

Application of Operations research in Optimizing Warehousing in Logistics

K.S.Devesh, Karan Reddy, Chaheti Agrawal, ApurvChhipani, Sanya S

^sBachelors of business Administration, NMIMS bangalore, Inida

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I. Introduction

Warehousing and Logistics is the backbone of a business. It is about the lifecycle of a product keeping in mind the following factors like detailed planning and organization, management and implementation of complex operations like loading unloading, palletizing, unpacking and replenishment, sorting, coding, packing etc. Warehousing has become very crucial with the growing modern day demand trends of the economy. E-commerce and online shopping have given warehousing a very important role to play.

The main objective of warehousing is to support manufacturing processes to ensure optimal functioning which indicates mobilized supply chain: efficient inventory management, lower operational costs and higher customization satisfaction. Warehousing process begins with a product being received which then has to be stored in the put away area. The product is then sent to the allocated storage location. Now once an order is received the product is first located in the storage area and then it is shipped.

The objective of our research paper is to show how operational research can be used to optimize various warehousing functions which includes receiving goods, putting away, packing and picking. The main focus is on the storage and shipping function. Reducing transportation cost, maximizing storage space, reducing waiting time and optimizing pallet allocation are also highlighted in the paper. An ideal warehouse logistics plan streamlines the life cycle of a product resulting in lower costs for the business, faster delivery for the customers and thus this way both the parties get the benefits.

II. Literature Review

ElveziaCepolina and Francesco Cepolina (September 2014) in this paper they give us insight into how to minimise the waste space in industrial warehouses by using the STATIC AND DYNAMIC APPLICATION as. The designed and implemented solver can only minimize the waste space.

E A Okunkova¹, I V Sharova², V N Burkov³, I V Burkova⁴, D Passmore⁵ and Z Daulbaeva⁶ (December 2019) focuses on the probability distribution laws- exponential, binomial and Poisson as they are used to determine the time parameters of random logistic processes The provided model of determination of material stock in warehouses of the construction organizations can be used both for civil, and for industrial construction.

Dr. D. Ghosh (December 2015) shows the importance of minimising cost in every business activity to make it a successful business, therefore they used Integrated cost and inventory control tool to work on the important components of logistics that are transportation, inventory management and warehouse management.

HenrietaHrablik , NatáliaHornáková, Dagmar B(January 2015) In order to enhance and optimize the flow of information, materials, and value throughout the entire enterprise, they have used multiple OR tools like Graph and Networks, Linear Programming, Network Analysis, Inventory Theory Model which creates huge savings and ultimately makes the enterprise profitable.

Xianyao Li (2017) the main aim of the paper is to add average fixed costs to unit transport costs, as they are simpler and quicker to use that provides a considerable suboptimal solution as compared to other heuristic algorithms which are more complicated and time consuming that is why they used the Greedy Algorithm

Anushika Fernando, UdithaMirando, DineshaPerera (January 2021) analyses the problem of optimizing the number of pallets required to meet the demand from each product type while maximizing warehouse storage space with efficient palletizing using Linear Programming

This paper uses queuing theory, vehicle flow formation, commodity flow formation, set portioning problems and network designing to optimally solve the issues in inbound and outbound transportation, warehousing and logistics.

Eizo Takai (October 2008) analyse the problems faced by logistics in Japan by applying various OR tools such as, transportation model, network model, game theory and dynamic programming which describes the effectiveness of support for rational planning and operations supply chains for optimization.

A. Gunasekaran, H.B. Marri, F. Menci (December 2018) in this paper defines how was warehousing done affectively with the use of inventory control and production control.

Focuses on the implementation of effective solution for optimisation of inbound and outbound transportation in warehousing with the help of network optimization problems, logistics network optimization, queuing theory, vehicle routine problem and simulation

Warren H. Hausman, Leroy B. Schwarz and Stephen C. Graves (February 1976) this paper main aim is to reduce cranes travel time in automatic warehousing systems by the use of multiple OR tools- random storage assignment, turnover based assignment, the turnover based assignment, the turnover distribution and class based turnover assignment.

Linear programming, transportation problem, assignment problem, networking & simple and storage capacity models, these are some OR tools which ensures profitability, efficiency and effectiveness of the store and also solves the problem of minimising cost and providing services to the places where there is maximum demand

Ana Rita Marques Carvalho in this paper provides insight into how to lower overall handling expenses with the help of MILP, GAMS and turnover which determines the best distribution of items among locations inside the warehouses

Xiwen Feng, Yu Zhou and Mengying Gao (October 2020) mapping of the value stream status quo of the existing production lines which optimise the warehouse operation process, improve storage efficiency.

WJ Pienaar (March 2005) focuses on some of the most crucial ones in the OR toolkit -linear programming, integer programming, feasibility analysis, transportation modelling and deterministic and probabilistic inventory model.

III. Analysis

APPLICATION OF OR IN SPACE OPTIMIZATION

Industrial warehouses go through the problem of wasted spaces due to an inability to utilize the spaces. This is where Operations Research helps solve the issue. Static and dynamic approach is used to optimize the waste space. Static approach tests all the possible combinations by numeric simulation. The complete list of combinations generated by the second solver in the static approach is therefore replaced by a dynamic list that is updated at each step. The recently created heuristic threshold technique delivers rapid, precise, high-quality results.

For this problem we have also used Mixed integer linear programming (MILP), the model discriminates how many pallets are allocated to each internal warehouse and to external to which, along with a dashboard with a practical approach to outcomes, decreases the overall handling cost by optimally distributing products to places within the warehouses. Also, dashboard is basically use to make a quick and simple result consultation possible .

