons, accounting and warehouse staff. The last storing procedure is involved with only warehouse staff.

4.2 Actual Cost of the Products

Pareto analysis i.e. 80/20 rule was utilized to select the key product items to study. The meat processing category which owns the most value of the purchase more than 80% is selected in this study as this category most affects the company's cash flow.

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Table 4.1: Purchase Value of ABC Company in 2013

Categories	Value in Thai Baht	Cumulative Frequency	Percentage
Meat Processing	176,881,905	176,881,905	**81%**
Dairy	36,258,061	213,139,966	98%
Flavour	4,380,050	217,520,016	100%
Total	217,520,016		

Source: ABC Company

Figures 4.2 shows the Pareto chart of percentage of total purchase value and percentage of total items in each category in 2013.

Figures 4.2: The Pareto Chart of Each Product Categories of ABC Company
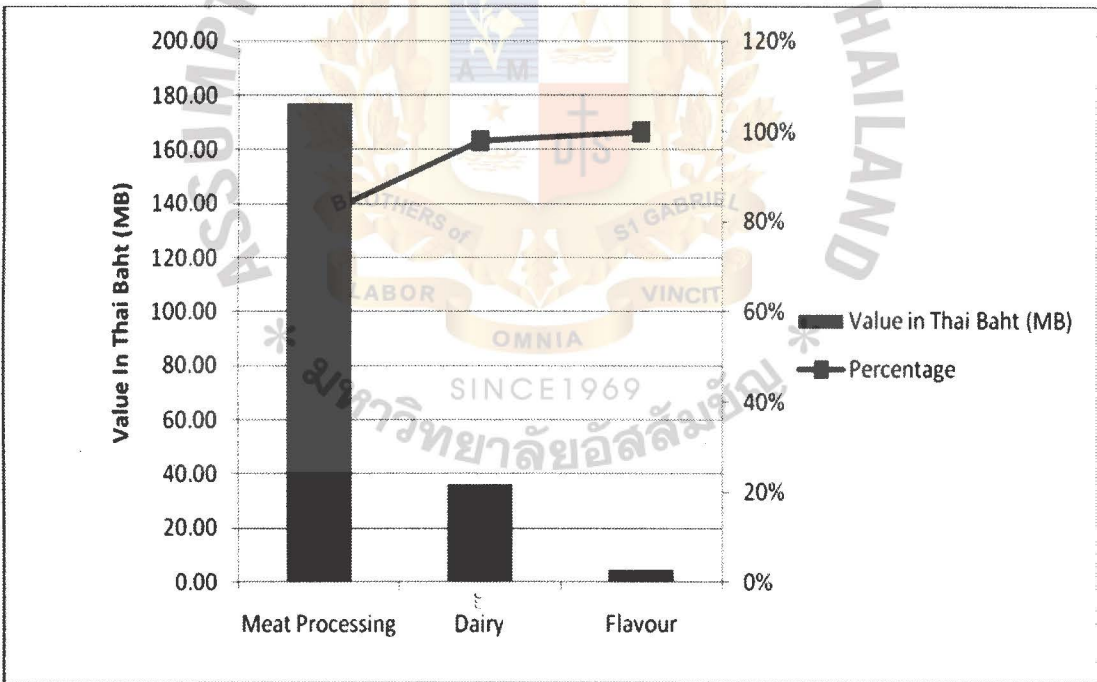
Source: ABC Company

The meat processing category has the purchasing value of more than 80 percent of the total purchasing value of ABC. Thus, the meat processing category is selected to focus in this study.

Table 4.2: Food Ingredient Imported in 2013

Product Type	Purchasing Quantity (KG)	Frequency of Purchase	Average Price per KG (THB)	Total Purchase Value (THB)	Annual Demand (KG)
Phosphate	311,485	9	159.31	49,623,518	310,481
Starch (France)	797,600	5	37.91	30,238,294	618,296
Starch (Australia)	1,287,500	6	23.36	30,076,545	1,164,831
Preservative	263,760	8	95.46	25,179,094	186,824
Soy Protein	239,000	6	93.86	22,431,752	144,155
Smoke Oil	39,230	3	406.48	15,945,948	33,074
Calcium Lactate	17,306	1	135.23	2,340,319	7,671
Spice	52,310	2	20	1,046,436	47,080

Source: CSmile Program of the ABC Company

To get average price per unit, the total purchase value in 2013 was divided by purchasing amount. Frequency of purchase is used to calculate quantity of ordering per time.

The actual cost of products was classified into two main categories: order processing cost and inventory holding cost. The operation cost model determine by following assumption;

i. Only eight products in high value purchase are involved.

ii. Annual demand requirements are known as certainty. Safety stock is not needed.

iii. Demand is spread evenly throughout the year so that the demand rate is reasonably constant.

iv. Products lead time does not vary.

v. There are no partial shipments.

vi. There are no quantity discounts.

The collective historical demand for twelve months in year 2013 is used to construct a time series plot. Figures 4.3, represent the relationship between time and product time

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series variable or monthly demand. Analyzing twelve months of historical demand found that the demand fluctuate around constant mean overtime although random variability is presented. It could say that these demand data is relatively constant.

Figures 4.3: Demand of ABC Company in 2013
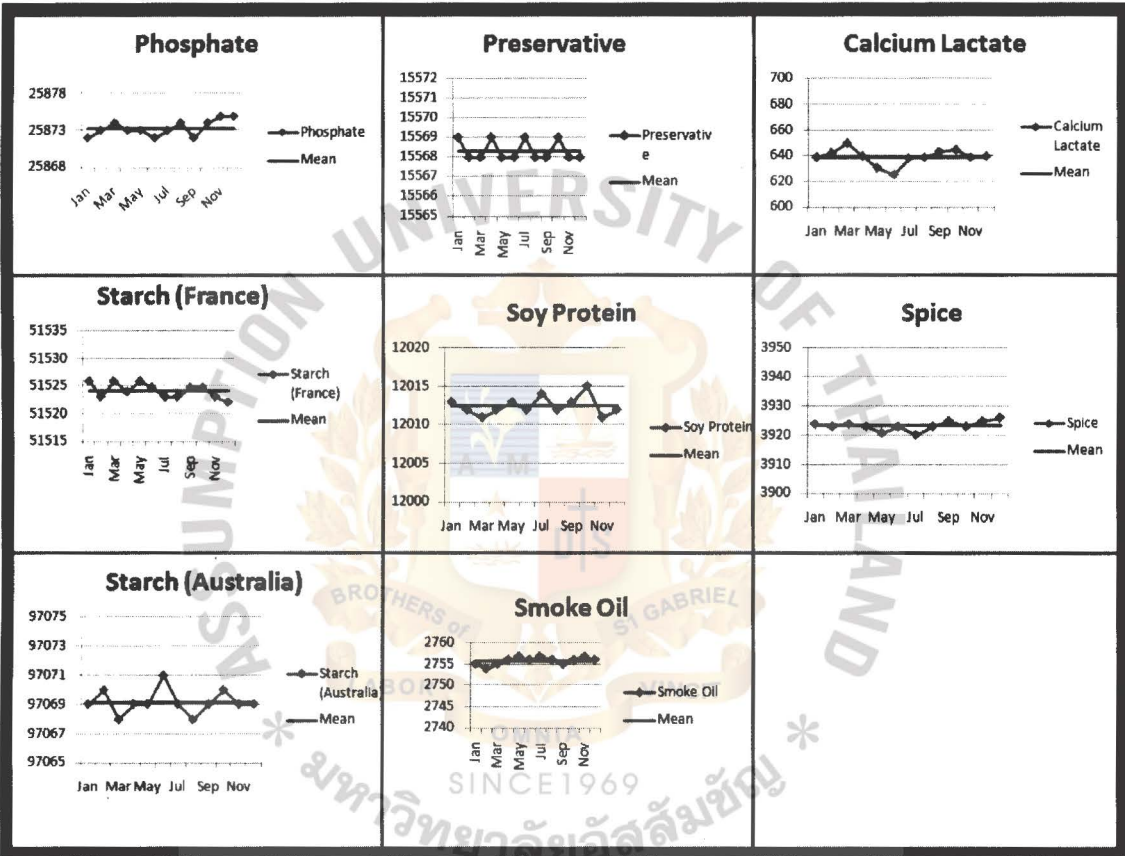
Source: CSmile Program of the ABC Company

