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Analysis of Inventory Management Practices using ABC and EOQ Models: A Case Study of Thailand's Cleaning Supplies Company

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Abstract

Over the past few years, the outbreak of the COVID-19 virus epidemic has led to a significant surge in the demand for cleaning products. Many companies have expanded their operations to include the sale of these products, including the organization examined in this case study. The case study for this research involves the procurement of cleaning items, maintaining a stock, and subsequently selling them to consumers. The diverse range of cleaning and COVID-19 related products has considerably increased the complexity of managing the inventory in this case study. This wide variety has resulted in higher and unnecessary inventory costs. Therefore, the objective of this study is to guide the company in minimizing inventory costs by utilizing two widely used inventory management methods: ABC Analysis and the EOQ Model. The initial step in this process is to categorize the inventory into three groups (A, B, and C) based on their importance. The study then focuses on the inventory items in group A, analyzing each to determine the optimal order quantity. Through the combination of these two methods, the inventory management of the case study is optimized. Items with high demand and value can be adequately stocked (based on ABC Analysis), while the EOQ Model ensures that the quantities ordered for items in category A are aligned with the goal of minimizing overall inventory costs. According to the findings, placing orders for all items at their optimum order quantity would lead to a 34% reduction in inventory expenses. Overall, this study provides a useful framework for businesses aiming to enhance inventory control and reduce costs.

Keywords: Supply chain management, Order quantity, Case study, Inventory management, Cost optimization

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1. INTRODUCTION

In recent years, the global COVID-19 outbreak has caused significant disruptions to economies and societies worldwide. Thailand, like many other countries, has had to adjust its health policies and implement measures to prevent the spread of the virus. This situation has led to a shift in people's lifestyles, with a greater emphasis on health and hygiene. According to a survey by Euromonitor International, the market value of global health products in 2020 was $272 billion, representing an average growth rate of 3.4% since 2015. Asia and the Eastern European region are expected to contribute most of this growth, with an average growth rate of 5.7% predicted for the period 2021-2025.

Considering this trend, there are many companies saw an opportunity to enter the health-related market by selling various cleaning products such as alcohol, detergents, and antibacterial soaps, including the organization examined in this case study. However, the health products business market is highly competitive, and the company's executives realized they needed to develop various strategies to achieve a competitive advantage. One significant cost element in production is the inventory cost, which can range from 10% to 60% of the total business cost. Therefore, the company sought ways to reduce the cost of inventory to improve its competitiveness.

To achieve this goal, the research group conducted a study on ABC Engineering Co., Ltd.'s inventory management to suggest ways to increase efficiency. The study applied the ABC Analysis theory to classify and prioritize inventory based on importance and proposed ways to improve order quantity and points for new orders using the EOQ Model method. The study aimed to compare the company's inventory management performance before and after the application of the ABC Analysis and EOQ Model methods to achieve greater efficiency.

2. LITERATURE REVIEW

Inventory refers to the stock of materials or goods that are stored for use in various operations, such as production, sales, or other inventory-related activities. It is often the most valuable asset among current assets, making effective inventory control a crucial aspect of business operations. Proper inventory management is essential to ensure that there is a sufficient quantity of products to meet customer demand, while avoiding the negative consequences of understocking or overstocking. Poor inventory control can lead to disruptions in business operations, a loss of customer trust, and ultimately, a decline in revenue. Conversely, implementing effective inventory management practices can help businesses increase profits and reduce expenses. Therefore, executives should prioritize inventory management and allocate sufficient resources to maintain an optimal inventory level.

To streamline inventory control, there are several methods available, including ABC Analysis and Economic Order Quantity (EOQ). ABC Analysis involves categorizing products into three groups based on their annual inventory value, sales value, or profit share. By grouping products based on their value and importance, organizations can prioritize their management efforts and allocate resources efficiently. On the other hand, EOQ focuses on determining the optimal order quantity that minimizes the total cost of ordering and holding inventory. By considering the costs associated with placing an order and storing goods, businesses can find the most economical order quantity that avoids unnecessary costs incurred in inventory holding, such as deterioration and storage expenses.

Due to the effective and ease of uses of both method, ABC analysis and EOQ have been used in many researches. ABC analysis can reduce costs in various industries. Kampf et al. (2016) found that applying ABC analysis to inventories in the automotive industry can lead to cost savings and process optimization. Themido et al. (2000) demonstrated the benefits of ABC costing in logistics, allowing for the analysis of profit by type of client, market segment, and distribution channel. Nallusamy et al. (2017)

found that a periodic review policy based on ABC classification improved inventory turnover ratio in an automotive manufacturing industry. Chu et al. (2008) proposed a new inventory control approach called ABC-fuzzy classification (ABC-FC), which can handle variables with either nominal or non-nominal attribute, incorporate manager's experience, judgment into inventory classification, and can be implemented easily.

