APPLYING AN EOQ MODEL TO REDUCE INVENTORY COST

By

RUSSARIN JIRARUTTRAKUL

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
Bangkok, Thailand

August 2016

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A Final of the Six-Credit Course
SCM 7203 Graduate Project

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Martin de Tours School of Management
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Bangkok Thailand

August 2016

Assumption University
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Declaration of Authorship Form

I, Russarin Jiraruttrakul, declare that this graduate project and the works presented in it are my own and had been generated by me as the result of my own original research.

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I confirm that:

1. This work was done wholly or mainly while in candidature for the Master of Science degree at this University;

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

3. Where I have consulted the published work of others, this is always clearly attributed;

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ADVISOR'S STATEMENT

I confirm that this project has been carried out under my supervision and it represents the original work of the candidate.

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(Dr. Srobol Smutkupt)

Date 19 Aug 16

ACKNOWLEDGEMENT

First of all, I like to express my deep gratitude to Dr. Piyawan Puttibarncharoensri for giving me the opportunity to study Supply Chain Management program at Assumption University. Second, I would like to express my great appreciation to Dr. Srobol Smutkupt for her suggestions and help during the progress of this research. Her willingness to give valuable time is very much appreciated. Without her full support, this project could not have been completed. Third, I would like to thank Dr. Chanasit Thanathawee for guiding me to the right direction in this research.

I also like to express my great appreciation to all Supply Chain team members for their great support throughout my study and work life. Advice given by the staff of ABC Company and their valuable time discussing and sharing information has been a great help in completing this project.

Special thanks is also extended to my friends for their enthusiastic encouragement and great assistance that motivated me to finish this project.

Finally, I wish to thank my parents for their support and encouragement throughout my study.

Russarin Jiraruttrakul
Assumption University
August 2016

ABSTRACT

Since the company started importing products into Thailand in 2011, at the initial stage, the order estimate was based mainly on the historical data and the past experience of the team. Therefore, the order per batch might not be accurate. The Economic Order Quantity (EOQ) model might be the solution to help improve the ordering process and calculation leading to more efficient order making in terms of quantity.

The purpose of this research is to reduce the carrying cost of inventory by applying EOQ. The EOQ model is one of the methods that would help the company to find the appropriate inventory level, the point to restock, and how much buffer stock to keep. The inventory costs consist of the ordering and carrying costs. Carrying costs are the major expenses of the inventory, which means that by reducing the carrying cost, the company would spend less on the annual inventory cost.

The primary data of ABC Company was collected from June 2015 to May 2016, to compute the economic order quantity, re-order point and safety stock using the EOQ model, and then compare with the current total annual inventory cost. After using the EOQ method, the result indicated that the proposed solution can help sustain the total annual inventory cost reduction of ABC Company. Thus, the EOQ model is the model that can improve inventory management and reduce carrying cost.

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CHAPTER I

GENERALITIES OF THE STUDY

The concept of good inventory management means having balance inventories between demand and supply. To get the optimal level of quantities and to know when the company should order, the EOQ model and re-order point need to be calculated. The EOQ model is generally used before planning to purchase an item. Anytime that the company has to repeat purchase the EOQ should be considered. The EOQ model is normally used when demand is constant but can also be used when demand varies, for example, with seasonality (Piasecki, 2001). The EOQ is one of the tools that can determine the optimum order quantity, and is associated with order and carrying costs.

The EOQ can be used to make good order quantity and can help to minimize the cost of inventory. After its calculation, the company will know the quantity it needs to order and how much should be kept in buffer for safety stock when demand is uncertain. Moreover, the cost of carrying can reflect the inventory level. If the cost of carrying is high then that means the company is holding high inventory.

The primary goal of the EOQ model is to get an optimum order level. Efficient inventory can fulfill the demands without having surplus. Moreover, the EOQ model can decrease the average monthly holding costs if the company decreases the order quantity by decreasing the average inventory level. By using the EOQ model, the inventory management could reduce in raw materials, wastages, optimize longer lead time, and back order penalty.

1.1 Background of the Research

ABC Company is a beer importer since 2011. Since the time ABC Company started importing beer the staff did not have standard ordering process and inventory

management. Due to this lack of knowledge in the company they are facing issues like high carrying cost and high inventory cost, which can be avoided by using the Economic Order Quantity (EOQ) model. The EOQ model would help the company to customize the most economical number of unit per order and maintain a balance between minimum cost of ordering and holding stock. The EOQ model will help to get an efficient number when restocking the inventory. Furthermore, the EOQ model has an advantage that points to a suggestion for inventory management. Therefore, the EOQ model is the most appropriate theory and practical method to manage inventory and helps in minimizing the stock handling cost of the inventory (Kisaka, 2006).

In Thailand the company has been selling two kinds of beers, Lager beer and Dark beer. Lager beer is brewed from the best local rice and high quality imported malt, which creates its unique taste. Due to its superior quality, Lager beer has become the best selling brand in Asia. Lager beer was launched in Thailand in 2012 and is available in 330ml size bottles.

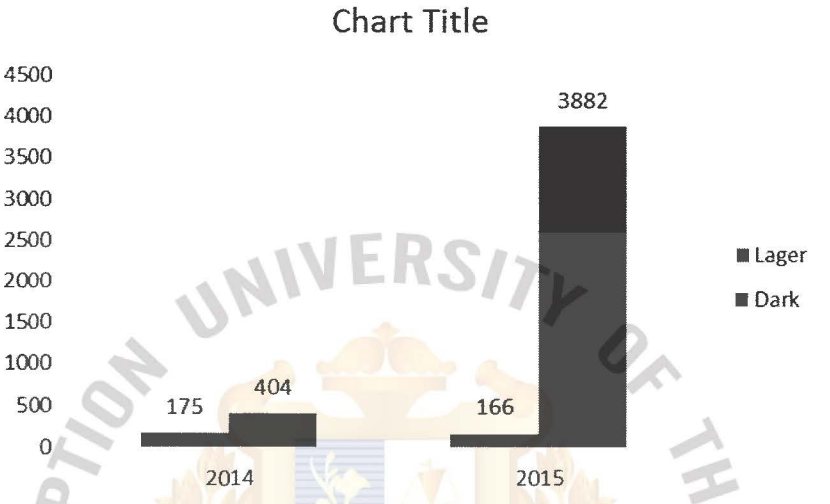
Dark beer is brewed from high quality black malt from Germany. Dark beer is the first premium local beer and has been critically acclaimed by international markets. Both of the beers have unique tastes. This has resulted in the global brand followers for the beer. In Thailand, Dark beer is available in limited areas such as tourist spots, Irish bars, selected supermarkets and hypermarkets.

1.2 Statement of the Problems

Since the year 2011, ABC Company did not have any standard method for ordering. They relied only on historical data to forecast and order from the manufacturer. ABC Company is facing high inventory costs as the ordering decisions are made based on the experiences and skills of the employees. However, the employees do not have adequate knowledge on standard ordering methods. Due to this problem the company has to pay high carrying cost which is the major cost of inventory and has led to lower

profit. The issue can be addressed with the use of EOQ model to improve and reduce the carrying cost.

