REDUCING INVENTORY COSTS BY DETERMINING AN APPROPRIATE ORDER QUANTITY USING ECONOMICAL ORDER QUANTITY PRINCIPLES CASE STUDY OF THE PRODUCTION PLANT MACHINE

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Abstract - The objective of this research was to investigate the Economic Order Quantity of raw materials to serve production properly. This study used historical data from 2022 to identify the cause of the problems by applying "Fishbone Diagram", and the ABC Classification System was applied to classify the material product groups. The Economic Order Quantity method followed, and the "Basic Model" was employed to find out the Economic Order Quantity. The total cost was compared between the current operations' total cost and total cost determined by considering the EOQ concept. The results of this research revealed that the cost of group "A", 9 items, compared with the original cost, was reduced to THB 128,737 per year. Group "B" was reduced to THB 76,982 per year and group "C" was reduced to THB 122,757 per year. In conclusion, the reduction of the total cost was reduced to THB 358,226 per year. accounting for 52.17 percent of the original total cost.

Keywords - Inventory Cost Reduction, Fishbone Diagram, ABC Classification, Economic Or-Der Quantity

I. INTRODUCTION

Today's highly competitive business environment has forced businesses to adapt to survive by developing more efficient operations and reducing costs and responding to the needs of consumers by adopting strategies that appropriate, where each business has different strategies to decide according to each type of business [1].

The purpose of this research is to improve, reduce costs in the work process, and increase the competitiveness of a case study company which is a manufacturer of various machinery that has a warehouse to store the used materials.

It is used in the production of machinery as well as the consumables that are required to work from the operation. Inventory Management at present [2], the company faces the problem of inappropriate inventory due to the quantity of each purchase order resulting in a shortage of some items, as well as the problem of employees working with errors in correcting data. in the system (Enterprise Resource Planning: ERP) does not match reality, resulting in errors in inventory, affecting production due to insufficient mate-rials for production often [3].

From various problems in inventory management, the researcher presents an analysis of inventory control by inventory segmentation method, material grouping system. ABC Classification system and finding the appropriate order quantity (Economic order quantity) to use with the case study company. By comparing the cost of ordering new materials with the cost of ordering old materials in the past to clearly know the cost that can be reduced [4].

II. LITERATURE REVIEW

A. F Fishbone diagram

Fishbone charts are used when looking for the cause of a problem, wanting to study and understand other processes. The fishbone sets the problem sentence to the fish head [5]. Identify a group of factors that will cause the problem and then brainstorm to determine the cause of each fac-tor to determine the root cause of the problem.

B. Classification of inventory according to the ABC method

Inventory classification according to the ABC method is the basic principle in grouping inventory into 3 categories, namely A, B and C, as appropriate for determining the management policy and calculating the appropriate quantity to be ordered by Type A material. It must be very strictly controlled. While category B material is moderately strict, it is followed by moderate control. and C-type materials are less rigorously regulated [6].

C. Economic order quantity: EOQ

The most economical ordering quantity is the calculation of the ordering quantity at the point where the storage cost and ordering cost are equal. As a result, the total cost of remaining materials is the lowest. Planners can apply this calculated quantity to purchase orders for each warehouse. This technique is the most popular technique because it can be applied easily to the basic formula [7][8].

EOQ is expressed as Equation 1

$$EOQ = \sqrt{\frac{2C_o D}{C_c}} \quad (1)$$

where D is the demand for the product (pieces per year), Co is the cost per order. (THB per time) and Cc is the cost of keeping the goods. (THB per unit per year)

D. Re-order Point: ROP

The Material procurement time is an important factor which leads to determining the amount of material to be re-ordered. point) is a point indicating the amount of mate-rial. Fixed product demand and fixed cycle times. The reorder point can be calculated as the following equation.

$$ROP = \bar{d} \times L \quad (2)$$

where $\bar{d}$ is the average demand rate and L is the order constant cycle time.