4.2.1 Order Processing Cost

The order processing costs is associated with procuring the inventory. The annual procurement cost was divided into two parts: there was the cost of actually buying the product and the cost of purchasing and processing the order.

i. The actual total buying cost refers to the total purchase value of each product multiplied by import duties as indicates in Table 4.2.

The import duty of each product comes from rules and regulations of Customs of Thailand. The duty of each product was different by its category and was calculated in percentage of total amount of each product as in the following formula;

Duty of each product (THB)   =   (Total purchase value of each product) x
                                           (Import duty rate in percentage)

Table 4.3: Total Cost of Actual Product Buying

Product Type	Total Purchase Value (THB)	Duty (%)	Import duty Per Year (THB)	Actual Product Buying (THB)
	(1)	(2)	(3)=(1)x (2)	(4)=(1)+(3)
Phosphate	49,623,518	5.00	2,481,176	52,104,694
Starch (France)	30,238,294	5.00	1,511,915	31,750,209
Starch (Australia)	30,076,545	0.00	0	30,076,545
Preservative	25,179,094	0.00	0	25,179,094
Soy Protein	22,431,752	0.00	0	22,431,752
Smoke Oil	15,945,948	5.00	797,297	16,743,245
Calcium Lactate	2,340,319	0.00	0	2,340,319
Spice	1,046,436	5.00	52,322	1,098,758
Total	176,881,906		4,842,710	181,724,616

Source: Computed based on the ABC Company Data

ii. The cost of purchasing and processing the order consists of wages of purchasers and customs clearance expenses from the port to ABC Company's warehouse or clearing cost.

Wages of purchasers was calculated by multiplying the wage of purchasers per hour by the time in hours that the purchaser used for processing that purchase.

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There were five purchasers in ABC Company. Each purchaser got a different salary based on their positions and work experience. Since, to question or reveal salary was prohibited in ABC Company, with the assistance of the purchasing manager the researcher got the information of total spent on the salary of the purchase department from the CSmile program. The total spent for salary of purchasers was 177,000 THB. So, the average salary of each purchaser was

$$= \text{(Total salary of purchaser) / (Amount of purchaser)}$$
$$= 119,000 \text{ THB} / 5$$

Average salary per person $= 23,800$ THB

The purchaser uses 30 minutes to complete the process of overseas ordering. The remaining hours per day are used to work internally within the company and ordering local products which will not count in this research. The average working days per month is 20 days and 8 hours per day. Thus, the wage of purchaser for ordering the overseas product is calculated as following;

Wage of purchaser per hour (THB per hour)	=	(Wage rate per month) / (Working hour per month)
	=	(23,800 THB per month) / (20 days per month x 8 hours per day)
	=	148.75 THB per hour

Wage of processing order (THB per time)	=	(Wage of purchaser per hour) x (hour of ordering per time)
	=	148.75 THB per hour x (1/2 hour)
	=	74.375 or 74.38 per time

For the clearing cost, ABC Company outsources shipping companies to precede through the customs clearance process including a transportation charge from port to warehouse. The average expense of each time was 25,000 THB.

Thus, the cost of purchase processing orders was:

$$= \text{(Wage of purchaser of each order THB)} + \text{(Clearing Cost)}$$
$$= 74.38 \text{ THB} + 25,000 \text{ THB}$$
$$= 25,074.38 \text{ THB}$$

4.2.2 Inventory Holding Cost or Storage Cost

The inventory holding cost is the cost of renting the space to hold the inventory, looking after it, wages of warehouse staff and paying for insurance.

The space rental charge of ABC Company was 160 THB per pallet. The fee charge of loading and unloading pallets per time was 60 THB per pallet. Hence, the storage cost per unit was:

$$= \text{(Rental space expenses)} + \text{(Fee charge of load and unloaded pallet per time)} / \text{(Quantity of product in one pallet)}.$$
$$= 160 \text{ THB} + 60 \text{ THB} / \text{(Quantity of product in one pallet)}.$$
$$= 220 \text{ THB} / \text{(Quantity of product in one pallet)}.$$

As of the ABC Company's policy the wage of workers in the warehouse is calculated 4% of the price of product per KG for high value product and the product insurance is calculated as 1% of the price of products per KG.

Wage of workers in the warehouse as of ABC Company is calculated as 4% of the price of product per KG as follows;

Wage of worker (THB per KG)   =   Price of product per unit (THB per KG) x 4%

Insurance of a product as of ABC Company is calculated as 1% of the price of products per KG as follows;

Product insurance (THB per KG) = Price of product per KG (THB per KG) x 1%

Table 4.4: Total Storage Cost per Unit

Product Type	Product per Pallet (KG)	Storage Cost* (THB)	Average Price per KG (THB)	Wage of Worker (THB/KG)	Insurance (THB/KG)	Holding Cost per KG (THB)
	(1)	(2)=220/(1)	(3)	(4)= (3)x4%	(5) = (3)x1%	(6)=(2)+(4)+(5)
Phosphate	1,000	0.22	159.31	6.37	1.59	8.19
Starch [a]	1,000	0.22	37.91	1.52	0.38	2.12
Starch [b]	1,000	0.22	23.36	0.93	0.23	1.39
Preservative	600	0.37	95.46	3.82	0.95	5.14
Soy Protein	1,000	0.22	93.86	3.75	0.94	4.91
Smoke Oil	360	0.61	406.48	16.26	4.06	20.94
Calcium Lactate	1,000	0.22	135.23	5.41	1.35	6.98
Spice	515	0.43	20	0.8	0.2	1.43

Note: *Storage cost is per KG per pallet
     **Wage of Warehouse Staff
     a Starch from France; b from Australia
Source: Computed based on the ABC Company Data