Figure 1.1: Stock Analysis Year (2014-2015)



Source: Author

The above graph (Figure 1.1) shows the ending inventory of beer in 2014 and 2015. In the year ending 2014, there were 175 and 404 cases of Lager beer and Dark beer respectively. In the year ending 2015, there were 166 and 3,882 cases of Lager beer and Dark beer respectively. In 2014, the company was not able to fulfill the demands of the customers due to low inventory. However, in the year 2015, the company had more inventories that they need. This situation had two negative impacts. Firstly, the company could not deliver the beer to the customers due to the time needed for delivery of beer from the manufacturer. Secondly, the company had to pay storage charge until the stocks were finally moved out of the warehouses. Therefore, the research question is "**How can the EOQ model help to minimize the cost of the inventory?**"

1.3 Research Objectives

The objective of this research is to analyze and apply the EOQ model.
The main objectives of the study are:

1.3.1 To identify an appropriate inventory level by applying the Economic Order Quantity (EOQ) model.

1.3.2 To be able to calculate and set up a Safety Stock (SS) in order to minimize inventory cost.

1.3.3 To apply EOQ and (ROP) Re-Order Point in order to get optimum order quantity.

1.3.4 To find the optimum level of ordering and gain cost savings for ABC Company.

1.4 Scope of the Research

The scope of this research is focused on items which are solely imported to develop inventory management. This study emphasizes finding the Economic Order Quantity, Re-Order Point, and Safety Stock. The inventory data from June 2015 to May 2016 were used to calculate and simulate by using the same data. Furthermore, the possibility of selecting the method will be checked by calculating and comparing, before and after application of the EOQ model.

1.5 Significances of the Research

This study focuses on applying the EOQ model to identify the optimal order quantity, including Re-Order Point (ROP) and Safety Stock (SS). The company will get the optimal order quantity per batch and at the optimal time to restock. The company will also achieve an adequate balance in inventories kept in warehouses. The EOQ model is a suitable method and effective tool that can help companies to solve the problem of inventory management (Jacobs, 2013). Moreover, it helps staff to be better informed before making product purchasing decisions. In addition, the company will have more

knowledge and understanding about inventory management by using EOQ, such as when to re-order and how much should be re-ordered. The company will be able to save costs of inventory after calculating the EOQ, as well as achieving the appropriate inventory level (Ray & Millman, 2007).

1.6 Limitations of the Research

This study focuses only on the beer which is imported from Laos because the company has its own distribution management. This study will calculate from the inventory report of June 2015 to May 2016 only because extensive sales data are not available. The company kept all sales related data such as consolidated sales orders from the customers, purchase orders to the Brewery, and the delivery notes in paper format. These records have been sent to archive for safekeeping. The records are in written format and not available in computerized format. Since 2015, the company has kept all sales data in spreadsheets and is readily available. Hence the research will focus on the inventory report from June 2015 to May 2016.

1.7 Definition of Terms

Carrying Cost (Holding Cost)	This is the cost of storage charge, handling goods, including insurance, pilferage, breakage, and taxes (Jacobs & Chase, 2013).
Economic Order Quantity	This is the optimum order quantity which a company should hold by minimizing inventory cost (Stevenson & Chuong, 2014).
Inventory	This is the stock of all items or resources that are kept in warehouse or in organization (Jacobs & Chase, 2013).

Inventory Management	This is the management of all goods to make the flow of inventory balance the supply and demand and not have a shortage or surplus of goods (Coyle, Bardi, & Langley, 2003).
Lead Time	This is the time it takes from the supplier to deliver the goods to customer once an order is placed (Vermorel, 2014).
Ordering Cost	This is the cost related to the preparation of purchasing the product, including administration cost i.e. phone bill, and paper printing (Jacobs & Chase, 2013).
Re-order Point	This is a model which can determine how much quantity should be ordered, and when the units are ordered to achieve an economical value (Wisner, Tan, & Leong, 2012).
Safety Stock	This is the number of extra stock to prevent running out of stock due to uncertainty of demand (Render, Hanna, & Stair, 2008).
Service Level	This is a stock level defined as a percentage for computing safety stock (Ballou, 2004).

CHAPTER II

LITERATURE REVIEW

In this chapter, the researcher focuses on the inventory management by applying the EOQ model. To get optimum order quantity, re-order point, and safety stock is necessary to the company. Holding sufficient inventories is most important in order to contribute to the satisfaction of the customer. The carrying cost is a major cost of inventory cost that companies try to reduce in order to generate more benefit. The benefit of applying the EOQ is to minimize the cost of inventory and get appropriate inventory level (Ho, 1989).

2.1 Inventory Management

Reid and Sanders (2007), explained that the standard of inventory management is concerned with two major objectives. Firstly, it is about good inventory management that can measure the efficiency of available goods during a demand period. Hence, it is important to provide the products at the right quantity and the right time. Secondly, it is to achieve service level against an optimal cost. Also, inventory management needs to realize on lead time as a related factor. Coyle et al. (2003), stated that many functions involved in inventory management consist of lead time, inventory carrying cost, asset management, inventory forecasting, inventory valuation, inventory visibility, physical inventory, available physical space for inventory, quality management, replenishment, returns and defective goods, and demand forecasting. However, Stevenson and Chuong (2014), stated that the primary objectives of inventory management are determining and controlling a stock level to reach with the physical distribution function. It deals with market demand, then balance the product availability with optimal stock holding and handling cost. Therefore, inventory management is the set of policies and controls in order to determine what levels should be maintained, when stocks should be replenished, and how large orders should be.

2.2 Types of Inventories

According to Hugos (2005), there are three kinds of inventories. They are the following.

2.2.1 Cycle Inventory

Cycle Inventory is the amount of inventory that meets with demand for a particular product during a period. The high level of purchases is resulting in economies of scale. However, high demand also response to the increased of carrying costs, storage cost, handling cost, and insurance cost (Hugos, 2005).

2.2.2 Safety Inventory

Safety Inventory is the inventory that is held for buffer against uncertain demand. As forecast is never perfect, the company should hold additional inventory in case customer demand is suddenly greater than anticipated and in order to approach customer service level. However, the company has to consider and weigh the options between keeping an extra inventory and incurring storage charge versus cost of lost sales due to inappropriate level of inventory (Hugos, 2005).

2.2.3 Seasonal Inventory

Seasonal Inventory is the inventory that is planned to meet with high demand for a certain period of the year. Seasonal inventory management also allows manufacturer to offer incentives to distributors in terms of price to purchase the inventory in advance and store it in their warehouse before the demand for them arises. It is necessary for the company to have physical inventory stock in order to anticipate demand especially during peak seasons of the year. However, keeping inventory is not free as there are three kinds of costs involved. Thus, companies should manage inventory of goods in order to minimize cost of storage. Companies need to have a good management of inventory to meet customer demand and at the same time deliver the right quantity, right quality, and deliver within the expiration date in order to avoid penalty charge (Hugos, 2005).

2.3 Inventory Cost

Piasecki (2001), suggested that the company needs to decide when to initiate a purchase order and how much to determine the lot size. Inventory attracts primarily three types of inventory related cost. They are as follows.

2.3.1 Ordering Cost

Ordering Cost is the cost of expenses incurred when a purchase order is placed. The cost is not related to the number of inventory but a significant process in releasing purchase order. It is included in administrative cost, progress chasing, inspection, and other cost (Piasecki, 2001).

2.3.2 Carrying Cost

Carrying Cost is the cost of holding or carrying a unit of material or finished goods for a period of time. The carrying cost is calculated of the finished goods held in the stock per unit. There are four subcategories in carrying cost. They are capital cost, storage cost, service cost, and risk cost (Piasecki, 2001).

2.3.3 *Shortage Cost or Stock-out Cost*

Shortage Cost or Stock-out Cost is the cost of not having sufficient stock to serve the customer when the customer orders. If the customers cancel orders, the company will lose income from the sales. The company may also lose credibility and production will have backlogs (Piasecki, 2001).

