Application of Different Methods for Product Selection in Inventory Management -A Literature Review

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***Abstract*- Firms must develop and implement effective inventory policies that minimize costs and maximize profits in today's market conditions where extraordinary competition is experienced. Inventory has an important place in the total assets of manufacturing enterprises. Implementation of effective inventory management policies for this important item is crucial for the future of firms. Firms can meet customer needs more effectively by controlling fewer inventories that they classify according to their importance level. The aim of this paper is to conduct a systematic literature review of published articles in the application of different methods in inventory management decisions at the strategic, tactical and operational levels**

***Index terms*- inventory management, multi-criteria decision-making, AHP, TOPSIS, VIKOR**

I.INTRODUCTION

A business can run smoothly its operating activities only when appropriate amount of inventory is maintained. Inventory affects all operating activities like manufacturing, warehousing, sales etc. The amount of opening inventory and closing inventory should be sufficient enough so that the other business activities are not adversely affected. Thus, inventory plays an important role in operations management.

1. Meaning & Types of Inventory

Inventory is an asset that is owned by a business that has the express purpose of being sold to a customer. Inventory refers to the stock pile of the product a firm is offering for sale and the components that make up the product. In other words, the inventory is used to represent the aggregate of those items of tangible assets which are –

- Held for sale in ordinary course of the business.
- In process of production for such sale.
- To be currently consumed in the production of goods or services to be available for sale.

Materials flow from suppliers, through a manufacturing organization, to the customers. The progressive states of a material are classified as raw materials, semi-finished goods, finished goods, and work-in-process (WIP).

Raw Materials

Purchased items or extracted materials that are converted via the manufacturing process into components and/or products. Raw materials appear in the bottom level of BOM. They are stored in the warehouse and are non-phantom items.

Semi-finished Goods

Semi-finished goods are items that have been stored uncompleted, awaiting final operations that will adapt them to different uses or customer specifications. Semi-finished goods are made under the instruction of a shop order, using the components issued by a picking order, and stored in the warehouse when finished. They are the items between the top and bottom levels in a management BOM (rather than engineering BOM) and are non-phantoms. Semi-finished goods are not sold to the customers.

Finished Goods

A finished good is a product sold as a completed item or repair part, i.e., any item subject to a customer order or sales forecast. Finished goods are non-phantoms and are stored in the warehouse before they are shipped.

Work-In-Process (WIP)

Products in various stages of completion throughout the plant, including all material from raw material that has been released for initial processing up to completely processed material waiting for inspection and acceptance as finished goods. WIP inventory is temporarily stored on the shop floor and appears as a phantom in the BOM.

Maintenance, Repair, and Operational Supplies (MRO)
Items used in support of general operations and maintenance such as maintenance supplies, spare parts, and consumables used in the manufacturing process and supporting operations. These items are used in production but do not become part of the product

2. Meaning of Inventory Management
Inventory management is the practice overseeing and controlling of the ordering, storage and use of components that a company uses in the production of the items it sells. A component of supply chain management, inventory management supervises the flow of goods from manufacturers to warehouses and from these facilities to point of sale. Inventory control means efficient management of capital invested in raw materials and supplies, work in progress and finished goods.

3. *Significance of Holding Inventory*
Inventory is considered to be one of the most important assets of a business. Its management needs to be proactive, accurate and efficient. Inventory is essential for every organization to ensure smooth running of the production process, to reduce the ordering cost of inventory, to take advantage of quantity discount, avoid opportunity loss on sales, to utilize and optimize the plant capacity and to reduce the overall price. Thus, it can be said that inventory is inevitable and has to be maintained in appropriate quantity. However, the concept of Just In Time (JIT) is becoming popular which is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs. This method requires producers to forecast demand accurately.

4. Objectives of Inventory Management

The objective of inventory management is to maintain inventory at an appropriate level to avoid excess or shortage of inventory. Inventory management systems reduce the cost of carrying inventory and ensure that the supply of raw material and finished goods remains continuous throughout the business operations. The objectives specifically may be divided into two categories mentioned below:

A. Operating objectives: They are related to the operating activities of the business like purchase, production, sales etc.

a. To ensure continuous supply of materials.
b. To ensure uninterrupted production process.
c. To minimize the risks and losses incurred due to shortage of inventory.
d. To ensure better customer services.
e. Avoiding of stock out danger.