4.3 Computing Economic Order Quantity for ABC Company

The computing of economic order quantity was from the results of total cost of actual product buying in Table 4.3 plus the cost of purchase processing orders and total storage costs from Table 4.4 to compute the actual cost of the products. The economic order quantity of each product was indicated in Table 4.5 by using the following formula:

$$Q = \sqrt{\frac{2DS}{H}}$$

where

D = Demand

S = Setup cost or cost of placing an order

H = Holding cost

Table 4.5: Economic Order Quantity

Product Type	Annual Demand (KG)	Cost of Placing Order Per Time (THB)	Holding Cost per KG (THB)	EOQ (KG)
	(1)	(2)	(3)	
Phosphate	310,481	25,074	8.19	43,602
Starch (France)	618,296	25,074	2.12	120,936
Starch (Australia)	1,164,831	25,074	1.39	204,999
Preservative	186,824	25,074	5.14	42,693
Soy Protein	144,155	25,074	4.91	38,371
Smoke Oil	33,074	25,074	20.94	8,900
Calcium Lactate	7,671	25,074	6.98	7,424
Spice	47,080	25,074	1.43	40,633

Note: EOQ is computed by the formula $Q = \sqrt{\frac{2x(1)x(2)}{(3)}}$

Source: Computed based on the ABC Company Data

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4.4 Computing Reorder Point

The consideration of the reorder point was set to cover the demand that was expected during the lead time. The reorder point is:

$$ROP = D \times L$$

From the above formula 'D' indicates demand or volume of sales in 2013 in kilograms and 'L' indicates lead time of placing an order until the product arrives at the warehouse.

The lead time of placing an order was divided into four processes. The first process starts from the process of ordering or placing orders to suppliers. This process needs one day to place an order and receive confirmation from suppliers.

Then, the second process was the lead time of manufacturing processes which starts from production lead time until completed and loading until the container is ready to ship. This process needs fourteen days.

The third process was the shipment lead time. The shipment lead time was varying based on distance of each product's source which is indicated in Table 4.6.

The last process was lead time of customs clearance until delivery to the warehouse. This process needed five days of lead time. Thus, the total lead time of ordering products was as follows:

Ordering Process + Manufacturing Process until Loading Products into Container for Shipping + Customs Clearance Lead Time until Delivery to Warehouse:

= 1+ 14+ 5 days

= 20 days (Lead time of ordering excluded shipment lead time)

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The above calculation was excluding shipment lead time. The shipment lead time was separated and shown in Table 4.6 for calculations.

Table 4.6: Reorder Point

Product Type	Shipment Lead Time * (Day)	Ordering Lead Time (Day)	Ordering Lead Time (Month)	Annual Demand (KG)	Demand Quantity per month (KG)	Reorder Point
	(1)	(2) =20 + (1)	(3) = (2)/ 30	(4)	(5) = (4)/12	ROP= (5) x (3)
Phosphate	21	41	1.37	310,481	25,873	35,446
Starch (France)	30	50	1.67	618,296	51,525	86,047
Starch (Australia)	21	41	1.37	1,164,831	97,069	132,985
Preservative	45	65	2.17	186,824	15,569	33,785
Soy Protein	14	34	1.13	144,155	12,013	13,575
Smoke Oil	45	65	2.17	33,074	2,756	5,981
Calcium Lactate	14	34	1.13	7,671	639	722
Spice	30	50	1.67	47,080	3,923	6,551

Note: *Shipment Lead Time is excluded from the ordering Lead Time
Source: Computed based on the ABC Company Data

From Table 4.6, it indicates the calculation of the reorder point. The results of the reorder point can help salespersons know when to order the product.

4.5 Comparing Total Annual Inventory Cost

Total annual cost was consisting of cost of purchasing, holding and ordering cost as shown in the following formula:

Total Annual Inventory Cost = Annual holding cost + Annual order processing cost

or

Total Annual Inventory Cost = $(Q/2)H + (D/Q)S$

4.5.1 Computing Actual Annual Inventory Cost

i. Calculating annual cost of ordering following the actual purchases in 2013 of ABC Company is shown in the following formula:

Annual order processing cost = $(D/Q)S$

where

D = Annual Demand

Q = Quantity to ordered in one purchase order

S = Setup cost or cost of placing an order

Table 4.7: Actual Annual Order Processing Cost of Each Product

Product Type	Annual Purchasing Quantity (KG)	Frequency of Purchase	Ordering Quantity Per Time (KG)	Annual Demand (KG)	Cost of Placing Order Per Time (THB)	Annual Order Processing Cost (THB)
	(1)	(2)	(3) = (1)/(2)	(4)	(5)	(6) = [(4)/(3)] x (5)
Phosphate	311,485	9	34,609	310,481	25,074	224,942
Starch (France)	797,600	5	159,520	618,296	25,074	97,186
Starch (Australia)	1,287,500	6	214,583	1,164,831	25,074	136,110
Preservative	263,760	8	32,970	186,824	25,074	142,081
Soy-Protein	239,000	6	39,833	144,155	25,074	90,742
Smoke Oil	39,230	3	13,077	33,074	25,074	63,416
Calcium Lactate	17,306	1	17,306	7,671	25,074	11,114
Spice	52,310	2	26,155	47,080	25,074	45,134

Note: *Shipment Lead Time is excluded from the ordering Lead Time
Source: Computed based on the ABC Company Data

Table 4.4 shows the calculation of Q and Table 4.6 shows the calculation of actual annual ordering costs.

ii. Calculating annual cost of storing following actual purchases in 2013 of ABC Company as shown in the following formula:

Annual Actual Holding Cost   =   (Actual Inventory) x
                                     (Holding Cost)

Table 4.8: Actual Annual Inventory Cost

Product Type	Ordering Quantity Per Time (KG)	Holding Cost per KG (THB)	Annual Holding Cost* (THB)	Annual Order Processing Cost (THB)	Actual Annual Inventory Cost (THB)
	(1)	(2)	(3) = Actual Inventory x (2)	(4)	(5) = (3) + (4)
Phosphate	34,609	8.19	659,802	224,942	884,744
Starch (France)	159,520	2.12	559,419	97,186	656,605
Starch (Australia)	214,583	1.39	492,153	136,110	628,263
Preservative	32,970	5.14	395,472	142,081	537,553
Soy Protein	39,833	4.91	465,704	90,742	556,446
Smoke Oil	13,077	20.94	344,068	63,416	407,484
Calcium Lactate	17,306	6.98	198,232	11,114	209,346
Spice	26,155	1.43	48,611	45,134	93,745

Note: *Annual holding cost calculation is shown in Appendix A
Source: Computed based on the ABC Company Data

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Table 4.8 shows the calculation of the actual annual inventory cost of ABC Company in 2013.

4.5.2 Computing Annual Inventory Cost Using EOQ

i. Calculating the annual cost of ordering using the economic order quantity from Table 4.5 instead of Q. The calculation is shown in Table 4.9.