The EOQ model is mainly proposed to reduce inventory cost by identify the optimal order quantity for inventory. Jiraruttrakul et al. (2017) found that implementing an EOQ model reduced inventory costs by 50% for a beer importer in Thailand. While the EOQ model can save up to 90% by Vania and Yolina (2021). Samal et al. (2022) analyzed the use of EOQ in agro-based industries and found that it can lead to profit maximization and customer satisfaction. Besides its application on inventory management, it has been revised to incorporate sustainability considerations, including environmental and social criteria, in addition to economic considerations. Arslan and Turkay (2013) proposes models for different policies that integrate sustainability factors into traditional cost accounting in the EOQ model. Liao and Li (2021) extend the application of the EOQ model to closed-loop supply chain systems and devises an optimal ordering strategy for the maximization of environmental benefits under market uncertainty conditions.

Overall, effective inventory management is essential to the success of a business, and businesses should invest in proper inventory control methods, such as ABC Analysis and EOQ, to maximize profits and reduce expenses.

3. RESEARCH METHODOLOGY

Figure 1 presents the research methodology. It comprises four main steps: data gathering and correction, categorization through ABC Analysis, determination of optimal order quantity for type A items, and comparison of pre- and post-implementation inventory costs.

In the first step, data about the items in the case study's inventory is gathered and corrected if there are any mistakes. Detailed information about all the items, including quantities, suppliers, and financial aspects, is obtained from the report and interviews with relevant officers. The purpose is to establish a precise and accurate foundation for the next step. The next step involves classifying inventory items into distinct categories using ABC analysis. This method helps to understand the importance of items based on their value and amount.

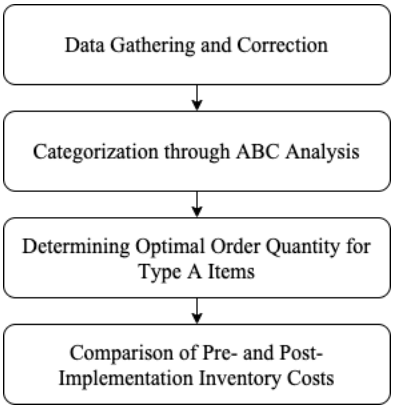

Figure 1 Research methodology

The third step focuses on finding the best order quantity for the inventory items that belong to type A using the Economic Order Quantity (EOQ) model. This method calculates the order quantity that

effectively reduces the costs associated with holding and ordering inventory. Finally, the last step compares costs before and after implementing the optimal order quantity for type A items. This comparison helps us evaluate the effectiveness of the proposed EOQ model and whether it has resulted in significant savings in inventory costs.

4. CASE STUDY

This research focuses on the case study of ABC Engineering Co., Ltd., a company that specializes in selling metal products, including plastic and metal lathe work. In response to the COVID-19 crisis, the company has expanded its business to distribute cleaning products such as alcohol, dishwashing liquid, detergent, and more. The total number of products sold by the company now stands at 42 items. The products are ordered from the delivery person and distributed to both larger and smaller customers in the area, with information being collected on the same. Historical inventory data from a period of one year (2021) is used in this study. The data is analyzed based on the number of purchase orders, the number of units ordered per time, the total amount of units used within a year, and the total value of each type of inventory (annual consumption multiplied by unit price).

5. RESULTS AND DISCUSSION

In this case study, data was collected on the demand quantity, unit price, and annual sales value of each product. Using the ABC analysis theory, the data was grouped, resulting in Table 1.

Table 1 Grouping result by using ABC analysis

Group	Number of Item	Percentage of Product	Item Value (Baht)	Percentage of Value
A	16	38.10	23,451,300.00	78.92
B	16	38.10	4,656,900.00	15.67
C	10	23.80	1,605,200.00	5.40
Total	42	100	29,713,400.00	100

Based on the data presented in the Table 1, the grouping of products according to the ABC analysis theory reveals that Group A encompasses products with an accumulated sales value between 0 to 80%, while Group B comprises products with an accumulated sales value between 80 to 90%, and Group C includes products with an accumulated sales value ranging from 90 to 100%. The analysis showed that Group A consists of 16 types of products, representing 38.10% of all product types, with a total value of 23,451,300 baht, which accounts for 78.92% of the total product value. Group B includes 16 types of products, accounting for 38.10% of total products, with a total value of 4,656,900 baht, representing 15.67% of the total product value. Group C comprises 10 types of products, accounting for 23.80% of the total product value, with a total value of 1,605,200-baht, accounting for 5.41% of the total product value.

Although the proportional quantities of the three types of goods do not strictly follow the ABC classification, this is due to the analysis being based on product value. Hence, the quantity of each product can be derived from the Table 1.

