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Economic order quantity determination model: A case study of construction material retailer

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***Abstract*---**Order processing and inventory management are critical to inventory costs. Therefore, this research aims to reduce cost and lead time for case study construction material retailer. The objectives are to 1) study the order processing and inventory management of construction material retailer; and 2) to study inventory analysis techniques in decision making to determine the appropriate order quantity. 30 employees are interviewed for collecting data and a case study company inventory raw material data from January – December, 2021 is used as data. ABC analysis and EOQ are used to calculate quantities for the right order and quantities as the high demand. The data in the analysis is collected from samples of products that are important to production process, high value and high demand. The result of comparison between a case study of construction materials retailer's inventory management model and ABC analysis and EOQ approach in group "A" material found that EOQ obtain cost 2,404,148.24 Baht and a case study of construction materials retailer's inventory management model obtain cost 3,314,648.93 Baht. Therefore, EOQ saves cost than a case study of construction materials retailer's inventory management model for 910,500.69 Baht per year. The totally cost is reduced from ordering cost and storage because the order quantity is appropriate. Thus, a case study of construction materials retailer has more financial liquidity. A case study of construction materials retailer is able to save money for investment and can use in other section to gain the business profit.

***Keywords*---**Economic order quantity, ABC classification analysis, Order processing.

Introduction

China's demand for building materials has grown rapidly in the past decade. During the next decade as well, production and demand will continue to grow. The Chinese economy is growing rapidly, which was spurred by the increase in industrial production, import and export, consumer consumption and continued capital investment for more than two decades. However, many businesses, including the construction material retail business, have been negatively affected by the coronavirus (COVID-19) epidemic, causing the economy to slow down (Aunyawong et al, 2021). Nevertheless, there is still ongoing competition, especially among the entrepreneurs of modern construction retailers who have penetrated the provincial market or in the suburbs by accelerating the opening of branches to compete in the market first, causing competition in the firsthand construction retail chain (Laura Wood, 2020)

One of the major problems facing construction material retailers is spare parts management and storage of materials in the warehouse, as well as inventory control (Moharana, 2016). Inventory is an important part of the supply chain in estimating a company's profit or loss (Wisedsin et al., 2020). Inventory is material or product that is stored in a company to support production or activities such as maintenance or sales. The responsibility of inventory management is to balance the level of stock and customer demand because demand uncertainty is difficult to predict (Srisawat and Aunyawong, 2021). Other important factors in the inventory system comprises replenishment level, order quantity, target stock, inventory policy review or the uncertainty of the lead time that affects the total inventory cost. Inventory management is therefore challengeable. Today, inventory management has become an important policy in many organizations to reduce costs related to exorbitant inventory levels and to cope with customer responsiveness. (Singha, 2017)

As mentioned above, inventory is necessary to keep operations running and how to purchase to reduce inventory costs is also important. This research, besides, aims to explore purchasing problems and inventory management of construction materials retailers and apply the material inventory analysis technique to the decision making in order to determine the appropriate purchase quantity to reduce the costs of the construction material retailer. The study analyzes procurement planning by ABC system together with the importance of economic order quantity (EOQ) calculation. The results of the research can be used for developing and planning work processes in the procurement of raw materials by applying the concept of inventory management.

Literature Review

Construction Material Retail Business

The construction material business is an important upstream industry in the construction and real estate sector in Thailand, where businesses in this supply chain often change in the same direction. This is reflected from the proportion of construction budget with construction material cost of up to 60%. Demand for construction materials in different types depends on price, value, taste and behavior

of consumers. Modern trade businesses will have continuous revenue growth in line with consumer behavior that prefers to purchase a variety of construction materials in one-stop shops. Entrepreneurs, therefore, have plans to expand more branches and continuously improve after-sales services to attract consumers. For traditional stores, wholesale retailers' income will come from large-lot orders from large-scale public and private projects that tend to increase but they may face high competition from both traders and manufacturers who turn to be sellers. For retail stores, their revenues tend to be stable according to the increasingly intense competition, especially with modern shops that start to expand small branches to reach more communities. Therefore, the construction material retail businesses have to speed up the adjustment to be able to sustain the business further.