Table 4.9: Annual Order Processing Cost of Each Product Using EOQ

Product Type	Annual Demand (KG)	EOQ	Cost of Placing Order Per Time (THB)	Annual Order Processing Cost (THB)
	(1)	(2)	(3)	[(1)/(2)]x (3)
Phosphate	310,481	43,602	25,074	178,547
Starch (France)	618,296	120,936	25,074	128,193
Starch (Australia)	1,164,831	204,999	25,074	142,474
Preservative	186,824	42,693	25,074	109,723
Soy Protein	144,155	38,371	25,074	94,200
Smoke Oil	33,074	8,900	25,074	93,179
Calcium Lactate	7,671	7,424	25,074	25,908
Spice	47,080	40,633	25,074	29,052

Source: Computed based on the ABC Company Data

ii. Calculating the annual cost of storing using the economic order quantity from Table 4.5 instead of Q. The calculation is shown in Table 4.10.

Annual Holding Cost   =   (Q/2)H

Where

Q = Quantity to ordered in one purchase order

H = Holding cost per KG per year

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Table 4.10: Holding Cost of Each Product Using EOQ

Product Type	EOQ	Holding Cost per KG (THB)	Annual Holding Cost (THB)
	(1)	(2)	[(1)/2] x (2)
Phosphate	43,602	8.19	178,550
Starch (France)	120,936	2.12	128,192
Starch (Australia)	204,999	1.39	142,474
Preservative	42,693	5.14	109,721
Soy Protein	38,371	4.91	94,201
Smoke Oil	8,900	20.94	93,183
Calcium Lactate	7,424	6.98	25,910
Spice	40,633	1.43	29,053

Source: Computed based on the ABC Company Data

Table 4.11 shows the calculation of the annual inventory cost after using EOQ.

Table 4.11: Annual Inventory Cost Using EOQ

Product Type	Annual Ordering Cost (THB)	Annual Holding Cost (THB)	Annual Inventory Cost Using EOQ (THB)
	(1)	(2)	(3) = (1) + (2)
Phosphate	178,547	178,550	357,097
Starch (France)	128,193	128,192	256,385
Starch (Australia)	142,474	142,474	284,948
Preservative	109,723	109,721	219,444
Soy Protein	94,200	94,201	188,401
Smoke Oil	93,179	93,183	186,362
Calcium Lactate	25,908	25,910	51,818
Spice	29,052	29,053	58,105

Source: Computed based on the ABC Company Data

From Table 4.11, calculations of annual inventory cost are cost of purchasing each product plus cost of storage of each product.

Table 4.12: Annual Inventory Cost Using EOQ VS Actual Annual Inventory Cost

Product Type	Actual Annual Inventory Cost (THB)	Annual Inventory Cost Using EOQ (THB)	Difference of Inventory Cost	Difference of Inventory Cost (%)
	(1)	(2)	(3) = (1) – (2)	(4) = [(1)-(2)]/(1)
Phosphate	884,744	357,097	527,647	60
Starch (France)	656,605	256,385	400,220	61
Starch (Australia)	628,263	284,948	343,315	55
Preservative	537,553	219,444	318,109	59
Soy Protein	556,446	188,401	368,045	66
Smoke Oil	407,484	186,362	221,122	54
Calcium Lactate	209,346	51,818	157,528	75
Spice	93,745	58,105	35,640	38
Total	3,974,186	1,602,560	2,371,626	60

Source: Computed based on the ABC Company Data

From the calculation of annual inventory cost it found that actual inventory cost in 2013 of ABC Company is 3,964,183 Baht. When calculating by using EOQ it found that inventory cost is 1,602,560 Baht.

The expected inventory cost saving can be calculated as follow;

	=	Actual inventory cost – Inventory cost using EOQ)
	=	3,974,186- 1,602,560
	=	2,371,626
	=	(3,974,186- 1,602,560)/ 3,964,183
Cost saving in percentage	=	60%

4.6 Summary

The secondary data and primary data are used in the calculation of the economic order quantity as shown in this chapter between the actual cost of ABC Company and the

costs after applying the economic order quantity are compared. Applying economic order quantity to calculate the inventory cost of ABC Company in 2013 found that it can help the company save costs of 2,371,626 THB or 60% per year.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

In this chapter the researcher summarizes the study and results of the research. It includes conclusions and summary of the findings, theoretical implications, managerial implications and recommendations for future research.

5.1 Conclusions and Summary of the Findings

The first purpose of this study is to indentify the root causes of the inventory problem of ABC Company. The procedure of ordering, selling and storing are described. In the ordering procedure it appears that the sale forecast of ABC Company comes from purchasing plans of the customers. Thus, the cause of inaccurate forecasts comes from inaccurate purchasing plans by customers.

The Pareto chart is shown the meat processing category has the purchasing value of more than 80 percent of the total purchasing value of ABC. Thus, the meat processing category is selected to focus in this study.

The actual cost of the products of ABC Company is computed by using annual processing costs and annual holding costs. Which the annual processing cost is divided into cost of actually buying and cost of purchasing and processing the order. The holding cost is storage cost.

This research focuses on implementation of the economic order quantity system. The historical data of ABC Company in 2013 is used to compute economic order quantity to finds the best quantity for each purchase order. Also, the reorder point is computed to find the suitable reorder point of ABC Company. The warehouse staff can set

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reorder points in the CSmile program to alert to salesperson when product levels reach the reorder point.

The comparing of total annual cost is shown between actual annual cost of ABC Company in 2013 and annual cost after applied economic order quantity system. The result of the annual cost after applied economic order quantity is 1,602,560 THB whereas the actual annual cost of ABC Company in 2013 is 3,974,186 THB. There is 2,371,626 THB or a 60% decrease after applying economic order quantity system. The applications of economic order quantity system can help ABC Company to save costs of inventory of up to 60% from the data of ABC Company in 2013.

5.2 Theoretical Implications

There are two systems commonly used for inventory management, one is the economic order quantity and another one is the periodic review system. This research has used the economic order quantity system to compute the data of ABC Company to decrease inventory costs. Chyr et al. (1989) stated that the goal in economic order quantity is to minimize the costs of inventory.

However, the nature of the products of ABC Company is consistency to economic order quantity. In 2013, Jacob and Chase have pointed out the difference between economic order quantity and periodic review systems. Firstly, the order quantity of ABC Company is the same amount ordered each time. Secondly, the order is placed when inventory position drops to the reorder level. Lastly, the products of ABC Company are important items and need close monitoring. Thus, the researcher has adopted to use economic order quantity in this study.

5.3 Managerial Implications

This study used the economic order quantity to identify the best order quantity for each purchase of ABC Company. ABC Company could use this study as the model to improve the way of purchasing products. However, the results of this study come

from one among three categories. Thus, ABC Company can first apply the economic order quantity to the meat processing category and apply it to the rest of the two categories later on.

ABC Company can use the reorder point to determine the particular level where the product has to be placed. The use of reorder point can help ABC Company reduce the risk in out of stock. ABC Company can set the results after calculating the reorder point where the new order needs to be placed into the CSmile program. The CSmile program will alert when the product level reaches the reorder point. The salespersons can issue purchase requisitions and pass to the purchase department to place new orders in time.