By gathering data on the demand for products in Group A, the optimal purchase quantity can be calculated and shown in Table 2.

Table 2 The optimal order quantity (EOQ) for Group A

No.	Item	Annual Demand - D (Unit/year)	Holding cost- H (Baht/unit/year)	Order Cost - O (Baht/time)	Q (Unit)	Q* (Unit)	Number of ordering time
1	Disinfectant for COVID-19, spray type, size 3.8 liters	8,300.00	27.81	1,165.25	1062.50	833.97	10
2	Alcohol gel, size 3.8 liters	8,500.00	26.27	1,233.80	1125.00	893.60	10
3	Covid disinfectant solution, size 3.8 liters	7,500.00	29.55	1,096.71	1000.00	746.13	10
4	Alcohol spray, size 3.8 liters	5,200.00	40.76	795.11	725.00	450.42	12
5	Floor cleaner, size 3.8 liters	6,200.00	36.37	891.08	812.50	551.19	11
6	Toilet cleaner, size 3.8 liters	4,500.00	42.98	753.99	687.50	397.34	11
7	Hand sanitizer, size 3.8 liters	5,500.00	39.40	822.53	750.00	479.21	11
8	Covid disinfectant solution, size 1 liter	5,850.00	36.37	891.08	812.50	535.41	11
9	Car wash liquid, size 3.8 liters	4,800.00	47.28	685.44	625.00	373.06	13
10	Liquid detergent, size 3.8 liters	5,000.00	39.40	822.53	750.00	456.91	11
11	Dishwashing liquid 3.2 liters	4,500.00	47.28	685.44	625.00	361.22	12
12	Glass cleaner, 3.8 liters	3,800.00	52.53	616.90	562.50	298.74	13
13	Fabric softener 3.8 liters	3,200.00	67.54	479.81	437.50	213.22	15
14	Disinfectant for COVID-19, spray type, size 1 liter	5,500.00	39.40	822.53	750.00	479.21	11
15	Covid disinfectant solution, size 600 ml.	2,700.00	67.54	479.81	437.50	195.86	14
16	Alcohol spray, size 150 ml.	4,000.00	47.28	685.44	625.00	340.56	12
Total		206,100.00					

As an example of a calculation, let's consider item 4: a 3.8-liter alcohol spray with an annual demand of 5,200 units. From Table 2, there are two types of expenses used in EOQ estimation: Ordering cost and Holding cost. These will be estimated from the relevant expenses. The associated ordering cost expenses will be shown in

Table **3**.

Table 3 Ordering cost

Items	Cost per year (Baht)
Purchasing employee wages	170,079.00
Telephone/internet	6,432.00
Transaction cost	75,600.00
Total	252,111.00

For all products, generally the case study will order 8 times/year so the ordering cost of a 3.8-liter alcohol spray is:

$$\begin{aligned} P &= \frac{\text{Ordering cost / unit} \times \text{Number of a 3.8-liter alcohol spray}}{\text{Ordering time}} \\ &= \frac{\left(\frac{252,111}{206,100}\right) \times 5,200}{8} \\ &\approx \frac{1.22 \times 5,200}{8} \\ &\approx 795.11 \text{ baht} \end{aligned}$$

The cost that related to the holding cost is show in

Table **4**.

Table 4 Holding cost

Items	Cost per year (Baht)
Inventory staff wages	191,55200
Inventory water-electricity bill	20,400.00
Total	211,952.00

So, the holding cost of a 3.8-liter alcohol spray is:

$$\begin{aligned} H &= \frac{\text{Total holdering cost}}{\text{Number of a 3.8-liter alcohol spray}} \\ &= \frac{211,952}{5,200} \\ &\approx 40.76 \text{ baht} \end{aligned}$$

Based on these values, the optimal ordering quantity and frequency can be calculated as follows:

$$\begin{aligned} \text{EOQ} &= \sqrt{\frac{2 \times 795.11 \times 5,200}{41}} \\ &= \sqrt{202,882.13} \\ &= 450 \text{ unit/order} \end{aligned}$$

The total cost (TC) of a 3.8-liter alcohol spray is:

$$\begin{aligned} \text{TC} &= \frac{795.11 \times 5,200}{450} + \frac{40.76 \times 450}{2} \\ &\approx 18,359 \text{ baht} \end{aligned}$$

Number of ordering time of a 3.8-liter alcohol spray is:

$$\begin{aligned} \text{Number of ordering time} &= \frac{\text{Demand}}{\text{Order quantity}} \\ &= \frac{5,200}{450} \\ &= 11.55 \approx 12 \text{ times} \end{aligned}$$

Therefore, it is recommended to purchase this type of product, with an estimated quantity of around 450 units per year (calculated value of 450.42). The products should be ordered approximately 12 times per year (calculated value of 11.55) to maintain optimal inventory levels.

