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A BRIEF LITERATURE REVIEW ON INVENTORY MANAGEMENT

B. Pranay Dishan[1], V. V. D. Sahithi[2], Dr. C. S. P. Rao[3]

[1] *Department of ME, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad 500090, India*
[2] *Department of ME, VNR Vignana Jyothi Institute of Engineering and Technology, Hyderabad 500090, India*
[3] *Director, National Institute of Technology, Tadepalligudem, Telangana, India*

Abstract: *Inventory management is the activity of controlling the continuous flow of inventory in any organization, which is into either production, trading, sales, or services. In spite of the reality that the rise of inventory management is inexact, it would be safe to say that shopkeepers and merchants were some of the initials to explore into these fields. Yet the interest in this managerial field is still great in the phase of optimizing. Low inventory usually results in the stock outs and maintaining excess inventory results in additional holding costs. Inventory management is an essential and much required activity that every organization would like to consider various purposes in order to maintain the customer's good will and to make comparatively high profits. The goal of each inventory planner is to achieve optimum inventory controlling plan. In this paper, an attempt is made to cover most of the techniques and models developed in order to achieve the most accurate, effective, and efficient inventory-managing plan from traditional methods to soft computing techniques, which are more user friendly in present days in the least possible time.*

Keywords-*: Inventory management; Lot-sizing; Supply chain management; Multi-objective Lot Sizing Problem; Logistics; Optimization.*

I. INTRODUCTION

All the functions in an organization are interlinked and connected to one another and often overlap with each other. Some key day-to-day tasks such as logistics, inventory management, and supply chain management form the chief support of an organization. One of the routine problems encountered by most of the organization is maintaining sufficient inventory. There is no proper solution to face this problem since the conditions at each organization are unique and include different features and limitations. Inventory management requires continuous and mindful evaluation of both external and internal factors and standard control through planning and review. Most of the inventory managing organizations, employs a separate department in order to continuously monitor, control and review inventory and interface with procurement, production, and finance departments. To formulate accurate, effective, and efficient inventory plan in such complex conditions, it becomes necessary to make use of system analysis and development of an organized approach to the problem. There is a much required need for developing new and effective methods for modelling systems associated with logistics, supply chain management, and inventory control and the solution to such critical issues rely on the conditions of organization's features, limitations and their practices. This paper focuses on some of the methods and models developed to overcome the mentioned problem, including traditional ways as well as emerging soft computing techniques.

II. INVENTORY MANAGEMENT

Inventory management is a key function that affects the strength of the supply chain as well as influences the financial condition of the organization. Modern day inventory is managed by advanced system applications, which needs a continuous and cautious evaluation of both external and internal factors. Need for inventory occurs at different stages in an organization. In case of a manufacturing industry, inventory may be in the form of raw materials, work in progress or finished goods. Besides this, there is also a need to keep the spare parts for servicing the products. Inventory procurement, storage and its management in any organization for smooth supply chain management comes with huge costs. Inventory management activities are based on managing the following costs efficiently:

- Ordering cost
- Carrying cost
- Shortage or stock out cost of replenishment.

Cost of procuring the material and their respective logistics costs forms the ordering cost and it depends on the quantity of the material that has to be procured. The cost incurred for the storage and maintenance of the material procured along with the capital cost form the carrying cost. The cost incurred for restoring the stock to the previous level in case of stock out is known as the storage or stock out cost. The cost reduction can be achieved in many ways for an efficient inventory management system as shown below

- Using the proper inventory methods
- Achieving cost reduction in the logistics

- Performing multi inventory operations
- Rectifying the issues that cause inventory problems
- By implementing emerging soft computing techniques

A. Inventory Controlling Methods

Considering all the discussed facts, Ford W. Harris [1] states that every organization that is into either production, trading, sales or services has to face the problem of finding the most cost effective quantity to place an order. There are many factors which affect the economics such as unit cost of the material, set up cost, interest and depreciation on stock, movement charges and also the manufacturing interval in case of a manufacturing unit. In order to show the significance of practicing the inventory management in a company, Marcia Perry and Amrik S. Sohal [2] performed a case study with the results gathered from 50 companies. Quick response practicing and technologies in supply chain management were implemented for proper management of the inventory. As a result, the company experienced the move towards additional profits and success. There are various methods of maintaining efficient and effective inventory. Tom Jose V., Akhilesh Jayakumar, and Sijo M. T. [3] discussed some of the traditional methods. Economic order quantity (EOQ), ABC analysis, safety stocks, FSN analysis are the methods analyzed in the paper and it is concluded that safety stocks is a better than EOQ under certain conditions but all the techniques are dependent on the flow of the materials. Similarly Syed Adeel Haneed Zaidi et al. [4] discussed some of the inventory management methods and performed a case study on the real furniture company to execute the inventory management system in the company. They worked on EOQ and Material Requirement Planning (MRP) to forecast the required inventory, which was found to be the optimum solution for minimizing the ordering and carrying cost. Dr. Angel Raphella S. et al. [5] have carried out similar work to overcome the problem of stock outs in a company by studying their forecasting model. ABC analysis was used to find out the most important materials that have to be maintained to keep the production running and EOQ for each material was developed to find their respective inventory model equation so that stock outs can be eliminated and optimal results have been achieved to stay in the competition.