Also, ABC Company can use the results of the economic order quantity to place the best order quantity for each purchase order. The economic order quantity system can help ABC Company reduce their annual inventory cost as the results appeared in Chapter 4.

5.4 Limitations and Recommendations for Future Research

There are some limitations found after studying this research. The data of ABC Company that was collected for computing inventory cost lack obsolescence costs, deterioration costs, stock out cost and opportunity cost. The data collection of this research is excluded and the data during seasonal periods of products is also excluded. Also, the confidential data of some database cannot be revealed and collected directly from ABC Company. This study was developed as a conceptual model by comparing the actual inventory cost of ABC Company with the inventory cost after applying the economic order quantity.

There are limitations in applied economic order quantity. The economic order quantity system can only see the primary transaction between inventory cost and order cost. Application of economic order quantity for different scenarios, it must be adjusted. This system does not account for seasonal or economic fluctuations. This

inventory system requires continuous monitoring of inventory levels. Also, the basic economic order quantity system is limited by assumption of a one product and not for combining several different products in the same order.

Safety stock is one of ABC Company limitation as its product is food ingredient with requires freshness and assures shelf life. ABC Company is strictly following the policy that the shelf life must remain more than 75% of production date when delivery to their customers. It is the ABC Company policy to not set the safety stock.

For future research, the researcher should study the nature of products of each category in order to select the right system for inventory management that is suitable for each particular product within the firm. Future studies, can also use the economic order quantity to compare inventory levels before and after the use of the economic order quantity; it can show how well the inventory is managed.
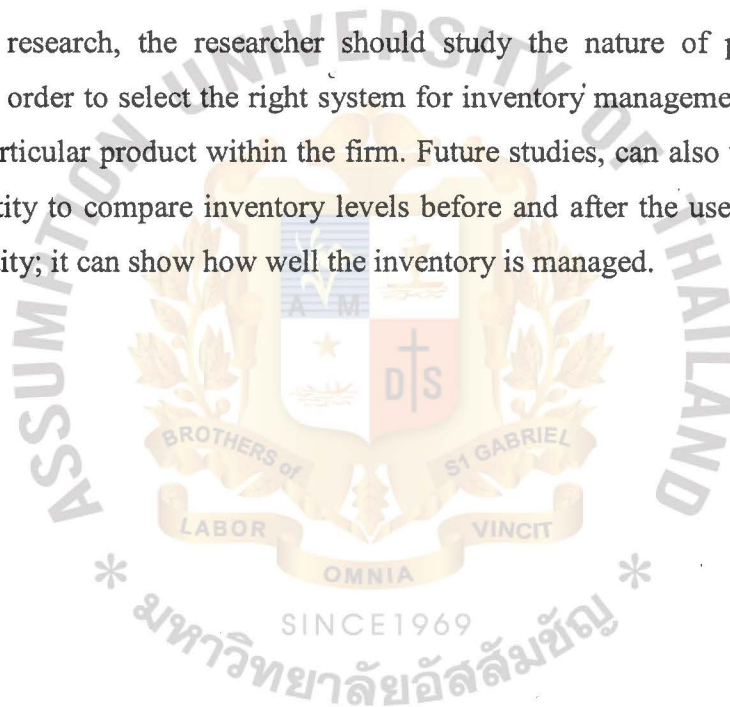
BIBLIOGRAPHY

Brown, M.V. (1999). *New Standard Institute*. Retrieved April 6, 2014, from
http://www.eam2go.com/articles/takestockofstoreroom.html

Chavan, S.K. (2010, October 14). *Advantages of Inventory*. Retrieved April 12, 2014,
from http://www.managementparadise.com/forums/elements-logistics/205346-advantages-inventory.html

Chyr, F., Lin, T.M., & Ho, C.F. (1989) An Extension of the EOQ Production Model
Based on Damage Costs. *International Journal of Operations & Production
Management,* 10(5), 71-76.

Finkin, E.F. (1989). How to Limit Inventory Expenses. *The Journal of Business
Strategy,* 10(1), 50-53.

Harris, F.W. (1913). How Many Parts to Make at Once. *Factory, The Magazine of
Management,* 10(2), 135-136,152. [Reprinted in Operations Research, 1990,
38(6), 947-950.]

Harris, F.W. (1915). What Quantity to Make at Once. *The Library of Factory
Management,* Vol. V. Operation and Costs, Chicago: A.W. Shaw Company, 47-
52.

He, W. (2013). An Inventory Controlled Supply Chain Model Based on Improved BP
Neural Network. *Discrete Dynamics in Nature and Society*, Retrieved April 6,
2014, from http://www.hindawi.com/journals/ddns/2013/537675/

Howard, K. (1984). Inventory Management. *International Journal of Physical
Distribution,* 5(2), 82-116.

Howard, K., & Lancioni, R.A. (1978). Inventory Management Techniques.
International Journal of Physical Distribution & Logistics Management, 8(8),
385-428.

Jacobs, F.R., & Chase, R.B. (2013). *Operations and Supply Chain Management: The
Core*. United State, US: McGraw-Hill/Irwin.

Mangal, D., & Chanda, P. (2009). Inventory Control in Supply Chain Through Lateral
Transshipment – A Case Study In Indian Industry. *International Journal of
Engineering,* 3(5), 443-457.

Mangan, J., Lalwani, C., Butcher, T., & Javadpour, R. (2012). *Global Logistics & Supply Chain Management.* United Kingdom, UK: John Wiley & Sons.

Roach, B. (2005). Origin of Economic Order Quantity formula; transcription or transformation? *Management decision,* 43(9), 1262-1268.

Stevenson, W.J., & Chuong, S.C. (2014). *Operations Management.* Singapore, SG: McGraw-Hill Education (Asia).

Thompson, H. (1975). Inventory management and capital budgeting: a pedagogical note. *Decision Sciences,* 6, 383-398.

Wallin, C., Rungtusanatham, J., & Rabinovich, E. (2006). What is the "right" inventory management approach for a purchased item?, *Journal of The Institution of Engineers,* 6(26), 50-68.

Ward, S. (n.d.) *Sales Forecasting.* Retrieved May 6, 2014, from http://sbinfocanada.about.com/od/management/g/salesforecast.htm

Wisner, J.D., Tan, K., & Leong, G.K. (2012). *Supply Chain Management: A Balanced Approach.* United State, US : Cengage Learning.