B. Financial Objectives:

a. To minimize the capital investment in the inventory.
b. To minimize inventory costs.
c. Economy in purchase.

Apart from the above objectives, inventory management also emphasize to bring down the adverse impacts of holding excess inventory. Holding excess inventory lead to the following consequences:

- Unnecessary investment of funds and reduction in profit.
- Increase in holding costs.
- Loss of liquidity.
- Deterioration in inventory.

2. LITERATURE REVIEW

Inventory management has great significance as it helps businesses to keep production costs at a low level. In addition, working with minimum inventory provides relief for the financing function of the business. Shift of funding resources, which is generally limited, to other areas has increased competition force of firm. Costs generated by inventories also are increased when they fall below appropriate level, such as they are increased when inventories level goes to above appropriate level. This precise balance can be protected by efficient

inventory management. A good inventory management foresees a balanced inventory to meet the needs of firm.

Zhou and Fan (2007) Ramanathan [R. Ramanathan, ABC inventory classification with multiple-criteria using weighted linear optimization, Computers & Operations Research 33 (2006) 695–700] recently proposed a weighted linear optimization model for multicriteria ABC inventory classification. Despite its many advantages, Ramanathan's model (R-model) could lead to a situation where an item with a high value in an unimportant criterion is inappropriately classified as a class A item. In this paper we present an extended version of the R-model for multi-criteria inventory classification. Our model provides a more reasonable and encompassing index since it uses two sets of weights that are most favourable and least favourable for each item. An illustrative example is presented to compare our model and the R-model. 2006 Elsevier B.V. All rights reserved.

Cakir and Canbolat (2008) they propose an inventory classification system based on the fuzzy analytic hierarchy process (AHP), a commonly used tool for multicriteria decision making problems. They integrate fuzzy concepts with real inventory data and design a decision support system assisting a sensible multi-criteria inventory classification. They report on a study conducted in a small electrical appliances company and validate the design of the proposed multi-criteria inventory classification system and its underlying fuzzy AHP model.

Chen et al. (2008) A dominance-based rough set approach (DRSA) to multiple criteria ABC analysis (MCABC) is designed and compared to other approaches using a practical case study. ABC analysis is a well-known inventory planning and control approach, which classifies inventory items, or stock-keeping units (SKUs), based solely on their annual dollar usage. Recently, it has been suggested that MCABC can provide more managerial flexibility by considering additional criteria such as lead time and criticality. This paper proposes an MCABC method that employs DRSA to generate linguistic rules to represent a decision maker's preferences based on the classification of a test data set. These linguistic rules are then applied to classify other SKUs. A case study is used to compare the DRSA with other MCABC approaches to demonstrate the applicability of the proposed method.

Hadi-Vencheh, A. (2010)In this paper we presented an extended version of the Ng-modelg [W.L. Ng, A simple classifier for multiple criteria ABC analysis, European Journal of Operational Research 177 (2007) 344–353] for multi-criteria inventory classification. The proposed model is a nonlinear programming model which determines a common set of weights for all the items. Our model not only incorporates multiple criteria for ABC classification, but also maintains the effects of weights in the final solution, an improvement over the model proposed by Ng. An illustrative example is presented to compare our model and the Ng-model.

Aydın Keskin and Özkan (2013) the number of stock keeping units (SKUs) possessed by organizations can easily reach quite a few. An inventory management policy for each individual SKU is not economical to design. ABC analysis is one of the conventionally used approaches to classify SKUs. In the classical method, the SKUs are ranked with respect to the descending order of the annual dollar usage, which is the product of unit price and annual demand. the few of the SKUs that have the highest annual dollar usage are in group A and should be taken into account mostly; the SKUs with the least annual dollar usage are in group C and should be taken into account least; the remaining SKUs are in group B. In this study, we proposed fuzzy c-means (FCM) clustering to a multicriteria ABC analysis problem to help managers to make better decision under fuzzy circumstances. The obtained results show that the FCM is a quite simple and an easily adaptable method to inventory management.