B. Logistics

Material Requirement Planning has developed into a supreme and dominant method in production scheduling and inventory controlling over last few decades. These methods need to be frequently updated in order to keep the nervousness away from the system. Charwan-Jyh Ho [6] has discussed various operating and environmental variables that cause the nervousness in the MRP system and has implemented the factory simulation method to study the effect of those factors. Lot sizing rules, length of lead-time, length of planning horizon and component commonability are said to operating factors where as demand variations, capacity utilization, and structure of cost are considered as environmental factors. Out of these variables, the focus was kept on lot sizing algorithms and capacity utilization and it is concluded that operating variable lot sizing has the greatest impact over the capability of the MRP system. Ronald H. Ballou and Apostolos Burnetas (2003) [7] worked on a traditional inventory method which fills the customer requirement from any one location. It is concluded that inventory level at primary source can be reduced by effective fill rates, which can be obtained through cross filling that depends on regular stock and safety stock. Mathew A. Waller et al. [8] studied the impact of cross filling on inventory in a decentralized retail supply chain management and found that application of cross filling will result in stock outs at the stores. To overcome such situations, additional inventory is required to be calculated and the physical space required for the same is generated automatically by the implementation of the cross shipping. C. John Langley [9] worked on several available methods to calculate the appropriate EOQ level when the input values of any model are not only certain but inexpressible to alert the logistic decision makers. Particularly working on transportation, i.e. in order to minimize the ordering cost, it is concluded that minimum, minimax, minimax regret, and Laplace criterion strategies are most appropriate in determining the most efficient EOQ equations. Similar work has been executed by Feng-Tsung Cheng and Chia-Kuan Ting [10] using the differential calculus and Hessian matrix equations. S.M. Disney et al. [11] worked on three different supply chain models, namely traditional supply chain, internal consolidation scenario, and Vendor Managed Inventory (VMI) supply chain to bring down the cost incurred due to transportation. As a result of their analysis, VMI supply chain provided smoother and dynamic response, enabling the minimization of the transportation costs. Heinrich Kuhn and Thomas Liske [12] presented a complete mathematical model with exact procedures to solve Economic Lot Size Scheduling Problems (ELSSP) using power of two policy based on the junction point method. This method is particularly advantageous in automobile industry and grocery retailers to minimize the cost incurred due to logistics while maintaining the effective inventory.

C. Multi-inventory problems

Inventory management problem are not just of a single item from a single supplier, it may be ‘n’ number of items from any number of suppliers at any given time. Leopoldo Eduardo Cardenas-Barron [13] proposed ‘n’ stage multi customer supply chain inventory model in order to supply items to many customers at a time. The fundamental inventory coordinating mechanism was used with algebraic approach to optimize the supply chain model. As a result of the proposed work, optimal equal cycle time and the optimal total annual cost were developed to minimize the overall inventory costs. Faizul Huq et al. (2016) [14] compared N-retailer replenishment systems of one warehouse and two ware house with the help of a statistical analysis in a simulation model and found that two warehouse n-retailer replenishment systems are more economical as they reduced delivery lead times under specific conditions. Sameer Kumar and Charu

Chandra (2001) [15] introduced new ordering rules for managing multiple items from a single supplier at a varying demand rate that occur in many real life situations. The required amount of quantity that has to be ordered is calculated by using the optimum values of common ordering cycle time, integer values of each orderings, and variance in lead-time demands. Interestingly, Moutaz Khouja (2002) [16] introduced three stage supply chain management where an organization can supply numerous customers. Three different coordination mechanisms were developed and worked on different cycle times throughout the supply chain in each mechanism to obtain the optimum inventory cost. The analysis revealed that the mechanism in which the cycle time of each firm was taken as power of two multiples of the basic cycle time was found to be economical compared to other coordination mechanisms considered.