APPENDICES

APPENDIX A

Calculation of Annual Inventory Cost

Figure 1: Calculation of Annual Inventory Cost for Phosphate

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1							79,558	8.19	651,579
	2				5,175	8.19	42,383	74,383	8.19	609,196
	7	34,610	8.19	283,456			-	108,993	8.19	892,652
	9				5,174	8.19	42,375	103,819	8.19	850,277
	16				5,174	8.19	42,375	98,645	8.19	807,902
	23				5,175	8.19	42,383	93,470	8.19	765,518
	30				5,174	8.19	42,375	88,296	8.19	723,143
Feb'13	4	34,610	8.19	283,456			-	122,906	8.19	1,006,599
	6				6,468	8.19	52,973	116,438	8.19	953,626
	13				6,468	8.19	52,973	109,970	8.19	900,653
	20				6,468	8.19	52,973	103,502	8.19	847,681
	27				6,469	8.19	52,981	97,033	8.19	794,699
Mar'13	6				6,469	8.19	52,981	90,564	8.19	741,718
	13				6,468	8.19	52,973	84,096	8.19	688,745
	20				6,468	8.19	52,973	77,628	8.19	635,773
	22	34,610	8.19	283,456			-	112,238	8.19	919,228
	27				6,469	8.19	52,981	105,769	8.19	866,247
Apr'13	3				6,468	8.19	52,973	99,301	8.19	813,274
	10				6,468	8.19	52,973	92,833	8.19	760,301
	17				6,468	8.19	52,973	86,365	8.19	707,329
	24				6,469	8.19	52,981	79,896	8.19	654,347
May'13	1				5,175	8.19	42,383	74,721	8.19	611,964
	8				5,174	8.19	42,375	69,547	8.19	569,589
	12	34,610	8.19	283,456			-	104,157	8.19	853,045
	15				5,175	8.19	42,383	98,982	8.19	810,662
	22				5,174	8.19	42,375	93,808	8.19	768,287
	29				5,175	8.19	42,383	88,633	8.19	725,903
Jun'13	5				6,468	8.19	52,973	82,165	8.19	672,931
	7	34,610	8.19	283,456			-	116,775	8.19	956,386
	12				6,468	8.19	52,973	110,307	8.19	903,414
	19				6,468	8.19	52,973	103,839	8.19	850,441
	26				6,469	8.19	52,981	97,370	8.19	797,459
Jul'13	4				6,468	8.19	52,973	90,902	8.19	744,487
	11				6,468	8.19	52,973	84,434	8.19	691,514
	18				6,468	8.19	52,973	77,966	8.19	638,541
	25				6,469	8.19	52,981	71,497	8.19	585,560
	29	34,610	8.19	283,456			-	106,107	8.19	869,016
Aug'13	7				6,469	8.19	52,981	99,638	8.19	816,034
	14				6,468	8.19	52,973	93,170	8.19	763,061
	21				6,468	8.19	52,973	86,702	8.19	710,089
	28				6,469	8.19	52,981	80,233	8.19	657,107
Sep'13	5				6,468	8.19	52,973	73,765	8.19	604,135
	12				6,468	8.19	52,973	67,297	8.19	551,162
	19				6,468	8.19	52,973	60,829	8.19	498,189
	23	34,610	8.19	283,456			-	95,439	8.19	781,645
	26				6,468	8.19	52,973	88,971	8.19	728,672
Oct'13	3				5,175	8.19	42,382	83,796	8.19	686,290
	10				5,175	8.19	42,382	78,621	8.19	643,908
	17				5,175	8.19	42,382	73,447	8.19	601,527
	24				5,175	8.19	42,382	68,272	8.19	559,145
	25	34,610	8.19	283,456			-	102,882	8.19	842,601
	31				5,175	8.19	42,382	97,707	8.19	800,220
Nov'13	7				6,469	8.19	52,979	91,238	8.19	747,240
	14				6,469	8.19	52,979	84,769	8.19	694,261
	21				6,469	8.19	52,979	78,301	8.19	641,282
	28				6,469	8.19	52,979	71,832	8.19	588,303
	29	34,605	8.19	283,415			. -	106,437	8.19	871,718
Dec'13	5				6,469	8.19	52,979	99,968	8.19	818,739
	12				6,469	8.19	52,979	93,499	8.19	765,760
	19				6,469	8.19	52,979	87,031	8.19	712,781
	26				6,469	8.19	52,979	**80,562**	8.19	**659,802**

Figure 2: Calculation of Annual Inventory Cost for Starch (France)

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1							84,570	2.12	179,288
	4				12,881	2.12	27,308	71,689	2.12	151,981
	7	159,520	2.12	338,182			-	231,209	2.12	490,163
	11				12,882	2.12	27,310	218,327	2.12	462,853
	18				12,881	2.12	27,308	205,446	2.12	435,546
	25				12,882	2.12	27,310	192,564	2.12	408,236
Feb'13	1				12,880	2.12	27,306	179,684	2.12	380,930
	8				12,881	2.12	27,308	166,803	2.12	353,622
	15				12,881	2.12	27,308	153,922	2.12	326,315
	22				12,881	2.12	27,308	141,041	2.12	299,007
Mar'13	1				10,305	2.12	21,847	130,736	2.12	277,160
	8				10,305	2.12	21,847	120,431	2.12	255,314
	15				10,305	2.12	21,847	110,126	2.12	233,467
	22				10,305	2.12	21,847	99,821	2.12	211,621
	26	159,520	2.12	338,182				259,341	2.12	549,803
	29				10,306	2.12	21,849	249,035	2.12	527,954
Apr'13	5				12,881	2.12	27,308	236,154	2.12	500,646
	12				12,881	2.12	27,308	223,273	2.12	473,339
	19				12,881	2.12	27,308	210,392	2.12	446,031
	26				12,881	2.12	27,308	197,511	2.12	418,723
May'13	3				10,305	2.12	21,847	187,206	2.12	396,877
	10				10,305	2.12	21,847	176,901	2.12	375,030
	17				10,305	2.12	21,847	166,596	2.12	353,184
	24				10,305	2.12	21,847	156,291	2.12	331,337
	31				10,306	2.12	21,849	145,985	2.12	309,488
Jun'13	7				12,881	2.12	27,308	133,104	2.12	282,180
	14				12,881	2.12	27,308	120,223	2.12	254,873
	15	159,520	2.12	338,182				279,743	2.12	593,055
	21				12,881	2.12	27,308	266,862	2.12	565,747
	28				12,882	2.12	27,310	253,980	2.12	538,438
Jul'13	5				12,880	2.12	27,306	241,100	2.12	511,132
	12				12,881	2.12	27,308	228,219	2.12	483,824
	19				12,881	2.12	27,308	215,338	2.12	456,517
	26				12,881	2.12	27,308	202,457	2.12	429,209
Aug'13	2				10,305	2.12	21,847	192,152	2.12	407,362
	9				10,305	2.12	21,847	181,847	2.12	385,516
	16				10,305	2.12	21,847	171,542	2.12	363,669
	19	159,520	2.12	338,182				331,062	2.12	701,851
	23				10,305	2.12	21,847	320,757	2.12	680,005
	30				10,305	2.12	21,847	310,452	2.12	658,158
Sep'13	6				12,881	2.12	27,308	297,571	2.12	630,851
	13				12,881	2.12	27,308	284,690	2.12	603,543
	20				12,881	2.12	27,308	271,809	2.12	576,235
	27				12,882	2.12	27,310	258,927	2.12	548,925
Oct'13	4				12,881	2.12	27,308	246,046	2.12	521,618
	11				12,881	2.12	27,308	233,165	2.12	494,310
	18				12,881	2.12	27,308	220,284	2.12	467,002
	25				12,882	2.12	27,310	207,402	2.12	439,692
Nov'13	1				10,304	2.12	21,844	197,098	2.12	417,848
	8				10,304	2.12	21,844	186,794	2.12	396,003
	15				10,305	2.12	21,847	176,489	2.12	374,157
	19	159,520	2.12	338,182				336,009	2.12	712,339
	22				10,305	2.12	21,847	325,704	2.12	690,492
	29				10,305	2.12	21,847	315,399	2.12	668,646
Dec'13	6				12,880	2.12	27,306	302,519	2.12	641,340
	13				12,881	2.12	27,308	289,638	2.12	614,033
	20				12,880	2.12	27,306	276,758	2.12	586,727
	27				12,881	2.12	27,308	263,877	2.12	559,419