III. METHOD OF OPERATION

A. Data collection

Planning and determining the appropriate amount of material purchases requires information on material purchases and disbursements to be used for calculation and planning.

The source of data used in the research consists of secondary data, such as material purchase volume data from January 2022 - December 2022, 48 items, including purchase cost data. and cost information for each item currently stored in inventory.

B. Inventory grouping using ABC classification technique.

The researcher has grouped the inventory by using ABC classification technique by calculating the value of the purchased material list and ranking each item according to the value of the inventory.

Descending materials from the data of material purchase orders for January 2022 – December 2022 48 items and find the material price per unit of each material item, then calculate the percentage of the value of each material. List and find the cumulative percentage of each material and group the materials by group.

A, B and C, with group A divided at an accumulated percent-age value of 60 -80 of the total material value, group B divided at 15 -25 %, and group C at 5 -15 percent, respectively, as shown in the Fig. 1.,

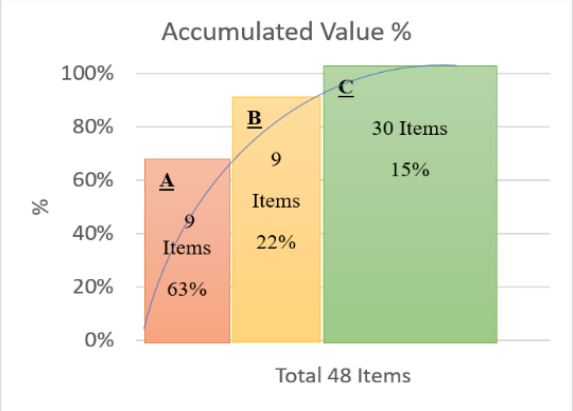


Fig. 1. Cumulative payout percentage level in material classification ABC

The researcher brought information on the annual payment and the value of the material. Each item is multiplied to get the annual payment value. Then sort by value in descending order. As a result, product group A has 9 items, representing 63% of the total number of items. The highest value is 2,542,290 THB. Product group B contains 9 items, representing 22% of the total that have a total value of 874,071 THB, and product group C contains 30 items, representing 15% of the total number of items with the lowest value, which is 665,619 THB.

No	List	Price/Unit (THB)	Consumption/year (unit)	Total Price	Accumulated Value (THB)	Accumulated value (%)
1	TL06IN0104R39010	715	700	500,500	500,500	12%
2	CONS01-001010002	100	4,305	430,500	931,000	23%
3	CONS01-002040004	26	14,400	374,400	1,305,400	32%
4	CONS01-001010001	340	1,031	350,540	1,655,940	41%
5	RM23PL000032230	3,350	65	217,750	1,873,690	46%
6	CONS01-004024001	18	11,000	198,000	2,071,690	51%
7	TL06IN010500003	340	500	170,000	2,241,690	55%
8	CONS01-004014002	13	11,700	152,100	2,393,790	59%
9	CONS01-002014100	55	2,700	148,500	2,542,290	62%
10	CONS01-002130002	190	672	127,680	2,669,970	65%
11	CONS01-002014120	55	2,200	121,000	2,790,970	68%
...	...	...	...	...	...	...
16	CONS01-002130001	195	384	74,880	3,280,140	80%
17	RM23MRING000032	12.75	5,500	70,125	3,350,265	82%
18	CONS01-002010006	4.5	14,688	66,096	3,416,361	84%
19	CONS01-001040233	47	1,200	56,400	3,472,761	85%
20	CONS01-002030003	18	3,000	54,000	3,526,761	86%
21	CONS01-001010001	20	2,661	53,220	3,579,981	88%
22	CONS01-004010001	170	310	52,700	3,632,681	89%
...	...	...	...	...	...	...
47	CONS01-002010100	10	300	3,000	4,081,388	100%
48	1801AC00101019	0.16	3,700	592	4,081,980	100%
		9,474.91	110,929	4,081,980		

Table 1. ABC Material Classification.