2.4 Inventory Management Models

There are many mathematical techniques that can be used to manage good inventory. Some researchers published their findings on Economic Order Quantity such as Piasecki (2001), Roach (2005), and Lucey (1992). They maintained that the application of the EOQ method results in adequate inventory level in organization.

2.4.1 The Economic Order Quantity (EOQ) Model

Piasecki (2001), defined that Economic Order Quantity (EOQ) is a formulation to determine the combination of ordering cost and carrying cost that should be applied. In Purchasing Department, it is known as quantity in ordering, while in Manufacturing, it is known as production lot size. A good inventory management is to balance the companies EOQ when they make their purchases. Besides, they should understand the factors that impact the EOQ fluctuation so the company needs to emphasize on measurement to achieve accuracy and up-to-date results.

According to Roach (2005), both engineering and business disciplines use Economic Order Quantity (EOQ). Various courses like, economics and industrial engineering offer insights on the EOQ formula for engineers. Moreover, for business disciplines, the EOQ model can be found in both operations and financial courses. The similarity between both the disciplines in terms of the EOQ model study is that, the EOQ formulas have practical and specific applications in illustrating concepts of cost tradeoffs as well as specific applications in inventory. Adeyemi & Salami (2010), studied Coca-Cola Bottling Company in Nigeria. The purpose of their study was to manage inventories efficiently and avoid the cost of changing product rate, unnecessary cost of sale, and back order penalty during period of peak demand. Due to the varieties of products at ABC Company such as Fanta Orange, Coke, Sprite, Krest, Bitter Lemon, Ginger Ale, and Eva water, they do not want to keep too much stock as cost of storage will be high. After analyses, the company used EOQ model to determine the optimum inventory level per year. The company emphasized on the EOQ model because it was seen to be in the best interest of manufacturing companies to maintain an optimal level of materials in stores, the level that minimizes total costs of investment in inventory. Furthermore, it was also found that good sales forecasting technique can ease inventory management process along with production cost reduction (Lucey, 1992).

Guga (2015), studied Shpresa Ltd. for inventory management by applying the EOQ model. Shpresa Ltd. provides cleaning services at hospitals, catering, and also does

wholesale marketing of natural flowers such as orchids in the Netherlands. As they lost sales due to competition and they were not able to predict their sales, they wanted to analyze the EOQ and ROP in inventory control and sought alternative methods for solving inaccurate forecasting. Re-order point may assist and advise when to re-order specific products. After analyzing the data, the company could reduce the cost of ordering, the cost of inventory holding, and also could get a new optimal number after calculating the EOQ. Moreover, the company could reduce the lead time in re-ordering orchids. The company used to re-order orchids every 8 weeks but after calculating ROP the company changed to re-ordering orchids every 6 weeks. Shpresa Ltd. found that the amount of time between orders made and orders delivered was the most significant interval. Before using ROP they could not determine the interval time. Therefore, they concluded that, this model is perfect for their business (Piasecki, 2001).

2.5 EOQ Assumptions

Gonzalez and González (2010), stated that the goal of the EOQ model is to minimize inventory cost by determining the optimal order quantity. If a company's holding inventory is too high the cost of carrying will increase. To meet customer satisfaction the company should keep sufficient inventory on hand. The EOQ model also can determine and get appropriate optimal re-order point for each order. Gonzales & González (2010), studied and analyzed on EOQ and ROP which applied the model in XYZ Company. The XYZ Company had found inventory problems such as ineffective forecasting, product stock outs, and loss of sales. In order to provide them a solution, forecasting model was implemented along with an EOQ and ROP. The study revealed that the EOQ and ROP could help the XYZ Company reduce its overall cost to almost 61% by applying the EOQ technique and ROP. Moreover, this could help the company reduce stock outs and backorders.

Below is a comparison between current method without the EOQ and after applying EOQ model.

Figure 2.1: Current Method Without EOQ

Current method

	Product 1	Product 2	Product 3	Product 4	Product 5	Product 6	Product 7	Product 8	Product 9	Product 10	Product 11	Product 12	Product 13
Times ordered(Qtr)	5	9	13	5	6	4	10	6	5	7	6	6	4
Ave.Demand (Qrt 1)	1466	17	183.5	1230	1710.5	15.85	1076	7	183.5	256.5	901.5	488.5	1659.5
Unit cost Price	3.55	208.38	13.00	3.00	2.18	160.00	2.19	280.07	5.25	3.48	0.73	0.73	0.17
Holding Cost	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Fix order cost	304.71	160.35	181.20	207.56	258.41	105.39	146.02	132.33	129.24	181.23	50.97	34.44	12.19
Lead Time (days)	10	14	5	10	7	7	4	7	6	4	10	10	10
Note: Q=(demand/times ordered)													
Q (EOQ)	293.2	1.9	14.1	246.0	285.1	4.0	107.6	1.2	36.7	36.6	150.3	81.4	414.9
Qtr Holding cost	130.11	49.20	22.94	92.25	77.69	79.25	29.46	40.84	24.08	15.94	13.71	7.43	8.82
Qtr order cost	1523.54	1443.14	2355.65	1037.81	1550.46	421.55	1460.22	794.00	646.20	1268.58	305.79	206.63	48.75
Total Qtr Cost($)	1653.64	1492.34	2378.59	1130.06	1628.15	500.80	1489.67	834.84	670.29	1284.52	319.50	214.06	57.56

Source: Gonzalez (2010)

From the above Figure 2.1, the current method without EOQ model shows the calculation of ordering cost each time additional product data was collected. The additional data collected was the number of orders placed per year, quarterly and monthly. With this data, the holding costs and the ordering costs were determined in order to compare the cost estimates from their current method and the recommend method.

Figure 2.2: Recommended Method with EOQ and ROP

Recommended method

	Product 1	Product 2	Product 3	Product 4	Product 5	Product 6	Product 7	Product 8	Product 9	Product 10	Product 11	Product 12	Product 13
Forecast (Qtr 1)	1667.4	19.3	204.7	1297.7	982.2	43.5	516.9	8.6	290.6	261.4	1357.7	1017.0	1048.8
Unit cost Price	3.55	208.38	13	3	2.18	160	2.19	280.07	5.25	3.48	0.73	0.73	0.17
Holding Cost	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Fix order cost	304.71	160.35	181.20	207.56	258.41	105.39	146.02	132.33	129.24	181.23	50.97	34.44	12.19
Lead Time (days)	10	14	5	10	7	7	4	7	6	4	10	10	10
EOQ	**1070.0**	**10.9**	**151.1**	**847.5**	**965.1**	**15.1**	**525.1**	**5.7**	**239.2**	**330.0**	**870.8**	**619.5**	**775.5**
ROP	**45.9**	**0.7**	**2.8**	**35.7**	**18.9**	**0.8**	**5.7**	**0.2**	**4.8**	**2.9**	**37.4**	**28.0**	**28.9**
Optimal Orders (n*)	1.6	1.8	1.4	1.5	1.0	2.9	1.0	1.5	1.2	0.8	1.6	1.6	1.4
Qtr Holding cost	474.83	283.55	245.48	317.81	262.98	302.76	143.74	199.27	157.00	143.55	79.46	56.53	16.48
Qtr order cost	474.83	283.55	245.48	317.81	262.98	302.76	143.74	199.27	157.00	143.55	79.46	56.53	16.48
Total Qtr Cost($)	949.65	567.10	490.96	635.63	525.97	605.51	287.48	398.55	313.99	287.11	158.92	113.06	32.96

Source: Gonzalez (2010)

From Figure 2.2, the recommended method using EOQ and ROP shows that after applying EOQ and ROP, the total cost for Product 13 has reduced from $57.56 (in current method) to $32.96, which means the company applied this method and saved cost by 43%.