Figure 3: Calculation of Annual Inventory Cost for Starch (Australia)

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1							231,401	1.39	321,647
	4				24,267	1.39	33,731	207,134	1.39	287,916
	7	214,583	1.39	298,270			-	421,717	1.39	586,187
	11				24,267	1.39	33,731	397,450	1.39	552,456
	18				24,267	1.39	33,731	373,183	1.39	518,724
	25				24,268	1.39	33,733	348,915	1.39	484,992
Feb'13	1				24,267	1.39	33,731	324,648	1.39	451,261
	8				24,268	1.39	33,733	300,380	1.39	417,528
	15				24,267	1.39	33,731	276,113	1.39	383,797
	22				24,268	1.39	33,733	251,845	1.39	350,065
Mar'13	1				19,414	1.39	26,985	232,431	1.39	323,079
	8				19,413	1.39	26,984	213,018	1.39	296,095
	15				19,414	1.39	26,985	193,604	1.39	269,110
	22				19,413	1.39	26,984	174,191	1.39	242,125
	27	214,583	1.39	298,270				388,774	1.39	540,396
	29				19,414	1.39	26,985	369,360	1.39	513,410
Apr'13	5				24,267	1.39	33,731	345,093	1.39	479,679
	12				24,267	1.39	33,731	320,826	1.39	445,948
	19				24,267	1.39	33,731	296,559	1.39	412,217
	26				24,268	1.39	33,733	272,291	1.39	378,484
May'13	3				19,413	1.39	26,984	252,878	1.39	351,500
	6	214,583	1.39	298,270				467,461		
	10				19,414	1.39	26,985	448,047	1.39	622,785
	17				19,414	1.39	26,985	428,633	1.39	595,800
	24				19,414	1.39	26,985	409,219	1.39	568,814
	31				19,414	1.39	26,985	389,805	1.39	541,829
Jun'13	7				24,267	1.39	33,731	365,538	1.39	508,098
	14				24,268	1.39	33,733	341,270	1.39	474,365
	17	214,583	1.39	298,270				555,853	1.39	772,636
	21				24,268	1.39	33,733	531,585	1.39	738,903
	28				24,268	1.39	33,733	507,317	1.39	705,171
Jul'13	5				24,267	1.39	33,731	483,050	1.39	671,440
	12				24,268	1.39	33,733	458,782	1.39	637,707
	19				24,267	1.39	33,731	434,515	1.39	603,976
	26				24,267	1.39	33,731	410,248	1.39	570,245
Aug'13	2				19,414	1.39	26,985	390,834	1.39	543,259
	9				19,414	1.39	26,985	371,420	1.39	516,274
	16				19,414	1.39	26,985	352,006	1.39	489,288
	21	214,583	1.39	298,270				566,589	1.39	787,559
	23				19,414	1.39	26,985	547,175	1.39	760,573
	30				19,414	1.39	26,985	527,761	1.39	733,588
Sep'13	6				24,267	1.39	33,731	503,494	1.39	699,857
	13				24,267	1.39	33,731	479,227	1.39	666,126
	20				24,267	1.39	33,731	454,960	1.39	632,394
	27				24,268	1.39	33,733	430,692	1.39	598,662
Oct'13	4				24,267	1.39	33,731	406,425	1.39	564,931
	11				24,267	1.39	33,731	382,158	1.39	531,200
	18				24,268	1.39	33,733	357,890	1.39	497,467
	25				24,268	1.39	33,733	333,622	1.39	463,735
Nov'13	1				19,413	1.39	26,984	314,209	1.39	436,751
	8				19,414	1.39	26,985	294,795	1.39	409,765
	15				19,414	1.39	26,985	275,381	1.39	382,780
	18	214,583	1.39	298,270				489,964	1.39	681,050
	22				19,414	1.39	26,985	470,550	1.39	654,065
	29				19,414	1.39	26,985	451,136	1.39	627,079
Dec'13	6				24,267	1.39	33,731	426,869	1.39	593,348
	13				24,267	1.39	33,731	402,602	1.39	559,617
	20				24,268	1.39	33,733	378,334	1.39	525,884
	27				24,267	1.39	33,731	354,067	1.39	492,153

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Figure 4: Calculation of Annual Inventory Cost for Preservative

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1	32,970	5.14	169,466				32,970	5.14	169,466
	2				3,113	5.14	16,001	29,857	5.14	153,465
	9				3,114	5.14	16,006	26,743	5.14	137,459
	16				3,114	5.14	16,006	23,629	5.14	121,453
	23				3,114	5.14	16,006	20,515	5.14	105,447
	30				3,114	5.14	16,006	17,401	5.14	89,441
Feb'13	6				3,892	5.14	20,005	13,509	5.14	69,436
	13				3,892	5.14	20,005	9,617	5.14	49,431
	20				3,892	5.14	20,005	5,725	5.14	29,427
	27				3,892	5.14	20,005	1,833	5.14	9,422
		32,970	5.14	169,466				34,803	5.14	178,887
Mar'13	6				3,892	5.14	20,005	30,911	5.14	158,883
	13				3,892	5.14	20,005	27,019	5.14	138,878
	20				3,892	5.14	20,005	23,127	5.14	118,873
	27				3,892	5.14	20,005	19,235	5.14	98,868
Apr'13	3				3,892	5.14	20,005	15,343	5.14	78,863
	10				3,892	5.14	20,005	11,451	5.14	58,858
	17				3,892	5.14	20,005	7,559	5.14	38,853
	24				3,893	5.14	20,010	3,666	5.14	18,843
May'13	1				3,113	5.14	16,001	553	5.14	2,842
	8				3,113	5.14	16,001	(2,560)	5.14	(13,158)
	12	32,970	5.14	169,466			-	30,410	5.14	156,307
	15				3,114	5.14	16,006	27,296	5.14	140,301
	22				3,114	5.14	16,006	24,182	5.14	124,295
	29				3,114	5.14	16,006	21,068	5.14	108,290
Jun'13	5				3,892	5.14	20,005	17,176	5.14	88,285
	7	32,970	5.14	169,466			-	50,146	5.14	257,750
	12				3,892	5.14	20,005	46,254	5.14	237,746
	19				3,892	5.14	20,005	42,362	5.14	217,741
	26				3,892	5.14	20,005	38,470	5.14	197,736
Jul'13	4				3,892	5.14	20,005	34,578	5.14	177,731
	11				3,892	5.14	20,005	30,686	5.14	157,726
	18				3,892	5.14	20,005	26,794	5.14	137,721
	25				3,893	5.14	20,010	22,901	5.14	117,711
	29	32,970	5.14	169,466			-	55,871	5.14	287,177
Aug'13	7				3,892	5.14	20,005	51,979	5.14	267,172
	14				3,892	5.14	20,005	48,087	5.14	247,167
	21				3,892	5.14	20,005	44,195	5.14	227,162
	28				3,892	5.14	20,005	40,303	5.14	207,157
Sep'13	5				3,892	5.14	20,005	36,411	5.14	187,153
	12				3,892	5.14	20,005	32,519	5.14	167,148
	19				3,892	5.14	20,005	28,627	5.14	147,143
	23	32,970	5.14	169,466			-	61,597	5.14	316,609
	26				3,892	5.14	20,005	57,705	5.14	296,604
Oct'13	3				3,113	5.14	16,001	54,592	5.14	280,603
	10				3,114	5.14	16,006	51,478	5.14	264,597
	17				3,114	5.14	16,006	48,364	5.14	248,591
	24				3,114	5.14	16,006	45,250	5.14	232,585
	25	32,970	5.14	169,466			-	78,220	5.14	402,051
	31				3,114	5.14	16,006	75,106	5.14	386,045
Nov'13	7				3,892	5.14	20,005	71,214	5.14	366,040
	14				3,892	5.14	20,005	67,322	5.14	346,035
	21				3,892	5.14	20,005	63,430	5.14	326,030
	28				3,892	5.14	20,005	59,538	5.14	306,025
	29	32,970	5.14	169,466			-	92,508	5.14	475,491
Dec'13	5				3,892	5.14	20,005	88,616	5.14	455,486
	12				3,892	5.14	20,005	84,724	5.14	435,481
	19				3,892	5.14	20,005	80,832	5.14	415,476
	26				3,892	5.14	20,005	76,940	5.14	395,472

