A LITERATURE REVIEW ON LOT SIZING

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Abstract: Inventory management is the activity of not only supervising and managing the ordering, usage and storage of items that an organization uses in the manufacture of the objects it sells but also overseeing and managing number of finished goods that are to be sold. The inventory in any business firm or organization is one of its dominant assets and represents an expenditure that is linked to the sale of the items. Successful inventory management requires creating a purchasing scheme to make sure that items are available whenever they are required and it is made sure that neither too much nor too little of them is bought which will lead to losses. There are various heuristic methods to obtain effective and efficient inventory schemes, out of which lot sizing is one of the commonly applied methods and the remaining are limited to the small instances in certain cases. Lot Sizing Problem (LSP) in inventory management systems refers to those problems that various firms face every day in properly organizing the overall production plans. Lot sizing plays a significant role in reducing the cost that incurs because of the improper inventory management. In the present work, a brief review on the efforts of various different scholars who have worked on lot sizing problems under different conditions and their achievements are provided.

Index Terms **- Inventory management, Lot Sizing Problem (LSP), heuristic methods, optimization.**

I. INTRODUCTION

Inventory control is a crucial characteristic for the growth of any company. Inventory is the backbone of any industry to store the material. Stock control or inventory control perhaps can be defined as "the process of scrutinizing a shop's stock". In one sentence, inventory control is merely to give continuous service to obtain good production, sales and maintenance in any firm, which is into production, service or trading with least number of stocks. Due to the effect of lot sizing on inventory levels and total cost, lot-sizing issue has gained the curiosity among the researchers. Lot sizing deals with finding the relevant order quantities of various items in the BOM structure with a sole objective to lessen the overall cost, which includes both setup and holding costs. Minimizing the total cost of production is always being a trade-off solution between holding and ordering costs. In fact, many costs like carrying costs, setup cost, minimum ordering quantity, shortage cost, handling cost and minimum ordering costs influence decision making. Considering the above-mentioned costs, multi items and multi levels give rise to complex inventory model and lead to most infeasible solutions. The objective of inventory planner is to make maximum profit with minimum amount of inventory investment without impinging upon consumer contentment levels.

II. LOT SIZING

One of the most commonly faced production planning issues is the Lot sizing problem. It is considered as the most principle and the most laborious issues in production planning. The solution of lot sizing problem controls production quantities for many items over a predetermined horizon, considering the fundamental trade-off between setup and inventory-holding costs. It is the procedure of deciding how much of each manufactured item is needed to make and when to make it. In financial markets, lot size is a quantity enlargement suitable to or summarized by the party, which is contributing to purchase or sells it. A basic example of lot size would be buying a lot of chocolate, which is a box of six chocolates. Lot size refers to the quantity of articles ordered for shipment on a specific date or produced in one production run. It is considered as skill required and most tough problems to solve in production planning work and belong to NP hard class of problems. Various lot-sizing methods have been evolved, few of them are:

- Economic Order Quantity (EOQ),
- Fixed Order Quantity (FOQ),
- Least Total Cost (LTC),
- Part Period Balancing (PPB).

Lot size directly influences inventory and scheduling problems. The motivation behind using lot for lot policy is minimizing inventory. If we order as much as it is needed, there would be no end to the inventory at all. A lot sizing procedure calculates how many units of a component should be purchased during a period with respect to the demand. To decide this, it needs information about the setup times. Lot sizing is categorized into two major groups- small lot size and large lot size. Small lots are very customizable. For businesses that function on a pull system, the products is made once they are purchased for which small lots are the standard. These custom-made products are not generally sold in hundreds or thousands. They are usually vended as a single item or a couple. It also brings down the required space needed for storage and practically eradicates the wastage, especially when

the products are made once they are purchased. They do not need much money to get started. In fact, the customer generally pays for the product before you even make it. Large lots are cheaper to make. It is always cheaper to make products in bulk. When an order is placed, shipment of the product to the consumer can be completed right away because the product is already made. It is not needed to wait until it is made. Each item in a large lot will look and work just the same as all the others. Large lots are perfect for businesses that operate on a push system where products are made before they are sold.