Lucey (1992), stated that the basic assumptions of the EOQ model that are necessary to know are the constant cost of holding stock, constant cost of ordering, demand rate, and the cost of the product per unit.

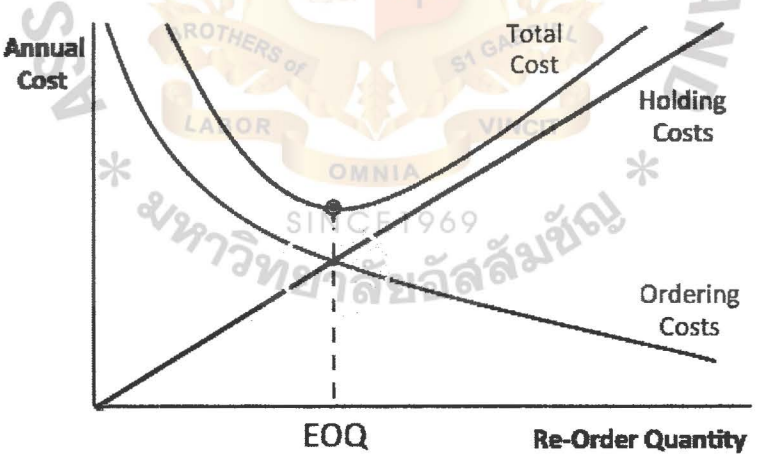
The formula of Economic Order Quantity is shown below:

$$EOQ = \frac{\sqrt{2CoD}}{Cc}$$

Where:

EOQ	=	Optimal number of units to order = Q*
D	=	Annual inventory demand (Units)
Co	=	Ordering cost of each order (Baht)
Cc	=	Carrying cost per unit per year (Baht)
Q	=	Quantity (number) of units to order

Figure 2.3: The Economic Order Quantity and Total Costs



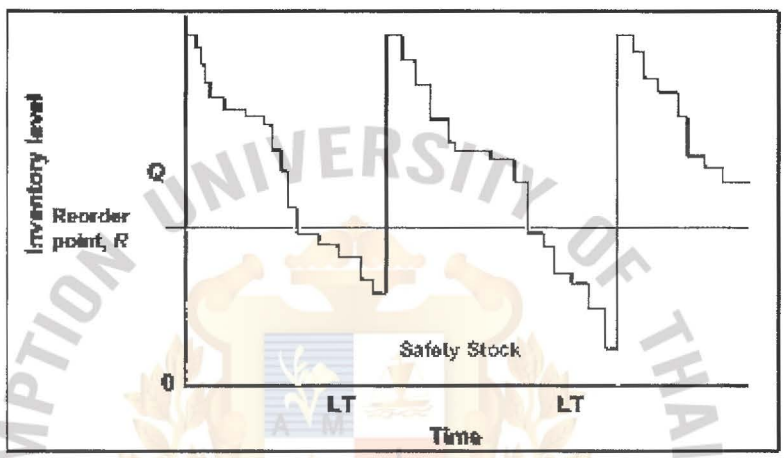
Source: Lucey (1992)

Figure 2.3 illustrates a graph representing the EOQ and the total cost. The lowest total cost will occur when the ordering cost equal to carrying cost.

2.6 Re-Order Point (ROP)

According to Chen (1998), one more very important method to use with the EOQ is the Re-order Point. The ROP quantity reflects the level of inventory that prompts the placement of an order for additional units.

Figure 2.4: Re-Order Point



Source: Jacobs & Chase (2013)

Re-Order formula:

Re-Order Point = Lead time * Demand per unit per time

ROP = LT * d

Where:

LT = Lead time

d = Demand per unit per time (Units)

2.7 Safety Stock (SS)

Ray and Millman (2007), have explained that safety stock is the buffer inventory to prevent product shortages when the demand item is higher than the availability. Once the company makes decision on re-order points, they will include the number of safety stock as well.

Safety Stock can be calculated by the formulation below:

$$\text{Safety Stock} = \sqrt{\overline{LT}\sigma_d^2 + \bar{d}^2\sigma_{LT}^2}$$

Where:

Z	=	Service level factor
$\overline{LT}$	=	Average replenishment lead time
$\bar{d}$	=	Average demand per unit of time
σ_d^2	=	Standard deviation of demand
σ_{LT}^2	=	Standard deviation of replenishment lead time

Render, Hanna and Stair (2008), studied the inventory of an electronic company in the United States. The study explained how to determine a level of safety stock and indicate re-order point. The conclusion can be defined by three situations. First, variable in demand but lead time is constraint. Second, there is constraint in demand but variable on lead time. Third, both demand and lead time are variable while all three formulas are upon the situation. Moreover, the researcher tested the relationship between the level of safety stock and different service levels. They came out with 97% service level which means Z value = 1.88 if demand is variable while lead time is constant. Vermorel, Schalit, and Nicollet (2012), considered the service level of product can be analyzed by turnover, profitability, number of order, and cost of goods sold. If the products have more than 80% turnover and classified with 95% service level, it means Z value is equal to 1.65.

1. Demand is variable but lead time is constant:

$$\text{ROP} = \bar{d}L + Z(\sigma_d \sqrt{L})$$

Where:

$\bar{d}$	=	Average daily demand
σ_d	=	Standard deviation of daily demand
L	=	Lead time in days

2. Demand is constant but lead time is variable:

$$\text{ROP} = d\bar{L} + Z(d\sigma_L)$$

Where:

$\bar{L}$	=	Average lead time
σ_L	=	Standard deviation of lead time
d	=	Daily demand

3. Both demand and lead time are variable:

$$\text{ROP} = \bar{d}\bar{L} + Z(\sqrt{\bar{L}\sigma_d^2 + \bar{d}^2\sigma_L^2})$$

Render et al. (2008), stated on the significance of the EOQ. It is balancing demand with available product during a period to avoid stocked out in the market. Even though consideration on the EOQ is useful for optimal stock level, realizing fluctuating demand and lead time also provide critical impacts. This uncertainty usually leads to opportunity loss following the company unable to fulfill all demand in a period. Therefore, to prevent stock out, it is necessary to consider additional inventory, called safety stock. The inventory concept should be computed by average

inventory during lead time and added up with safety stock to avoid stock out occurrence. Therefore we come out with the following formula.

ROP = (Average demand during lead time) + (Safety Stock)

Where:

SS = Safety Stock

2.8 Chapter Summary

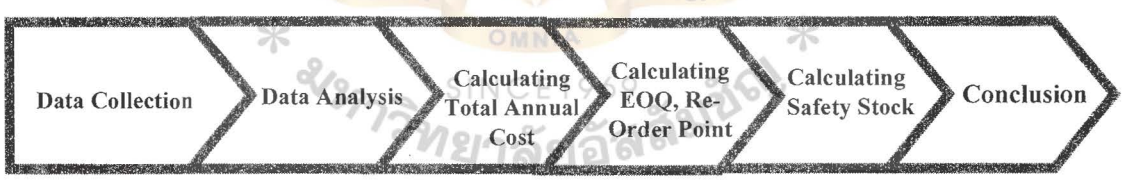
In this study, the main focus is on the EOQ model, ROP, and SS level in order to figure out the most appropriate ordering quantity. The EOQ model has been reviewed because it is a problem solving tool that can help to minimize the carrying cost and develop better inventory management. The aim of applying the EOQ model is to improve annual inventory cost, hold sufficient inventory and achieve appropriate inventory level.