D. Relationship and significance of inventory management

Inventory management operations are being implemented in every respective organizations as awareness of having adequate inventory has been made known to them. Some of the added advantages that comes up with its implementation are uninterrupted production, reduced ordering and carrying costs, maintaining sufficient stock during price change or non-availability, permits better utilization of the stock, and customer satisfaction which is indeed the most essential consideration for the success of an organization . Syed Jamal Abdul Nasirbin S. Mohamad et al. [17] examined the impact of implementing inventory management in a textile store and found the performance of the company has increased. The study analyzed using inventory days and Return on Analysis (ROA) method. The problems such as unorganized inventory arrangement, large amount of inventory days, no cycle counting, and inaccurate record balance due to unskilled labor have been solved. Kamau Lucy Wangari and Dr. Assumpta W. Kagiri [18] carried out similar work and found that practicing the inventory management affects the profit maximization, customer satisfaction, market share growth and production quality targeting when the factors like inventory shrinkage, inventory turnover, and inventory investment are properly controlled. Jefwa Mwachiru Mathiasa and Everlyn Datche Owuorb [19] tested a research framework using the key variables of inventory management and the organization performance and established a convincing relationship between inventory management and organization performance when the variables like inventory cost, inventory speed, and inventory accountability is considered. Few more identical works were carried out by A.N. Augustine and Okoro Agu [20] in some of the selected organization in Enagu using Survey and case study. K. M. Mogere et al. [21] in a tea firm, Nsikan Efiok John et al. [22] in a flour milling company, Lawrence Imeokparia [23] in a food and beverage company. In all the works, the effect of inventory management on organizational performance was found to be very important. Considering a different scenario, Hong Shen, Qiang Deng, Rebecca Lao, and Simon Wu (2017) [24] examined the impact on inventory management practicing with respect to the supplier cooperation by taking a case study. Analysis was executed using supply contract, safety stocks, VMI, and postponement and concluded that keeping the calculated inventory is essential in case the supplier do not guarantee the availability of required amount of the material or price changes regularly. Apart from these, Rajeev Narayanapillai [25] clarified that it is not only technology, but also the non-technology factors such as human resources, employee training, management attitude, behavioral aspects, and interaction between supplier and customer affect the inventory management efficiency.

E. Relationship and significance of inventory management

Now days, most of the organizations are not practicing the traditional inventory management operations which are discussed till now. The emerging techniques in the departments of inventory management are the applications of computers, logics, etc. to achieve the most efficient inventory management plan from the multiple inputs. Md. Saiful Islam et al. [26] developed a Material Requirement Planning (MRP) software that uses computer programming to generate an inventory plan using an algorithm. To cross check the accuracy, efficiency, and effectiveness of the algorithm, the results were compared with the manual methods and was found to be accurate. S.R. Singh and Tarun Kumar [27] proposed an efficient method which utilizes Genetic Algorithm (GA) to develop an optimum inventory plan in supply chain management by focusing on reducing surplus and shortage level of stocks. P. Radhakrishnan et al. [28] carried out similar works to obtain the optimum inventory level. William Hernandez and Gursel A. Suer [29] also made use of GA to resolve the lot-sizing problem of non-capacitated case in which scaling factor was found to have an effective impact on the solution of the inventory plan. Shaymaa Elsherbiny et al. [30] proposed a new solution using nature based Intelligent Water Drop (IWD) optimization method to optimize the scheduling of the resources. A simulation tests in different cost models were compared using the algorithms of min-max, max-min, first come first serve, etc and found better results with respect to cost and performance. Yashveer Singh et al. [31] presented a review on the importance of soft computing in the inventory managing field by taking fuzzy logics and genetic algorithm as a case study for illustration. Apart from these techniques, some hybrid techniques were also developed. Vahid Hajipour et al. [32] developed a hybrid algorithm by combining ant colony algorithm with one of the heuristic methods called shifting technique. The proposed hybrid model was used to solve multi-level lot sizing problem having capacity constraints to fulfill the customer needs. The results achieved have been compared with tabu search and genetic algorithms and found to be efficient. V. V. D. Sahithi et al. [33] have carried out similar work with the combination of iterative improvement local search mechanism and particle swarm optimization for lot sizing problem in the MRP systems. The algorithm developed has explored good results to the problem considered and stated that the approach was better than other methods in terms of quality of solution. C. S. P. Rao et al. [34] carried out work on minimization of the total set up costs and holding using binary particle swarm optimization to handle large product structures of single level lot sizing problems. Experimental simulation was also carried out and concluded that proposed method was cost effective and time efficient. S. K. Mishra et

al. [35] developed a hybrid algorithm by combining particle swarm optimization and iterative improvement local search mechanism to deal with large capacitated multi-level lot-sizing problems. The hybridization of particle swarm optimization with iterative method was found to explore much more efficient results to the considered problem.

III. CONCLUSION

In the last few decades, the significance of inventory management has drastically increased. Achieving efficient and effective inventory plan has become an area of major concern in different organizations, which maintain inventory for various purposes. This paper has attempted to present a brief literature survey on inventory management and came up with different angles from which optimum solutions are achieved. Most of the inventory models are divided into uncapacitated and capacitated types depending upon the supplier and single level or multi-level based on the inventory required by the organization. Achieving optimum inventory plan was started by using the traditional techniques such as EOQ, safety stocks, FSN analysis, cross docking, drop shipping and many more. Each one of them had its own advantage in solving the type of inventory problem occurring in the organization. The only disadvantage of using traditional methods were that they are time consuming and accuracy is not upto the mark. This issue has overcome by the developing Material Requirement Planning (MRP) software that uses of soft computing techniques such as fuzzy logics, particle swarm optimization, genetic algorithm, intelligent water drop optimization and many. The soft computing technique is found to be more efficient and effective in planning optimum inventory plans in less time with the uses of computer logics and processors. Both traditional and non-traditional i.e. soft computing techniques can be implemented for various inventory problems. The study is quite general with an overview of inventory management showing the significance in different fields and can be extended.

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