Inventory Management

Inventory is a type of current assets. The business must have the inventory for use in the production which consists of raw materials, maintenance materials, and finished goods. Raw materials are items or parts purchased for use in production and works during the production process. It is a part that is in the production process or waiting to be produced in the next step while still not going through all the production processes. Maintenance materials are parts or spare parts of machinery that are reserved for replacement when the original part is damaged or has expired. Finished goods are production factors that have passed all production processes ready to be sold to customers

Order Processing

Purchasing and supplying are known as procurement. It is an important link in the supply chain and can influence the overall success of the organization greatly. The importance of procurement works in any manufacturing firms or factories is that there must be a sufficient supply of raw materials at a reasonable price, with a quality as desired, in the right place and at the right time. Over the years, many organizations have created large divisions or departments to deal with transactions with suppliers

ABC Inventory Classification Analysis

Inventory classification with the ABC system is a method of grouping inventory by dividing inventories into 3 groups: A, B and C. This method focuses on the product groups by ordering the products according to sales. Product group A consists of only a few types of products or a small number of products, but are products that have the highest sales or profit shares. The product that receives the less importance as product group B is the product that has sales or secondary profit share. Finally, product group C is the product with the lowest sales or profit shares.

Economic Order Quantity (EOQ)

EOQ is a management to provide good customer services and low total inventory costs. This can be done in a number of ways, depending on the nature of product demand, organizational resource, availability of personnel involved in supply chain management as well as the nature of the production process. In addition,

the advancement of information technology and computers also helps the inventory management system has become more diversified, allowing managers to choose a system that is more suitable for their businesses as well. The most popular inventory management systems in the industry are EOQ, Material Requirement Planning (MRP), and Just-in-Time (JIT) Manufacturing (Wisner & Siferd, 1995). From various concepts and theories reviewed, it can be summarized as a research conceptual framework as follows:

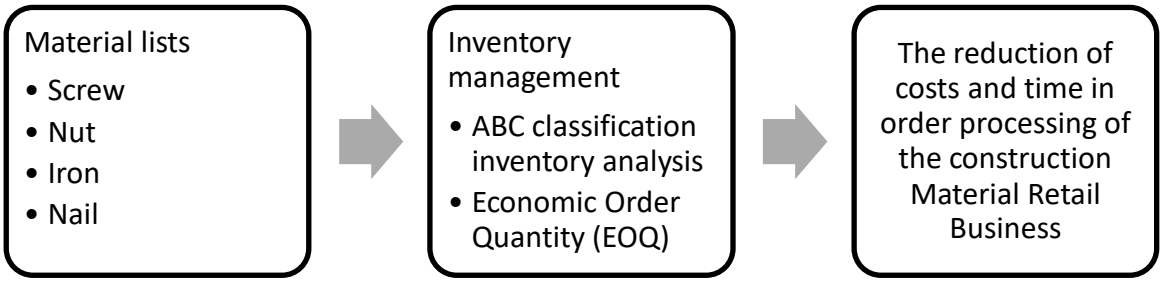

Figure 1. Conceptual Framework

Methodology

Population and Sample

The population was 380 executives, managers, supervisors, departments and employees working in fields related to the logistics activities of the case study construction material retailers, which was an upstream industry. The 30 key informants, arisen from purposive sampling, were interviewed for collecting information about company's purchasing process problems and inventory management about all 4 types of construction material products, together with collecting data from the case study company ERP system which recorded product information. These data analyzed in the decision making to determine the appropriate order quantity to reduce the company's cost.

Data collection

This research consisted of two sources of data: primary and secondary data. Primary data was obtained from interviews with individuals in the case study company in which case company. The characteristics of the interviewees were in accordance with the research objectives. The data collected from each department.