CHAPTER III

RESEARCH METHODOLOGY

This chapter explains the research methodology and procedure which the researcher implemented in the study. The EOQ model is a well-known model, used in a variety of businesses to allow the maximum inventory level to be ordered at the lowest cost and also to minimize the holding cost of inventory. Kisaka (2006), analyzed and used the EOQ model method to solve inventory issues for his project. After using the EOQ model he compared the current total costs of inventories of raw materials. He found that there was a cost saving through using the EOQ model. This study used the historical data to analyze and followed procedures with calculations. The total annual cost, ordering cost, carrying cost, EOQ, ROP, and SS need to be calculated. The research methodology consists of six key steps as referred to data collection in Figure 3.1 which covers actual sales data and inventory data separated in two SKUs which consist of Lager beer and Dark beer.

Figure 3.1: Six Key Steps Procedure



Source: Author

3.1 Data Collection

Since the historical figures of sales data and inventory data were readily available in computerized format, the researcher used the data of June 2015 to May 2016 for this study. The researcher used inventory report, actual ordering cost, and actual carrying cost to make calculations. The data was exported from Navision software. The

Navision software is special software used at ABC Company as spreadsheet for easy access and tabulated summary of sales data. The summary also included purchased product quantities and inventory report.

Table 3.1: Actual Sales & Inventory Data: June 2015-May 2016, Lager Beer

Product: Beer Lager						
Total Stock Balance	Sales data	Inventory data				
	Actual demand from sale	Beginning stock	Stock in	Stock out	Ending stock	Back order
June-16	2,140	1,208	3,200	2,140	2,268	0
July-16	2,117	2,268	1,600	2,117	1,751	0
August-16	2,431	1,751	1,600	2,431	920	0
September-16	2,629	920	3,200	2,629	1,491	0
October-16	3,478	1,491	6,400	3,478	4,413	0
November-16	7,197	4,413	8,000	7,197	5,216	0
December-16	4,134	5,216	2,800	4,134	3,882	0
January-16	2,373	3,882	1,200	2,373	2,709	0
February-16	4,144	2,709	2,400	4,144	965	0
March-16	6,873	965	5,600	6,565	-	-308
April-16	580	(308)	6,400	580	5,512	0
May-16	2,740	5,512	665	2,740	3,437	0

Source: ABC Company

Table 3.1 shows the actual sales data and inventory data from June 2015 to May 2016. The company had high ending inventory of Lager beer in November 2015 at 5,216 cases and in April 2016 at 5,512 cases which resulted in high inventory cost, subsequently impacting the profitability of the company. If the company had used EOQ model they could have purchased optimal quantity which would minimize the ending stock of Lager beer.

Table 3.2: Actual Sales & Inventory Data: June 2015-May 2016, Dark Beer

Product: Beer Dark						
Total Stock Balance	Sales data	Inventory data				
	Actual demand from sale	Beginning stock	Stock in	Stock out	Ending stock	Back order
July-16	1,711	1,339	1,600	1,711	1,228	-
August-16	1,880	1,228	1,600	1,880	948	-
September-16	2,320	948	1,600	2,320	228	-
October-16	3,581	228	4,800	3,581	1,447	-
November-16	4,883	1,447	4,800	4,883	1,364	-
December-16	4,095	1,364	3,135	4,095	404	-
January-16	2,222	404	6,000	2,222	4,182	-
February-16	4,039	4,182	4,800	4,039	4,943	-
March-16	7,589	4,943	2,400	7,343	-	(246)
April-16	1,200	(246)	4,800	720	3,834	-
May-16	2,641	3,834	935	2,641	2,128	-

Source: ABC Company

Table 3.2 shows the summary of the company's actual sales data and inventory data from June 2015 to May 2016. The company had high ending inventory stock similar to Lager beer. The result is the company had to pay high carrying cost which is unnecessary until the products are moved out from the warehouse. To improve and minimize carrying cost of inventory the EOQ model is recommended.

3.2 Data Calculation

After collecting all data, the next step is to calculate the total cost which consists of ordering cost and carrying cost. The company spends two hours for ordering process per order. An ordering cost includes telephone call, purchase order paper, and staff salary. The researcher calculated the cost based on the actual data from June 2015 to May 2016. Once the data was analyzed, the company could see the differences between before and after applying the EOQ method. All the calculation of related total cost is presented in Chapter 4.

3.2.1 Calculating Total Cost

The total cost is computed by summarizing the ordering cost and adding up carrying cost. The cost of ordering of the company is a fixed cost which is the same amount each month, no matter how much quantity the company will order. The carrying cost is a cost that varies according to the quantity of order. The company's carrying cost consists of unloading and staging charge, warehouse management, handling fee, etc. The optimal order quantity will represent a compromise between these two inversely related costs.

Table 3.3: Total Cost of Lager Beer from June 2015-May 2016

Month	Qty Received Beer Lager	Qty Received Beer Dark	Ordering Cost Beer Lager	Carrying cost Beer Lager	Total Cost Beer Lager
June-15	3,200	3,000	227.27	22,892.18	23,119.45
July-15	1,600	1,600	227.27	14,137.96	14,365.23
August-15	1,600	1,600	227.27	12,987.58	13,214.85
September-15	3,200	1,600	227.27	12,747.92	12,975.19
October-15	6,400	4,800	227.27	49,991.26	50,218.53
November-15	8,000	4,800	227.27	24,734.18	24,961.45
December-15	2,800	3,135	227.27	32,463.96	32,691.23
January-16	1,200	6,000	227.27	22,340.18	22,567.45
February-16	2,400	4,800	227.27	17,496.23	17,723.50
March-16	5,600	2,400	227.27	31,134.65	31,361.92
April-16	6,400	4,800	227.27	10,305.13	10,532.40
May-16	665	935	227.27	27,276.92	27,504.19
Total	43,065	39,470	2,727.24	278,508.15	281,235.39

Source: ABC Company

Table 3.3 shows the data which consist of the actual quantity of Lager beer received each month, and the ordering cost is calculated based on staff salary and working hours spent in ordering process. The company is determined to spend two hours per batch order and the cost is fixed each month. Therefore, the cost of ordering will be the same amount each month. The carrying cost is based on the quantity received or order quantity each month.

Table 3.4: Total cost of Dark Beer: June 2015-May 2016

Month	Qty Received	Qty Received	Ordering Cost	Carrying Cost	Total Cost
	Beer Lager	Beer Dark	Beer Dark	Beer Dark	Beer Dark
June-15	3,200	3,000	227.27	16,085.92	16,313.19
July-15	1,600	1,600	227.27	8,881.74	9,109.01
August-15	1,600	1,600	227.27	11,060.78	11,288.05
September-15	3,200	1,600	227.27	7,283.56	7,510.83
October-15	6,400	4,800	227.27	27,411.05	27,638.32
November-15	8,000	4,800	227.27	17,936.69	18,163.96
December-15	2,800	3,135	227.27	15,099.18	15,326.45
January-16	1,200	6,000	227.27	11,280.45	11,507.72
February-16	2,400	4,800	227.27	9,724.82	9,952.09
March-16	5,600	2,400	227.27	20,188.91	20,416.18
April-16	6,400	4,800	227.27	18,517.72	18,744.99
May-16	665	935	227.27	27,748.65	27,975.92
Total	43,065	39,470	2,727.24	191,219.47	193,946.71

Source: ABC Company

Table 3.4 shows the summary data of the actual quantity received for Dark beer, ordering cost, carrying cost, and total cost from June 2015 to May 2016. The carrying cost is based on the amount of quantity ordered. Therefore the cost of carrying/holding is not the same as ordering cost. Because consumers demand for Dark beer is less than Lager beer by a total 3,595 cases, the total carrying cost of Dark beer is less than Lager beer by a total of 87,288.00 baht.