APPLICATION OF OR IN COST MINIMIZATION

The cost of company logistics must be known to the operations management. The management of a firm must keep costs as low as possible for all operations to be successful. The OR tools used to try to achieve this are Integrated cost and inventory control. Logistics activities are crucial for the efficiency of company operations. Important logistical components include inventory management, warehouse management, and transportation. The operations management is aware of the expense of company logistics. It is highly helpful for managers to see problems since the application of operations research models enables the computation of various expenses.

APPLICATION OF OR IN MINIMIZING TRANSPORTATION COST AND TIME

The main problem here is about how to optimize the inbound and outbound transportation. Higher transport cost, unnecessary waiting time for loading and unloading of trucks are some of the problems that the manufacturers face. The routes that are chosen for shipment should be the cheapest to ensure that minimum cost is incurred. The OR Tools used for solving this problem are: linear programming, queueing theory, greedy algorithm, VRP and simulation. It involves finding the most optimal delivery route from a factory to a warehouse where the road has some capacity and cost associated. The theory focuses on minimizing the waiting time of trucks at the gates and goods at the service points using labour, conveyor belt points, offloading bays, e-points for warehousing. Greedy algorithm solves the problem by choosing the best choice at the time but the solution is suboptimal. VRP aims at choosing the optimal(shortest) route to minimize the delivery time.

Simulation is used in designing, analysing and managing logistics and transport systems to improve vehicle utilisation and material handling systems.

APPLICATION OF OR IN STORAGE ASSIGNMENT

Increased labour costs, non-optimal floor utilization, high chances of theft are the problems that are faced here. With storage and inventory control accounting for more than 40% of logistical expenditures, improving this process can lower overall operating cost and our primary objective of determining the best distribution of items among locations inside the warehouses, an optimization model that utilizes penalties to avoid product decentralisation within the warehouses was presented. Assignment techniques are used to solve such problems. Random Storage Assignment- the "closest open location" rule works here. Turnover-Based Assignment- the one-way journey time is reduced if the closest location is assigned to the pallet with the highest turnover. The Turnover Distribution- ranks all items in an inventory by their contribution to total demand. The "ABC" curve is a plot of ranked cumulative % demand versus % of inventoried items. Class Based Turnover Assignment- the racks and pallets are portioned into classes based on one-way travel times and turnover, based on which the pallets are then assigned to a class of storage randomly.

APPLICATION OF OR IN LOGISTICS

In order to enhance and optimize the flow of information, materials, and value throughout the entire enterprise, logistics solves this problem by specifying the functional, organizational, personnel and material resources. Various different OR tools help tackle logistic problems:

Graph and Network theory: This is used for modelling various transport systems. In the field of mathematical modelling, a graphic representation of the real system is particularly instructive and easy to grasp, even for laypeople. As a result, models of this kind are frequently used. Graph theory techniques are used as diagnostic and optimization tools. For the study of the material and information flows, these techniques are required for an accurate description of the numerous procedures and processes.

Linear programming: Among the methods for solving LP, the special methods for solving distribution problems are mostly used in logistics

Methods that were developed within the theory of LP are at once relatively simple in its mathematical structure and applicable to solve a large number of different tasks.

Inventory theory models: The development of useful models for supply chain management currently is a particularly active area of research. Continued growth is occurring in the computerization of inventory data processing, along with an accompanying growth in scientific inventory management. This model does the following

1. Formulate a mathematical model describing the behaviour of the inventory system.
2. Seek an optimal inventory policy with respect to this model.
3. Use a computerized information processing system to maintain a record of the current inventory levels.
4. Using this record of current inventory levels, apply the optimal inventory policy to signal when and how much to replenish inventory

Value stream map analysis:mapping the value stream allows researchers interested in lean manufacturing to investigate the flow of production materials. Reduce non-value-added linkages and lower inventory costs by using value streams to optimise the architecture of the warehouse operating process. Make logical suggestions to shorten storage operation times and increase storage effectiveness based on value stream analysis.

Integer programming:The pressures placed on supply networks have risen as a result of increasing expenses, decreasing consumer loyalty, shorter product lifespans, and cheaper pricing. It has become clear that retaining competitiveness in an increasingly volatile corporate environment requires cogent, integrated supply chain management. Certain combinations of routing guidelines and locations can be provided using mixed integer programming that result in reduced logistic costs while retaining excellent client service.

IV. Limitations and recommendations

The problems that we faced while writing this paper was the lack of understanding to use OR methods. It was more focused with the theory aspect of proving the subject. Greedy algorithm that is used in solving the problem of transportation focusses on just the current best solution while neglecting the final result.

The research paper does not include any new suggestion regarding the application of operational research in the warehousing and logistics industry.

V. Conclusion

In the process of collecting and researching all the data we have found that every industry aims at maximizing the productivity and minimizing the costs, to achieve both, industries apply various types of operations research tools to a heavy extent.Operations research tools use number of scientific methods to find

the optimal set of solutions to solve the real-life warehousing or logistics problems. In our research paper the main focus is on storage and shipping, with efficient palletizing and optimizing the costs. Storage- one of the most crucial parts of warehousing as it maintains the costs of the product stored and with the help of operations research tools we can save labour costs, high floor utilization improved material flow and inventory control and lower incidence of misplacement or theft. Shipping- industries faces a lot of time lag problems due to lack of proper infrastructure of roads and rails we conclude that tools mentioned above has helped in making warehouse more efficient and effective in areas like storage, shipping, receiving etc. Also, the life cycle of a product is optimized by a perfect warehouse logistics strategy, which cuts costs for the company and quickens client delivery, benefiting both parties.

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