Lolli, F., Ishizaka, A., & Gamberini, R. (2014) Multi-Criteria Inventory Classification (MCIC) groups inventory items with respect to several criteria, in order to facilitate their management. This paper introduces a new hybrid method based on AHP and the K-means algorithm. On benchmarking data, it provides a clearly higher clustering validity index than previous sorting methods. However, as with previous methods, it is a full compensatory method. This means that an item scoring badly on one or more key criteria may still be placed in the best class because these bad scores are compensated. In order to prevent these hidden bad scores, a new variant method is introduced: AHP-K-Veto. The sorting is performed on each single criterion, where a veto system prevents an item evaluated as high/bad on at

least one criterion to be top/bottom ranked in the global aggregation. This veto system is an assurance against hidden problems but slightly worsens the clustering validity index

Makram Ben Jeddou (2014) The ABC classification of inventory items splits them into three different classes to which we will assign specific monitoring and control rules. The usual ABC classification is based on a single criterion, namely the value of annual use. Single criterion classification can also be done according to other criteria but considered separately. However, the inventory managers need more than one factor to take into account simultaneously in classification. Several models in literature have focused on multi-criteria classification. This article is based on Ng model to elaborate a multi-criteria classification of stocks in a company in the field of vehicle spare parts wholesale. A comparison was made with the traditional single criterion ABC classification.

Park, J., Bae, H., & Bae, J. (2014).Multi-criteria ABC inventory classification (MCIC), which aims to classify inventory items by considering more than one criterion, is one of the most widely employed techniques for inventory control. This paper suggests a cross-evaluation-based weighted linear optimization (CE-WLO) model for MCIC that incorporates a cross-efficiency evaluation method into a weighted linear optimization model for finer classification (or ranking) of inventory items. The present study demonstrated the inventory management-cost effectiveness and advantages of the proposed model using a simulation technique to conduct a comparative experiment with the previous, related investigations. We established that the proposed model enables more accurate classification of inventory items and better inventory management cost effectiveness for MCIC, specifically by mitigating the adverse effect of flexibility in the choice of weights and yielding a unique ordering of inventory items.

Babai, M. Z., Ladhari, T., & Lajili, I. (2015) A number of multi-criteria inventory classification (MCIC) methods have been proposed in the academic literature. However, most of this literature focuses on the development and the comparison of ranking methods of stock keeping units (SKUs) in an inventory system without any interest in the original and most important goal of this exercise which is the combined service-cost inventory performance. Moreover, to the best of our knowledge these MCIC methods have never been compared in an empirical study. Such an investigation constitutes the objective of this paper. We first present the inventory performance evaluation method that we illustrate based on an example commonly used in the relevant literature which consists of 47 SKUs. Then, we present the empirical investigation that is conducted by means of a large data-set consisting of more than 9086 SKUs and coming from a retailer in the Netherlands that sells do-it-yourself products. The results of the empirical investigation show that the MCIC methods that impose a descending ranking of the criteria, with a dominance of the annual dollar usage and the unit cost criteria, have the lowest combined cost-service performance efficiency

Hatefi and Seyed (2015) Organizations typically employ the ABC inventory classification technique to have an efficient control on a huge amount of inventory items. The ABC inventory classification problem is classification of a large amount of items into three groups: A, very important; B, moderately important; and C, relatively unimportant. The traditional ABC classification only accounts for one criterion, namely, the annual dollar usage of the items. But, there are other important criteria in real world which strongly affect the ABC classification. This paper proposes a novel methodology based on a common weight linear optimization model to solve the multiple criteria inventory classification problem. The proposed methodology enables the classification of inventory items via a set of common weights which is very essential in a fair classification. It has a remarkable computational saving when compared with the existing approaches and at the same time it needs no subjective information. Furthermore, it is easy enough to apply for managers. The proposed model is applied on an illustrative example and a case study taken from the literature. Both numerical results and qualitative comparisons with the existing methods reveal several merits of the proposed approach for ABC analysis.

May et al. (2017), Inventory classification aims to ensure that business-driving inventory items are efficiently managed in spite of constrained resources. There are numerous single- and multiple-criteria approaches to it. Our objective is to improve resource allocation to focus on items that can lead to high

equipment availability. This concern is typical of many service industries such as military logistics, airlines, amusement parks and public works. Our study tests several inventory prioritization techniques and finds that a modified multi-criterion weighted non-linear optimization (WNO) technique is a powerful approach for classifying inventory, outperforming traditional techniques of inventory prioritization such as ABC analysis in a variety of performance objectives.