Similar calculations can be used for other types of products. It is suggested to apply the same method to quantify the appropriate purchase quantity and ordering frequency for each type of product which shown in Table 2.

Figure 2 presents a comparison between the costs associated with the current ordering quantity and the EOQ for the 3.8-liter alcohol spray. Currently, the case study orders 725 units, incurring an annual cost of 20,478 baht. This cost comprises 6,800 baht for ordering and 14,775 baht for holding the inventory. By contrast, if the case study orders the product at the EOQ level of 450 units, the total cost will be 18,359 baht per year, with each ordering and holding cost amounting to 9,187 and 9,171baht per year. The implementation of the EOQ method resulted in a significant reduction in storage costs for the case study. The total annual cost decreased from 20,478 baht to 20,046 baht, representing a cost savings of 432 baht. This reduction was primarily due to optimizing the ordering quantity and frequency, resulting in lower ordering and holding costs.

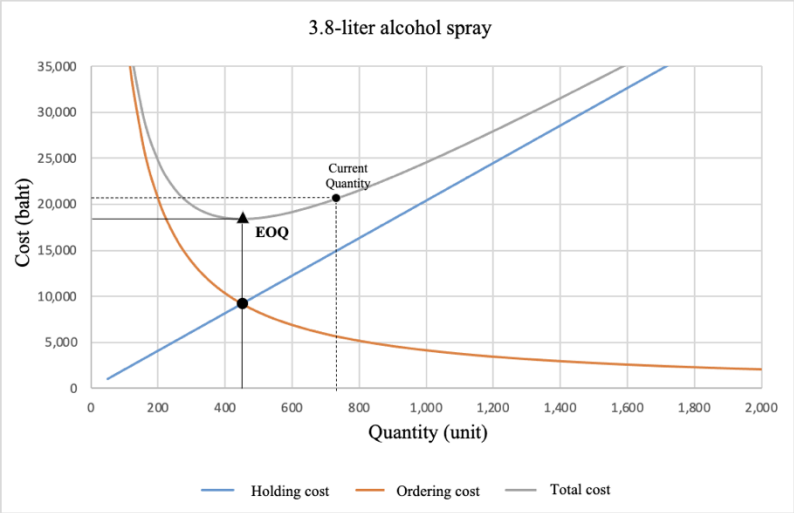

Figure 2 Comparison of current ordering quantity and EOQ of alcohol spray, size 3.8 liters

Table 5 Comparison of expenses using the current order quantity and the EOQ method

	Holdering cost (Baht/year)	**Ordering cost (Baht/year)**	**Total cost (Baht/year)**	**Number of ordering time**
Current quantity	236,400.00	93,275.21	329,675.21	114
EOQ	146,788.31	146,788.31	293,576.61	187
Difference	89,611.69	-53,513.09	36,098.60	-73

Based on Table 5, the analysis reveals that the cost of inventory storage decreased by 89,611.69 baht/year. However, there was an increase in the cost of purchasing products per year by 53,513.09 baht and the number of purchase orders increased by 73 times per year. Nonetheless, the implementation of the EOQ theory resulted in a reduction of the total cost per year by 36,098.60 baht.

The ABC analysis method allowed the case study to identify the most important products and prioritize their management. By focusing on group A products, which are the primary source of income, the case study was able to allocate resources and attention more effectively. Additionally, implementing the EOQ method further optimized the inventory management by determining the optimal ordering quantity and frequency for each product category. To further enhance the inventory management practices, future research could explore the implementation of advanced inventory management techniques such as Just-in-Time (JIT) or Vendor-Managed Inventory (VMI). These approaches have shown promising results in reducing costs and improving overall supply chain efficiency.

In conclusion, the implementation of the ABC analysis and EOQ methods in the case study resulted in significant cost savings and improved inventory management. By categorizing products based on their importance and value, and optimizing the ordering quantity and frequency, the case study was able to reduce storage costs and enhance overall efficiency.

6. CONCLUSION

The present study aims to provide an analytical approach to inventory management for a case study that did not employ the ABC and EOQ inventory management systems yet. The research focuses on implementing the ABC analysis method to categorize inventory items into three groups based on their importance and value to the case study operations. The researcher chose to consider products in group A due to their significance as the primary source of income for the case study.

The optimal ordering quantity is determined using the EOQ method and compares the resulting expenses to the method currently in use by the case study. The analysis of EOQ for the 16 items in group A resulted in a cost reduction of 17,449 baht in the storage expenses. However, it was found that only 6 items could be applied, while the remaining 10 items had specific conditions and restrictions on application due the minimum purchase quantity specified by the suppliers. To enhance the quantity of products, the study recommends developing relationships with suppliers or considering finding new suppliers.

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