C. Determination of a solution to the problem of EOQ

For ways to improve costs and increase efficiency of inventory management of a case study of a company The researcher used to find the economical ordering quantity (EOQ) and calculate the re-order point or ROP), which the data used for the calculation consists of The amount of purchase of some parts in the year 2022, including The purchase volume of some parts in 2022, including costs related to inventory management, such as Cost of ordering products per time storage cost per unit, etc.

IV. RESEARCH RESULTS

A. Root cause analysis

The researcher collected data on the company's inventory, which is consumables used as components in the production of 48 items and used the fishbone diagram technique to analyze the root causes of the problem of insufficient inventory. Appropriate As shown in Fig. 2., it can be found that the Company has various important causes that cause the problem of inappropriate. inventory, for example: Lack of a policy to calculate and specify the exact order quantity. Lack of software systems that facilitate data management lack of grouping good.

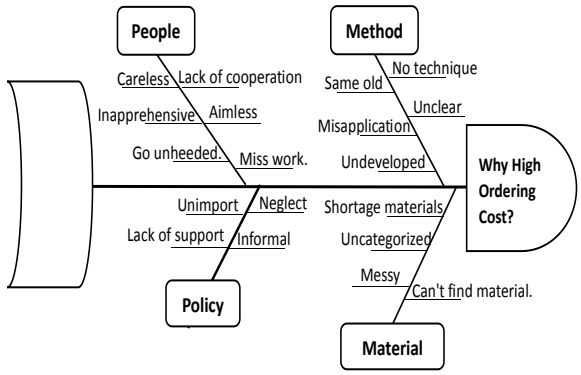


Fig. 2. Problem analysis by fishbone chart technique.

That they can be prioritized in management. and employee error by all causes the researcher consulted and brainstormed with specialists involved in warehouse management work. Resulting in a summary of the reasons that should be feasible and can see the results as quickly as possible by setting up a storage system, categorizing material priorities and calculating quantities in a clear systematic order.

Therefore, the researcher has planned to solve the problem by first sorting the material in the form of ABC grouping, including taking it to calculate the quantity in ordering. Save in the EOQ format, which will be explained in the next section.

B. Finding the right order quantity

After the researcher has grouped the materials according to type A, B and C, the next step is to calculate the appropriate order quantity for each group of materials based on the historical usage data together with the calculation of the cost. in ordering per time (Ordering cost) and expenses in storage (Holding cost) by collecting data the cost per order is calculated from the sum of all expenses / number of orders (PO) in 2022, resulting in the cost of ordering per time to 2,213 THB per time.

List	Expenses January – December 2022
Purchasing labor cost	2,691,000.00
Labor cost of Inv	1,088,717.00
cost of communication	89,760.00
cost of consumables	9,907.00
stationery equipment cost	3,388.00
total cost	3,882,184.00
Total PO /year 2022	1,754.00
Ordering cost/time	2,213.00

Table 2. Ordering cost in 2022

Finding the appropriate order quantity can be calculated from the ordering cost and storage data by using the EOQ calculation formula as in Equation 1. An example of substituting the EOQ calculation for material types can be shown as follows:

Example- in group A materials are parts TL06IN0104R39010.

$$EOQ = \sqrt{\frac{2*700*2,213}{715*0.17}}$$

Therefore, order quantity (EOQ) = 160 units.

Number of purchases $\frac{D}{Q}$ = 4.4 times/year

Example- in group B materials are parts CONS01-002130002

$$EOQ = \sqrt{\frac{2*672*2,213}{190*0.17}}$$

Therefore, order quantity (EOQ) = 303 units.

Number of purchases $\frac{D}{Q}$ = 2.2 times/year

Example- in group C materials are parts CONS01-001040233

$$EOQ = \sqrt{\frac{2*1,200*2,213}{47*0.17}}$$

Therefore, order quantity (EOQ) = 315 units.