3.2.2 Calculating Economic Order Quantity

Once the ordering cost and carrying cost are known, the EOQ can be calculated. After knowing the number of total annual cost which is from ordering cost and carrying cost, the next step is to calculate the Economic Order Quantity which will use data from June 2015 to May 2016.

3.2.3 Calculating Re-Order Point with Variable Demand & Constant Lead Time

After calculating the EOQ, the next step is to calculate ROP to know at which point the company should make the next order. ROP is an important technique used along with the EOQ which can determine when to place the new order. The ROP concerns the annual demand and lead time by placing the order until receiving the products. To calculate ROP under uncertain demand, it is necessary to know the average annual demand during the protection period and the number of Safety Stock.

3.3 Expected Results

Using the calculated EOQ, the company will be able to reduce the cost of inventory and generate more revenue for the company. Moreover, holding sufficient safety stock would help the company to fulfill customer demand by 100%.

3.4 Evaluation and Conclusion

After getting the results the researcher will compare two things. First is to compare the number of actual order quantity for both Lager beer and Dark beer and how much is the difference before and after using the EOQ. Second is to compare the carrying cost of the inventory with the actual amount spent including the Re-order Point and Safety Stock with and without the EOQ.

3.5 Chapter Summary

In this chapter the researcher collected adequate information before applying the actual data to identify the appropriate ordering quantities and ordering times with the EOQ technique, ROP, and SS. The researcher expected the company will save cost by using the proposed EOQ model and this will lead to a more profit. The chapter also identified two major costs in inventory management, the ordering cost and the carrying cost.

CHAPTER IV

PRESENTATION AND CRITICAL DISCUSSION OF RESULT

In this chapter the researcher presents the result of the data analysis from historical data. The aim of this chapter is to find optimal order quantity, at which point the company should make the re-order and how much inventory should be kept. The inventory level should not be too high in order to avoid a high storage cost. Furthermore, the EOQ result would help the company to reduce carrying cost which is a major cost of inventory. The calculation of the EOQ, ROP, and SS will be applied to the historical data from June 2015 to May 2016 accordingly. First are the actual quantity received for both Lager beer and Dark beer. Second is the ordering cost which is a fixed cost from June 2015 to May 2016. The ordering cost is calculated by the company at two hours per month for ordering process. The ordering process involved placing an order and mostly a fixed cost. An ordering cost includes telephone bill, purchase order paper, staff salary, etc.

4.1 Computing Actual Total Cost

4.1.1 Computing Actual Total Cost for Lager Beer

The total cost consists of actual ordering cost, which the company spent, and actual carrying cost. The ordering cost will come from the cost of the ordering process, and the carrying cost which is the storage charge per SKU pallet. The company uses outsourcing and rents space in a warehouse to store its inventories. Therefore, outsourcing will be calculated based on storage day and dimension of pallet, which is 10.93 baht per pallet. The total costs are computed from the ordering cost and carrying cost. The amount of the carrying cost depends on the order quantity per batch. The calculation data of Lager beer and Dark beer are presented below.

Table 4.1: Computing Actual Total Cost of Lager Beer

Month	Qty Received	Qty Received	Ordering Cost	Carrying cost	Total Cost
	Beer Lager	Beer Dark	Beer Lager	Beer Lager	Beer Lager
June-15	3,200	3,000	227.27	22,892.18	23,119.45
July-15	1,600	1,600	227.27	14,137.96	14,365.23
August-15	1,600	1,600	227.27	12,987.58	13,214.85
September-15	3,200	1,600	227.27	12,747.92	12,975.19
October-15	6,400	4,800	227.27	49,991.26	50,218.53
November-15	8,000	4,800	227.27	24,734.18	24,961.45
December-15	2,800	3,135	227.27	32,463.96	32,691.23
January-16	1,200	6,000	227.27	22,340.18	22,567.45
February-16	2,400	4,800	227.27	17,496.23	17,723.50
March-16	5,600	2,400	227.27	31,134.65	31,361.92
April-16	6,400	4,800	227.27	10,305.13	10,532.40
May-16	665	935	227.27	27,276.92	27,504.19
Total	43,065	39,470	2,727.24	278,508.15	281,235.39

Source: Author

Table 4.1 shows that the total numbers of cases of Lager beer received from June 2015 to May 2016 is higher than Dark beer. The ordering cost is fixed, not variable as carrying cost. The total carrying cost of Lager beer is 278,508.15 baht for 43,065 cases.

4.1.2 Computing Actual Total Cost of Dark Beer

The actual total cost of Dark beer from June 2015 to May 2016 is similar to Lager beer. The ordering cost did not vary with the number of order quantity and the carrying cost is calculated based on the actual quantity received and will be variable depending on the size of the order.

Table 4.2: Computing Actual Total Cost of Dark Beer

Month	Qty Received	Qty Received	Ordering Cost	Carrying Cost	Total Cost
	Beer Lager	Beer Dark	Beer Dark	Beer Dark	Beer Dark
June-15	3,200	3,000	227.27	16,085.92	16,313.19
July-15	1,600	1,600	227.27	8,881.74	9,109.01
August-15	1,600	1,600	227.27	11,060.78	11,288.05
September-15	3,200	1,600	227.27	7,283.56	7,510.83
October-15	6,400	4,800	227.27	27,411.05	27,638.32
November-15	8,000	4,800	227.27	17,936.69	18,163.96
December-15	2,800	3,135	227.27	15,099.18	15,326.45
January-16	1,200	6,000	227.27	11,280.45	11,507.72
February-16	2,400	4,800	227.27	9,724.82	9,952.09
March-16	5,600	2,400	227.27	20,188.91	20,416.18
April-16	6,400	4,800	227.27	18,517.72	18,744.99
May-16	665	935	227.27	27,748.65	27,975.92
Total	43,065	39,470	2,727.24	191,219.47	193,946.71

Source: Author

Table 4.2 shows that the total numbers of cases of Dark beer received was 39,470 cases. The carrying cost for Dark beer is 193,946.71 baht. The amount of carrying cost is variable, depending on the quantity kept in the warehouse. The total cost is calculated by adding the carrying cost and the ordering cost. Ordering cost is fixed and does not vary with order quantity.

4.2 Computing Economic Order Quantity (EOQ)

4.2.1. Computing the EOQ for Lager Beer

Before calculating EOQ, the necessary data are the annual inventory demand in unit, ordering cost, and carrying cost. The EOQ of each SKU Lager beer and Dark beer are shown below by using the following formula.

Table 4.3: Computing EOQ Lager Beer

Annual Demand Lager Beer D	Ordering Cost Lager Beer Co	Carrying Cost Lager Beer Cc	Q
43065	227.27	6.47	1739

Source: Author

$$EOQ = \sqrt{\frac{2(227.27)(43065)}{6.47}}$$

From Table 4.3, computing the EOQ of Lager beer, the researcher got the result of optimal order quantity at 1,739 cases per order. The result is calculated based on annual demand at 43,065 units, the actual data from June 2015 to May 2016. The total ordering cost is 2,727.00 divided by 12 months as the company orders once in a month. The ordering cost per order is 227.27 baht. The carrying cost per unit per year is calculated from the storage charge for 12 months divide by the annual inventory demand, and the cost of carrying per unit per year is 6.47 baht per case.