For purchasing department, assistant purchasing manager and purchasing staff were inquired regarding the process of purchasing raw materials in the country, labor costs, and time spent on work related to Process of purchasing raw materials, preparing documents for submission to the accounting department as well as document storage. For warehouse department inquires with assistant

warehouse manager and warehouse officers were inquired concerning the process of receiving raw materials, reimbursing-dispensing raw materials, labor costs, time spent on work related to the raw material receiving process, raw materials storage in the location, document preparation to send to the purchasing department., and document storage. For quality control department, the head and staff were inquired in terms of the process of issuing the Pass Inspection List, wages, time spent in work related to the issuance of Pass Inspection List of domestic raw materials, and document storage. For accounting Department, account manager and officers were required in terms of working procedures, billing, disbursement of wages, time spent on work related to the raw material receiving process, document storage. For information technology department, information technology manager and officers were inquired regarding age and usage of computers, fax machines, copiers as well as repair and maintenance costs.

Secondary data was obtained from the collection of raw material purchase quantity data during January - December 2021 from the company's ERP system. Case studies include schoolwork from textbooks, documents, Internet journals and related research, making the information more complete

Data analysis

Descriptive analysis describes the general problems of the company's procurement and inventory. The researchers conducted a study from the past raw material purchase data from January - December 2021 (1 year). Then the data was analyzed by grouping products using computer programs to manage the database. Items were divided into 3 groups. First, group A was the group of raw materials with the least purchase volume and highest purchase value. Second, group B was a group of raw materials with moderate purchase volume and purchase value. Third, group C is the group with the largest purchase volume and least purchase value. Then, group A raw materials were used to EOQ and reorder point (ROP) and compare. After that, current purchasing model and the new purchasing model derived from this research were compared.

Results

Part 1 : The study of purchasing problems and inventory management of construction materials retailer

When collecting data and reviewing relevant documents on 120 items of the case study company's domestic raw materials in year 2021, totaling the value of use for the whole year of 5,781,876.86 baht, the following problems were found:

1. There was no clear policy on proper order quantity.
2. No reorder point has been set. Each officer also relied on experience and different computational methods.
3. The consumption of each raw material varied greatly, which made it quite difficult to estimate the order.
4. Insufficient raw materials in production were due to lack of proper ordering.

Part 2 Inventory analysis to determine the EOQ to reduce costs of construction materials retailer

From the aforementioned problems, problem solving was divided into 2 parts: finding a method for separating the appropriate types of raw materials by using principles and techniques of data analysis using ABC Inventory Classification and finding EOQ to reduce the total costs of ordering.

Results of ABC Inventory Classification Analysis

ABC Inventory Classification Analysis was used as a solution to find a suitable model for purchasing in this case study. The study emphasized that which products should be ordered and taken care of in counting and specially control the order quantity in relation to their importance. Data was collected on the amount of purchases of raw materials in the country for each item throughout the year 2021. There were 120 items, total use value for the whole year, equivalent to 5,828,000 baht. Then the groups of raw materials in the country were sorted out according to the value of the purchase. The criteria for grouping were as follows: the raw materials with a purchase amount of 70% of the total purchase value were classified as Group A, the raw materials with a purchase amount of 25% of the purchase value were classified as Group B, and the raw materials with purchase amount of 5% of the total purchase value were classified as Group C. From the analysis of raw material purchasing data of the company, the researchers used the data of Group A raw materials only.

Results of EOQ for domestic raw material analysis

After obtaining raw material procurement information, only the products belonging to group A were analyzed to find the right order to achieve the lowest total purchase cost. In this case study, the calculation of EOQ was applied according to the theoretical assumptions of EOQ: constant demand, receiving all ordered products at the same time, fixed price, raw materials ordered from different suppliers, and no condition of stockout. When calculating EOQ, two main costs: ordering costs and the inventory carrying costs need to be considered.