Number of purchases $\frac{D}{Q}$ = 1.5 times/year

C. Finding a new order point (ROP)

Finding the right purchase quantity determines the treasury policy in terms of storage quantity. In terms of when the material should be ordered, the new order point value is determined. From this case study, the researcher has determined that under the condition of the rate of Need a fixed stock and order lead time The reorder point value can be calculated from Equation

2, which can show an example calculation for each type A material as follows.
The average working day for the case study company was 315 days.
Example- Items in Group A TL06IN0104R39010
d = average demand = 700/315 = 2.2 units/day
L=15 days will get ROP=2.2*15
Therefore, the Reorder Point for this item = 33 units.
Example- Items in Group BCONS01-002130002
d = average demand = 672/315 = 2.1 units/day
L=15 days will get ROP=2.1*15
Therefore, the Reorder Point for this item = 32 units.

Example- Items in Group CCONS01-001040233
d = average demand = 1,200/315 = 3.8 units/day
L=15 days will get ROP=3.8*15
Therefore, the Reorder Point for this item = 57 units.

D. Analysis of improvement results

	List	A	B	C	D = B/C	E = C*2,213	F = (D+0)/2	G = F*A	H = G*0.17	I = E+H
		Price /unit (THB)	Amt of use/Year	PU/Year	PU Amt/ Time	OC/Year (THB)	Inv Avg Quantity	Avg Inv Value (THB)	Cost storage/Year (17%)	Total Cost of Inv (THB/Year)
A	TL06IN0104R39010	715	700	2	350	4,426	175	125,125	21,271	25,697
B	CONS01-002130002	190	672	4	168	8,852	84	15,960	2,713	11,565
C	CONS01-001040233	47	1,200	3	400	6,639	200	9,400	1,598	8,237

Table 3. Cost Calculation of Current Inventory Management Sample Groups A, B and C

	List	A	B	C	D = B/C	E = C*2,213	F = (D+0)/2	G = F*A	H = G*0.17	I = E+H
		Price /unit (THB)	Amt of use/Year	Pu/Year	Pu Amt/ Time	OC/Year (THB)	Inv Avg Quantity	Avg Inv Value (THB)	Cost storage/Year (17%)	Total Cost of Inv (THB/Year)
A	TL06IN0104R39010	715	700	4	175	8,852	88	62,563	10,636	19,488
B	CONS01-002130002	190	672	2	336	4,426	168	31,920	5,426	9,852
C	CONS01-001040233	47	1,200	2	600	4,426	300	14,100	2,397	6,823

Table 4 Cost Calculation of EOQ Inventory Management Sample Group A, B and C

At present, the company does not have a policy to place a certain order. Based on the information on the purchase volume and the number of purchases per year, it is possible to estimate the purchase quantity per time of 3 sample materials from 3 types of materials as shown in Table 3 and from Fig. 3. is a graph showing the total cost of all three groups of orders A, B and C. This shows that the current procurement model has a cost of 599,723 THB, which is higher than the total cost of purchasing an EOQ procurement model calculated and estimated by the researcher as shown in Table 4 and Fig. 4., which is equal to 174,827.
Therefore, ordering with EOQ and ROP policies will cause total inventory costs to be less than the current policy of 424,896 THB per year. In terms of current

order quantity, Group A has an order quantity of 111 times/year, while in EOQ, Group A has reduced to 29 orders/year. 53 orders/year, while in the EOQ model, Group B orders 18 times/year, and finally, Group C materials are currently ordered 2,703 times/year, with the EOQ policy remaining 32 orders/year.

When analyzing the total cost of storage in the three groups A, B and C as shown in Fig. 4., it was found that the current procurement model has the total cost of storage equal to 86,979 THB, which is lower than the total cost of storage. Stored in EOQ form with a value of 153,649 THB, which is more valuable than the current form of storage of 66,670. THB due to the number of times in purchasing less, but the quantity of units increases, thus increasing the EOQ storage rate and thus increasing the cost of storage. However, this increases in storage costs. The proportion is much less than the reduced procurement costs. Thus, EOQ's overall inventory cost is still more cost-effective than purchasing with the current policy, showing the lowest total cost of inventory across the three groups A, B, and C. It was found that the current procurement model has a total cost of inventory equal to 686,702 THB, which is higher than the total cost of inventory from the EOQ procurement model that is equal to 328,476 THB. The cost is reduced by 358,266 THB per year from the policy. original purchase