4.2.2 Computing EOQ for Dark Beer

Before computing the EOQ for Dark beer the researcher collected the data of annual demand, ordering cost per order, and the carrying cost per case. The formula and computation are shown below.

Table 4.4: Computing EOQ of Dark Beer

Annual Demand Dark Beer D	Ordering Cost Dark Beer Co	Carrying Cost Dark Beer Cc	Q
39470	227.27	4.84	1925

Source: Author

$$EOQ = \sqrt{\frac{2(227.27)(39470)}{4.84}}$$

From Table 4.4, the EOQ calculation of Dark beer is similar to Lager beer, but the annual inventory demand per year is in different units. The annual inventory demand of Dark beer is less than Lager beer, and the ordering cost is fixed for 12 months. The carrying cost does vary according to order quantity and annual inventory demand per year. Computing the EOQ for Dark beer, the researcher got the optimal order quantity at 1,925 cases per order. The carrying cost per unit per year is 4.84 baht per case. The total annual demand was 39,470 cases.

4.3 Computing ROP Using Variable Demand, Constant Lead Time, and SS

4.3.1. Computing ROP with Variable Demand, Constant Lead Time, and Safety Stock for Lager Beer

Based on historical data from June 2015 to May 2016 the order quantities were variable because of customer consumptions. Therefore, the researcher chooses to calculate ROP including Safety Stock. The formula and variable demand are shown on Table 4.5.

Table 4.5: ROP with Variable Demand, Constant Lead Time Constant, and Safety Stock for Lager Beer

Month	Qty Received Beer Lager	Average daily demand $\bar{d}$
June-15	3200	106.67
July-15	1600	53.33
August-15	1600	53.33
September-15	3200	106.67
October-15	6400	213.33
November-15	8000	266.67
December-15	2800	93.33
January-16	1200	40.00
February-16	2400	80.00
March-16	5600	186.67
April-16	6400	213.33
May-16	665	22.17
Total	43065	$\bar{d}$ = 119.63

Source: Author

$$119.63(30)+1.65(5\sqrt{30}) = 3588.90 + 1.65(5*5.48)$$

From Table 4.5 the researcher got the average daily demand for Lager beer at 119.63 cases. The company's service level is at 95% where Z is 1.65 and delivery lead time is 30 days. The result of ROP is that the company should make the re-order when the supply is down to 3,634 cases.

4.3.2. Computing ROP with Variable Demand, Constant Lead Time, and Safety Stock for Dark Beer

Table 4.6 ROP with Variable Demand, Constant Lead Time, and Safety Stock of Dark Beer

Qty Received Beer Dark	Average daily demand $\bar{d}$	Total Qty. Order
3000	100.00	6200
1600	53.33	3200
1600	53.33	3200
1600	53.33	4800
4800	160.00	11200
4800	160.00	12800
3135	104.50	5935
6000	200.00	7200
4800	160.00	7200
2400	80.00	8000
4800	160.00	11200
935	31.17	1600
39470	$\bar{d}$ = 109.64	82535

Source: Author

$$109.64(30) + 1.65(5\sqrt{30}) = 3289.20 + 1.65(5*5.48)$$

$$= 3{,}334 \text{ cases}$$

From Table 4.6, the researcher got the average daily demand for Dark beer at 109.64 cases. The company's service level is at 95% where Z is 1.65 and delivery lead time is 30 days. The result of ROP is that the company should make the re-order when the supply is down to 3,334 cases.

4.4 Computing Average Daily Demand of Lager Beer and Dark Beer

The benefit of calculating the average daily demand is to get the effective amount that the company used daily. The formula and calculation is shown below.

Table 4.7: Computing Average Daily Demand of Lager Beer and Dark Beer

Month	Qty Received Beer Lager	Average daily demand $\bar{d}$	Qty Received Beer Dark	Average daily demand $\bar{d}$
June-15	3,200	106.67	3,000	100.00
July-15	1,600	53.33	1,600	53.33
August-15	1,600	53.33	1,600	53.33
September-15	3,200	106.67	1,600	53.33
October-15	6,400	213.33	4,800	160.00
November-15	8,000	266.67	4,800	160.00
December-15	2,800	93.33	3,135	104.50
January-16	1,200	40.00	6,000	200.00
February-16	2,400	80.00	4,800	160.00
March-16	5,600	186.67	2,400	80.00
April-16	6,400	213.33	4,800	160.00
May-16	665	22.17	935	31.17
Total	43,065	$\bar{d}$ = 119.63	39,470	$\bar{d}$ = 109.64

Source: ABC Company

Table 4.7 shows the computation of average daily demand of Lager beer and Dark beer. The researcher used historical data from June 2015 to May 2016 to calculate the average daily demand for both Lager beer and Dark beer. The average daily demand will be calculated from the actual quantity received each month divided by 30 days. The researcher calculated month by month for 12 months and then the sum of 12 months divide by 12 months. The result will be average daily demand.

The researcher summarized the variable of Lager beer and Dark beer. It shows the variable p-value of Lager beer and Dark beer including service level. The company's service level is at 95% and standard deviation is 5 cases per day. Annual demand, new optimal order quantity, and re-order point with variable demand but constant lead time for both Lager beer and Dark beer are also shown to clarify and calculate the EOQ.

4.5 Computing Annual Ordering Cost Using EOQ

The annual ordering cost is calculated from working hours that the employees spend in ordering process which includes administration cost which is paper and telephone bills. The company is selling Lager beer and Dark beer so the researcher will divide the total amount of annual ordering cost by two.

Table 4.8: Annual Ordering Cost of Lager Beer and Dark Beer Using EOQ

Product SKU	Annual Demand	EOQ	Cost of ordering per time (THB)	Annual ordering cost (THB)
Beer Lager	43065	1739	227.27	5,628.17
Beer Dark	39470	1925	227.27	4,659.92

Source: Author

Calculation for annual ordering cost using EOQ is by annual inventory demand divide by the new number of the EOQ and multiplied by ordering cost. The annual ordering cost of Dark beer is less than Lager beer because the annual inventory demand for Lager beer from June 2015 to May 2016 was higher than Dark beer.

4.6 Computing Carrying/Holding Cost Using EOQ

To calculate the carrying cost using the EOQ, the researcher used the historical data from June 2015 to May 2016. The necessary data of annual demand and the carrying cost per case must be known before making the calculation.

Table 4.9: Carrying/Holding Cost Using EOQ

Product SKU	EOQ	Carrying Cost per carton (THB)	Actual Annual Carrying Cost	Annual Carrying Cost Using EOQ	Saving %
Beer Lager	1739	6.47	278,508.15	135,015.96	52%
Beer Dark	1925	4.84	191,219.47	111,804.00	42%

Source: Author

Table 4.9 shows the calculation of the annual carrying cost without EOQ and using the EOQ model. The actual annual carrying cost of Lager beer was 278,508.15 baht. For Dark beer, it was 191,219.47 baht. After calculating the EOQ, the annual carrying cost of Lager beer is reduced from 278,508.15 to 135,015.96, and for Dark beer it is reduced from 191,219.47 to 111,804.00 baht. The company could save carrying cost, which is a major cost of inventory for Lager beer for a total of 143,492.19 baht (or 52%), and the cost saving for Dark beer is 79,415.47 baht (or 42%).