1. Ordering costs were the costs incurred in the purchasing activities of the case study companies throughout 2021. Most of the costs were the wages of employees working in different departments, which are calculated from the time spent on the job multiplied by the labor hourly rate. Managers and heads of related departments in the case of the company were asked in terms of working hours and wages. Ordering costs per item can be obtained by taking the total cost of the activities in the section of procurement divided by the total number of purchase orders in the 2021, equal to 2,112.14 baht per time.
2. Inventory carrying costs of the case study company had insufficient data, resulting in the difficulty to figure out inventory carrying costs per item, so the researchers used the assumed 23% of inventory storage costs (Richardson, 1995) by which the average inventory carrying cost was a percentage of parcel value.

Table 1 Comparison between current and new raw material procurement models

No.	Comparison list	Current model	New model
1	Paying attention to each ingredient	Gives equal importance to all items	Grouped using ABC Analysis to focus on each type of raw material.
2	Quantity ordered each time	Relies on each staff experience and expertise, causing different methods.	Use the economical method of ordering (EOQ)
3	Number of purchases per year (times)	2,099	1,130
4	Total cost of inventory management per year (Baht)	3,314,648.93	2,404,148.24

From Table 1 , it can be seen that the new domestic raw material procurement model is an interesting model and should be applied because at present, the company has never used whether ABC classification analysis method to group raw materials or EOQ calculation. If the company applies these results, it can help reduce costs and expenses in procurement of raw materials as well as inventory management costs.

Conclusion and Discussion

For exploring procurement problems and inventory management of case study construction material retailer, the study concludes that there are no clear policy on proper order quantity and new order point set. Officers also rely on their experience to use computational methods differently. In addition, the consumption of each raw material varies greatly, making it quite difficult to estimate the purchase order and facing the problem of insufficient raw materials in production due to lack of proper ordering.

For analyzing inventory used in decision making to determine the appropriate order quantity to reduce company costs of the case study construction material retailer, the results of cost comparison between current inventory management and EOQ inventory management of group A raw materials found that the total cost of EOQ inventory management was 2,404,148.24 baht, while the total cost of current inventory management was 3,314,648.93 baht. So, it can save the inventory total cost of the year up to 910,500.69 baht. This is due to the cost of ordering per time and the cost of storage being reduced since the quantity ordered is more suitable. As a result, the company can increase the financial liquidity by a case study using this saved money to invest or spend on other activities to increase profits for the business. It can be seen that the new domestic raw material procurement model is an interesting model and should be applied because at present, the case study company haven't tried it yet, whether it is ABC Classification Analysis method or EOQ. If the company has used the results of the experiment, it can help reduce expenses in procurement of raw materials and

inventory management costs. In the research, there are outstanding findings that should be discussed to cover all research objectives as follows:

The results have shown that when the EOQ is used to calculate the order quantity appropriate to have enough products to meet the needs of the case study company and compared to the current method of the company, it will save the total cost for the year up to 910,500.69 baht. This is in line with the past studies of Rithisang and Kongchan (2017) that applies EOQ and new point of purchase in inventory management in the construction material business. As a result, costs can be estimated in the actual operating activities of the business and effective inventory management, Plika and Suwannasap (2016) that uses EOQ Model technique to reduce inventory costs, and Mahagaonkar and Kelkar (2017) that investigates ABC analysis for residential construction material management, allowing for efficient material flow, better quality control and reduced material loss as well as the production of construction materials takes a lot of resources and money.

For practical implications, the results of this research are beneficial to those working in purchasing planning, procurement of raw materials, and inventory management by assisting in the decision to purchase products to avoid accumulating excessive inventory. Further research should collect information from several companies in other types of industrial factory since this research may study and find information only for a single industrial plant. The future study, moreover, should focus on products in groups B and C as well to cover purchasing determination.

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