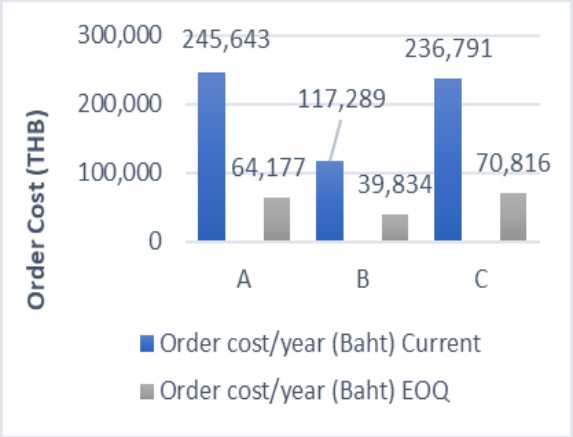


Fig. 3 Comparison of ordering costs between the current design and EOQ.

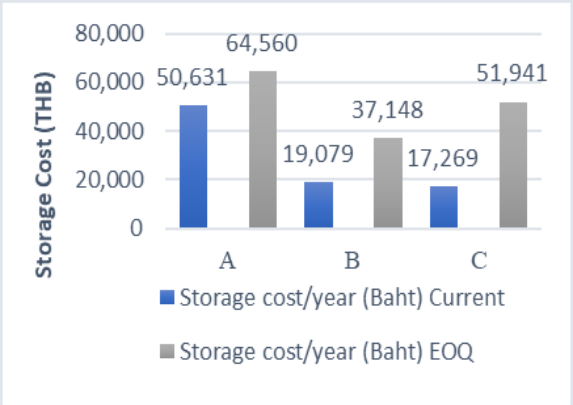


Fig. 4 Comparison of current ordering costs and EOQ.

V. CONCLUSION

A conclusion This research aims to improve and reduce inventory costs of a machinery manufacturing company. From the results of the study of the problem analysis from the fishbone, the researcher found the exact cause of the problem, which is the lack of a storage system to classify the material and the lack of quantification in the process. Order that is a clear system.

The researcher therefore came up with a solution and applied it to warehouse management. In the material prioritization model ABC and EOQ calculations to find the optimal order quantity by comparing current and post-adjusted inventory costs with the appropriate order quantity system.

company case study using the data of orders throughout the year 2022, it was found that the value of inventory in the material item group A was 9 items, representing 63% of the total number of items, B was 9 items, representing 100. 22 per cent and product group C has 30 items, representing 12 percent, so the researcher brought all 48 inventory items. come to find the appropriate order quantity to be used as a guideline for man-aging each type of material by calculating the appropriate order quantity and re-ordering points for each type of material.

The researcher has calculated and compared the total inventory costs of Group A, Group B, and Group C. It was found that ordering in the EOQ format will have a lower total cost than ordering in the current form. The current model has a total cost of inventory of 686,702 THB, which is higher than the total cost of inventory of the EOQ order model, which is valued at 328,476 THB, which is 358,226 THB less. Because of the reduced cost of using the EOQ model, the volume of orders will increase from the current procurement model and reduce the frequency of orders, resulting in lower cost of purchase orders. followed by, at the same time, the inventory of the order from EOQ.

There will be more materials stored suitable for use, not running out too quickly. When comparing the cost of increasing storage, it was found that it was worth the cost of reducing the purchase order from reducing the frequency of material purchases.

Therefore, it can be concluded that the overall cost of inventory in the EOQ model used by the research has been presented to improve the factory warehouse to be more efficient in cost management than in the EOQ model. Management with cur-rent ordering patterns

Acknowledgment "This research was funded by Thammasat School of Engineering (TSE), Thammasat University."

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