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Figure 5: Calculation of Annual Inventory Cost for Soy Protein

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1	39,833	4.91	195,580				39,833	4.91	195,580
	8				12,013	4.91	58,984	27,820	4.91	136,596
Feb'13	5				12,012	4.91	58,979	15,808	4.91	77,617
Mar'13	5				12,011	4.91	58,974	3,797	4.91	18,643
	13	39,833	4.91	195,580				43,630	4.91	214,223
Apr'13	2				12,012	4.91	58,979	31,618	4.91	155,244
May'13	1				12,013	4.91	58,984	19,605	4.91	96,261
Jun'13	5				12,012	4.91	58,979	7,593	4.91	37,282
	7	39,833	4.91	195,580			-	47,426	4.91	232,862
Jul'13	4				12,014	4.91	58,989	35,412	4.91	173,873
Aug'13	7				12,012	4.91	58,979	23,400	4.91	114,894
Sep'13	5				12,013	4.91	58,984	11,387	4.91	55,910
	23	39,833	4.91	195,580			-	51,220	4.91	251,490
Oct'13	3				12,015	4.91	58,994	39,205	4.91	192,497
	25	39,833	4.91	195,580			-	79,038	4.91	388,077
Nov'13	7				12,011	4.91	58,974	67,027	4.91	329,103
	29	39,833	4.91	195,580			-	106,860	4.91	524,683
Dec'13	26				12,012	4.91	58,979	94,848	4.91	465,704

Figure 6: Calculation of Annual Inventory Cost for Smoke Oil

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1							10,270	20.94	215,057
	8				2,755	20.94	57,690	7,515	20.94	157,367
Feb'13	5				2,754	20.94	57,669	4,761	20.94	99,698
Mar'13	5				2,755	20.94	57,690	2,006	20.94	42,009
	13	13,077	20.94	273,832				15,083	20.94	315,841
Apr'13	2				2,756	20.94	57,711	12,327	20.94	258,131
May'13	1				2,757	20.94	57,732	9,570	20.94	200,399
Jun'13	5				2,756	20.94	57,711	6,814	20.94	142,688
	7	13,077	20.94	273,832				19,891	20.94	416,521
Jul'13	4				2,757	20.94	57,732	17,134	20.94	358,789
Aug'13	7				2,756	20.94	57,711	14,378	20.94	301,078
Sep'13	5				2,755	20.94	57,690	11,623	20.94	243,389
Oct'13	3				2,756	20.94	57,711	8,867	20.94	185,678
	25	13,077	20.94	273,832				21,944	20.94	459,511
Nov'13	7				2,757	20.94	57,732	19,187	20.94	401,779
Dec'13	26				2,756	20.94	57,711	16,431	20.94	344,068

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Figure 7: Calculation of Annual Inventory Cost for Calcium Lactate

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1							18,764	6.98	130,973
	8				639	6.98	4,460	18,125	6.98	126,513
Feb'13	5				642	6.98	4,481	17,483	6.98	122,031
Mar'13	5				650	6.98	4,537	16,833	6.98	117,494
	13	17,306	6.98	120,796		6.98		34,139	6.98	238,290
Apr'13	2				640	6.98	4,467	33,499	6.98	233,823
May'13	1				630	6.98	4,397	32,869	6.98	229,426
Jun'13	5				625	6.98	4,363	32,244	6.98	225,063
Jul'13	4				638	6.98	4,453	31,606	6.98	220,610
Aug'13	7				639	6.98	4,460	30,967	6.98	216,150
Sep'13	5				643	6.98	4,488	30,324	6.98	211,662
Oct'13	3				645	6.98	4,502	29,679	6.98	207,159
Nov'13	7				639	6.98	4,460	29,040	6.98	202,699
Dec'13	26				640	6.98	4,467	28,400	6.98	198,232

Figure 8: Calculation of Annual Inventory Cost for Spice

Month	Date	Incoming Inventory			Sales			Inventory On Hand		
		Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)	Volume (KG)	Inventory Cost (THB)	Total Inventory Cost (THB)
Jan'13	1							28,764	1.43	41,133
	8				3,924	1.43	5,611	24,840	1.43	35,521
Feb'13	5				3,923	1.43	5,610	20,917	1.43	29,911
Mar'13	5				3,924	1.43	5,611	16,993	1.43	24,300
	13	26,155	1.43	37,402		1.43		43,148	1.43	61,702
Apr'13	2				3,923	1.43	5,610	39,225	1.43	56,092
May'13	1				3,921	1.43	5,607	35,304	1.43	50,485
Jun'13	5				3,923	1.43	5,610	31,381	1.43	44,875
Jul'13	4				3,920	1.43	5,606	27,461	1.43	39,269
Aug'13	7				3,923	1.43	5,610	23,538	1.43	33,659
Sep'13	5				3,925	1.43	5,613	19,613	1.43	28,047
	23	26,155	1.43	37,402		1.43	-	45,768	1.43	65,448
Oct'13	3				3,923	1.43	5,610	41,845	1.43	59,838
Nov'13	7				3,925	1.43	5,613	37,920	1.43	54,226
Dec'13	26				3,926	1.43	5,614	33,994	1.43	48,611