III. LITERATURE REVIEW

Considering the discussed theory above, Jose Roberto Dale Luche and Rodolfo Egon Perhs [1] support decisions throughout production control and planning in the Personal Protective Equipment (PPE) industry. A case study in Brazilian company was executed which focused on increasing the productivity and customer service to meet deadlines. A mixed integer linear programming was revisited and the problem with relevance to planning and production control in PPE industry was examined. The problems related to product lot sizing were described. A. Drexl and A. Kimms [2] illustrated the contemporary worked in the area associated to lot sizing, scheduling, also focused on capacitated, dynamic and deterministic cases, and stated that ongoing research tries to incorporate additional real world aspects into lot sizing and scheduling models and methods. Luca Baciarello et al. [3] executed a different kind of modeling approach and described few of the ultimate lot sizing algorithms, which have been successfully executed on several different scenarios. Iman Parsa et al. [4] discussed the complicated lot sizing issue in case of a single item considering supplier selection to be in a two-stage supply chain. A mathematical modeling formulation is presented for the proposed issue and dynamic programming methodology is provided to solve it. Christoph H. Glock et al. [5] provided a literature review on lot sizing area whose goal was to present which fields of research came up from Harris' influential lot size model and whose vital achievements have been investigated in those particular domains. Yingha Kang [6] presented a dynamic lot sizing problem with complex multiple product-single machine in production planning system. Nabil Absi [7] introduced latest environmental restraints, mainly carbon emission constraints in multi-sourcing lot sizing problems. These restraints aim to restrict the emission of carbon per unit of product supplied with various modes. Few types of carbon emission restraints were proposed in his work. Mark Loparic et al. [8] presented two extended mathematical formulations, algorithm for dynamic programming and an entire report for the solutions on the convex hull. Campello B. S. C et al. [9] addressed the lot-sizing problem in one of the paper industry combined with the problem of cutting the stock using a multi-objective approach. Considering a few of the computational results, a decrease in the costs of production was achieved with an increase in the waste of material of cutting process and vice versa. C. Gic quel et al. [10] focused on capacitated lot sizing models, which are a sort of production planning models, which are to be appropriate for inflexible production resources found in certain process industries. Bernardo Almada-Lobo et al. [11] described that researchers have been trying to evolve stronger mathematical formulations that are equipped with real-world requirements from many applications, presented some of these necessities, and illustrated how small and big-bucket models, which were modified and broadened. S.C. Poltroniere et al. [12] worked in one of the paper industry on the optimization of cutting problem and lot sizing problem and proposed two mathematical formulations for the combined problems and solved these models both heuristically on an optimization platform. In an attempt to achieve lower bounds of the problem, hassle-free versions of the models also have been developed and solved. Finally, the computational experiments were suggested and examined for the same. Ann M. Noblesseet al. [13] examined the lot sizing decisions in an inventory and production problems, where lead times are calculated from a queuing model that is linked internally to the orders positioned by the inventory model. Assuming a continuous review inventory policy, a procedure was developed to obtain the proper management of lead times as well as inventory levels, in which the inventory model endogenously determines the lead times. Masoumeh Mahdieh et al. [14] modelled a lot sizing and scheduling problems parallelly in a flexible flow line (FFL) rather than separately. The problem, called the 'General Lot sizing and Scheduling Problem in a Flexible Flow Line' (GLSP-FFL), optimizes the lot sizing and scheduling of various products at many stages, each stage having various analogous machines. V.V.D. Sahithi et al. [15] have carried out similar by collaborating two distinct methods, namely, particle swarm optimization and iterative improvement local search mechanism in order to find the optimal result of the lot sizing problem in the MRP systems. The algorithm developed has explored good results for the type of problem considered and stated that the approach was better than the rest soft computing techniques in terms of quality of solution. Amit Gupta et al. [16] carried out work on four different lot sizing techniques, namely classical economic order quantity, lot for lot, economic order quantity-fixed unit price, minimum order quantity and technique which are most widely used in Indian automotive industry as per the bodies involved in lot sizing selection which can be either directly or indirectly. Nabil Absi et al. [17] worked on multi-item capacitated lot-sizing problem, which particularly dealt with times related in setting up and lost sales. To find better lower limits, a Lagrangian relaxation of the capacity constraints with single-item incapacitated lot-sizing problems with lost sales has also been solved. Each sub-problem is solved using the O(T2) dynamic programming algorithm from (Aksen et al.). Harish C et al. [18] practically tested the four processes by solving popular benchmark problems. These methods differ in their efficiency and are provided with some suggestions for the proper selection of lot-sizing practices in various manufacturing environments. R. Radhakrishnan et al. [19] evaluated the lot-sizing problem using six sigma method depending on the double sampling plan with a Poisson distribution. A table is also constructed for the easy selection of the plan. S.K. Mishra et al. [20] effectively developed PSO based technique called iterative improvement binary particles swarm approach to address very large capacitated multi-item lot sizing problem. In this technique, binary particle Swarm Optimization algorithm is first employed to find an optimal result in a reasonable time and later the iterative improvement local search procedure is utilized to improvise the solution obtained by BPSO algorithm. This hybrid procedure of using local search for the global solution in order to improve the quality of results with respect to time. Thus, IIBPSO method is found to be the best and showed excellent results. V.V.D. Sahithi et al. [21] solved very large Capacitated Multi Item Multi Level Lot Sizing Problem (CMIMLLS) using an Iterative Improvement Binary Particle swarm Optimization (IIBPSO). Kizhanatham V. Ramaswamy [22] dealt with the lot-sizing problem with non- instantaneous delivery and continuous utilization of produced products has been extensively inspected integrating various non- manufacturing related cost and lot size variables. Raf Jans et al. [23] gave a broad

outline of latest progresses in the field of modeling deterministic single-level dynamic lot sizing problems. He also concentrated on the modeling of different extensions in the industries and not on the solution approaches. Albert Wagelmans, Stan Van Hoesel [24] presented an algorithm to solve the economic lot sizing problem in O (n log n) time, and showed that Wagner- Whitin's case can also be solved in linear time. Boaz Golany et al. [25] studied regarding production planning issues faced during remanufacturing. A general formulation regarding the problem was provided and assessment of its computational complexity under different cost structures was done. Gislaine Mara Melega et al. [26] mathematical model has been proposed for a General Integrated Lot- sizing and Cutting Stock (GILSCS). Maryam Darvish et al. [27] investigated a multi- plant, production planning and distribution problems for parallel optimization of production, inventory control, demand allocation, and distribution conclusions.

IV. CONCLUSION

In the past few decades, the importance of the inventory management has increased considerably. Every organization that is into production, trading or service has to maintain the inventory to overcome the unexpected problems that may arise at any time. Achieving efficient inventory plan is the goal of every organization with minimum cost consumption. In order to achieve the same, there are many different methods from traditional to the emerging soft computing techniques. This paper has attempted to present a concise review on lot sizing problem, including the methods to manage inventory-using lot sizing techniques. Out of many available techniques, the EOQ and LFL were found to be efficient and productive in most of the lot sizing problems and others methods were found to be limited in certain instances. The study is quite general with an overview of solving inventory management problems using lot-sizing approaches showing the significance in different fields and can be made extended further deeply.

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