4.7 Computing Annual Inventory Cost Using EOQ

After the researcher got the results of annual ordering cost and annual carrying cost, the annual inventory cost was known. The result of the annual inventory is shown below.

Table 4.10: Annual Inventory Cost Using EOQ

Product SKU	Annual Ordering Cost (THB)	Annual Carrying/ Holding Cost (THB)	Annual Inventory Cost Using EOQ (THB)
Beer Lager	5,628.17	135,015.96	140,644.13
Beer Dark	4,659.92	111,804.00	116,463.92

Source: Author

Table 4.10 shows the computation and results of the annual inventory cost for Lager beer and Dark beer. When calculating by using EOQ, the researcher found that the new inventory cost of Lager beer is 140,644.13 baht and the new annual inventory cost of Dark beer is 116,463.92 baht. The comparison between the actual inventory and the new annual inventory cost using EOQ is shown in Table 4.11.

4.8 Actual Annual Inventory Cost VS Annual Inventory Cost Using EOQ

After the researcher calculated and got the new results of annual inventory cost without EOQ and using EOQ model, the researcher will compare the results. With the differences of the actual annual inventory cost and the new inventory cost using EOQ, the researcher is able to help the company reduce its cost.

Table 4.11: Comparison of Actual Annual Inventory Cost and Annual Inventory Cost Using EOQ

Product SKU	Actual Annual Inventory Cost (THB)	Annual Inventory Cost Using EOQ (THB)	Different of Inventory Cost (THB)	Different (%)
Beer Lager	281,235.39	140,644.13	140,591.26	50%
Beer Dark	193,946.71	116,463.92	77,482.79	40%

Source: Author

Table 4.11 shows the comparison of the actual annual inventory cost which the company spent from June 2015 to May 2016 and the new annual inventory cost using EOQ. The result shows the different cost from Lager beer is 140,591.26 baht or 50% lower if compared with the actual spent at 281,235.39 baht. For Dark beer the annual inventory cost using the EOQ is 116,463.92 baht and the actual amount spent is 193,946.71 baht. The difference is 77,482.79 baht, a reduction from the actual amount spent of 40%.

4.9 Chapter Summary

The data simulation in this chapter is based on real historical data from June 2015 to May 2016. The researcher realized a cost saving of the annual inventory cost by using the EOQ model. There is a cost saving of 140,591.26 baht for Lager beer and a cost saving of 77,482.79 baht for Dark beer. The average inventory carrying cost could be reduced by 50% for Lager beer and 40% for Dark beer. Therefore, after calculating the EOQ, the new proposed model is able to minimize carrying cost and annual inventory cost. They could be improved by 50% and 40% respectively. In addition, the advantage of the EOQ model is for the company to be able to identify an appropriate inventory level and they can develop their inventory management.

CHAPTER V

SUMMARY FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

In this chapter, the researcher summarizes the results of the research. It comprises of a summary of the findings, showing the amount of annual carrying cost saved after simulations using EOQ. Next is the conclusion and discussion, which show the theoretical implications of this study. Some researchers mentioned that EOQ can help to minimize inventory cost and allow appropriate inventory level to be attained. The managerial implications presented that EOQ model can improve and develop the carrying cost of the company. Finally, the limitations and recommendations for future research are discussed. The obstacles that the researcher encountered during the study are also explained in this chapter.

5.1 Summary of the Findings

The main purpose of this research is to minimize the carrying cost of inventory by applying the EOQ model. The second purpose is to be able to identify an appropriate inventory level. The EOQ model was simulated for both Lager beer and Dark beer, including ROP and SS in order to get the optimum order quantity and to attain sufficient buffer stock to last until the next shipment arrives. The actual annual inventory cost is computed by using the actual annual ordering cost and the actual annual carrying cost. The ordering cost comes from the order process, and it is a fixed cost regardless of how much quantity the company orders. The carrying cost is calculated from the storage charge.

How can the EOQ help to minimize the cost of inventory? As the carrying cost is a major cost of inventory, the researcher selected to focus by proposing the EOQ model in this research. The EOQ model can show that it can help the company reduce its

carrying cost by an average of 50% for Lager beer and Dark beer, which mean ABC Company can generate more revenue.

This research focuses in the implementation of EOQ to find the optimum number for purchase per order. Moreover, the ROP and SS are computed to find an appropriate inventory level to re-order and buffer stock for the company. After applying the EOQ model, the result of the annual inventory cost of ABC Company for Lager beer is 140,644.13 baht and 116,463.92 baht for Dark beer. The amount of cost savings is 140,591.26 baht, or approximately a 50% decrease from the actual amount spent in Lager beer. Furthermore, there is a cost saving of 77,482.79 baht, or approximately 40% after applying the EOQ model for Dark beer.

5.2 Conclusion and Discussion

The EOQ model is one of models that are well known in all industries for inventory management. This research has used EOQ to compute the historical data of ABC Company to decrease the carrying cost of its inventory. Bill Roach (2005), stated that the goal of the EOQ model is to minimize the inventory cost by determining the optimal order quantity. If a company's holding inventory is too high, the cost of carrying inventory will increase. To meet customer satisfaction the company should keep sufficient inventory on hand. The EOQ model can also determine and get appropriate inventory level. Meanwhile, the ROP will give advice at which point should the company refill its stock. After simulation the researcher found out that the company should re-order when the stock falls down to 3,634 cases for Lager beer and 3,334 cases for Dark beer. These numbers include safety stock.

However, Lucey (1992), stated that the basic necessary assumptions of the EOQ are to know before calculation the constant cost of carrying/holding inventory, the constant cost of ordering, the demand rate and cost of product per unit. Thus, the researcher has adopted to use Economic Order Quantity model in this study.

5.3 Managerial Implications

This study is mainly a guideline for ABC Company, as well as for other companies who have similar imported alcohol products. The result of this research shows that the EOQ model can help to determine optimal order quantity before making decision to re-order the product and also minimize the cost of carrying. The EOQ method helps to deal with inventory management and achieve cost saving in cost of ordering and carrying cycle stock. Hence, the company should apply the EOQ model to improve its inventory management and reduce its carrying cost which is a major cost of inventory (Bassin, 1990).

In addition, ABC Company can use ROP and SS to determine the particular stock level. The ROP can help the company to reduce risk as the company will get to know the best point when to repeat order and buffer stock to prevent uncertainty demand.

Lastly, the appropriate inventory level can also help the company fulfill customer demand and meet customer satisfaction (Ray & Millman, 2007). This is because the company will have sufficient stock to serve the customer when demands fluctuate.

5.4 Limitations and Recommendations for Future Research

Some limitations were found after studying this research. The data of ABC Company was not available from the company system and the data period did not include seasonal demand. The researcher used historical data to simulate and analyze, but due to time limit, the result from calculating the EOQ was not available to implement for the current period. There are limitations of the EOQ model, which is not available for seasonal production, as it is quite difficult to manage inventory.

For future research, it is suggested that there should be more study in forecasting time method during high or low season. ABC Company is a distributor and importer of alcohol. It should be aware that there is high alcohol consumption in April and

December. Therefore, more study and researches in time series method are advised, to get accuracy in forecasting. There is seasonal Dummy variable model which can be used to manage the seasonal demand fluctuations. The Dummy variable represents a numerical value 0 or 1 and before analyzing, the Dummy coding needs to be created. Dummy variable can be created by using date, year, quarter, day or week. After creating the Dummy variable, there will be an improvement in the accuracy of predicting the seasonal demand (Oyeka, 1993).

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