3. CONCLUSION

In today's competitive world, businesses have begun to pay more attention to inventory management to be able to compete better in the business world and survive in this environment. Inventory management has critical importance for firms in terms of reducing inventory holding cost, keeping inventory levels at the required level and allocating generally limited funding sources to appropriate areas to provide a competitive advantage. When literature was examined, generally they were suggested inventory should be scaled down by classifying or clustering methods instead of managing the whole during inventory management. Thus, this management style helps to reduce holding costs and increasing customer satisfaction. One of the most used methods in inventory management is the multi-criteria decision-making method.

REFERENCES

[1] Aydın Keskin, G. and Ozkan, C. (2013). Multiple criteria ABC analysis with FCM clustering. Journal of Industrial Engineering, 2013.

[2] Aydın, Ö. (2009). Hospital Location for Ankara with Fuzzy AHP. Dokuz Eylul University Faculty of Economics and Administrative Sciences Journal, 24(2), 2009.

[3] Bhattacharya, A., Sarkar, B. and Mukherjee, S. K. (2007). Distance-based consensus method for ABC analysis. International Journal of Production Research, 45(15), 3405-3420.

[4] Boulos, M. N. K. (2003). Location-based health information services: a new paradigm in personalised information delivery. International journal of health geographics, 2(1), 2.

[5] Cakir, O. and Canbolat, M. S. (2008). A web-based decision support system for multi-criteria inventory classification using fuzzy AHP methodology. Expert Systems with Applications, 35(3), 1367-1378.

[6] Chen, Y., Li, K. W., Kilgour, D. M. and Hipel, K. W. (2008). A case-based distance model for multiple criteria ABC analysis. Computers & Operations Research, 35(3), 776-796.

[7] Ertugrul, I. and Tanriverdi, Y. (2013). ABC Method for Stock Controls and the Application of the AHP Analysis to Yarn Company. International Journal of Alanya Faculty of Business, 5(1), 2013.

[8] Görgülü, I., Korkmaz, M. and Eren, T. (2013). Analytic network process and TOPSIS methods with selection of optimal investment strategy. Sigma, 31, 203-213.

[9] Hatefi, S. M. and Torabi, S. A. (2015). A common weight linear optimization approach for multicriteria ABC inventory classification. Advances in Decision Sciences, 2015.

[10] Hwang, C. L. and Yoon, K. (1981). Methods for multiple attribute decision making. In Multiple attribute decision making (pp. 58-191). Springer, Berlin, Heidelberg.

[11] Kılıç, A., Aygün, S., Aydın Keskin, G. and Baynal, K. A. (2014). Variant Perspective to Multi Criteria ABC Analysis Problem: Fuzzy Analytic Hierarchy Process-Technique for Order Preference by Similarity to Ideal Solution. Pamukkale University Journal of Engineering Sciences, 20(5), 179-188.

[12] Kumar, G. A., Anzil, A., Ashik, K., James, A. T. and Ashok, J. K. (2017). Effective Inventory Management system through selective inventory control. Imperial Journal of Interdisciplinary Research, 3(6).

[13] May, B. I., Atkinson, M. P. and Ferrer, G. (2017). Applying inventory classification to a large inventory management system. Journal of Operations and Supply Chain Management, 10(1), 68-86.

[14] Opricovic, S. (1998). Multicriteria optimization of civil engineering systems. Faculty of Civil Engineering, Belgrade, 2(1), 5-21.

[15] Opricovic, S. and Tzeng, G. H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS.

European journal of operational research, 156(2), 445-455.

[16] Özdemir, A., Özveri, O. (2013). Application of Analytic Hierarchy Process Analysis in Multi-Criteria Inventory Classification. Dokuz Eylul University Faculty of Economics and Administrative Sciences Journal, 19(2).

[17] Partovi, F. Y. and Burton, J. (1993). Using the analytic hierarchy process for ABC analysis. International Journal of Operations & Production Management, 13(9), 29-44.

[18] Saaty, T. L. (1980). The analytic hierarchy process: planning, priority setting, resources allocation. New York: McGraw, 281.

[19] Zhou, P. and Fan, L. (2007). A note on multi-criteria ABC inventory classification using weighted linear optimization. European journal of operational research, 182(3), 1488-1491.