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Application of Crossdocking in FMCG Industries

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Abstract:

Numerous FMCG companies are looking for cost-effective distribution options in order to reduce customer order fulfilment lead times while reducing warehouse expenses and dangers. Crossdocking is a business technique that involves moving things via flow consolidation centers or cross docks rather than storing them. A distribution center is often made up of crossdocking and warehousing areas. The center's operator must be clear about which products, and even how much of each sort of product, should be cross docked. The industry requires a guideline and model to aid in crossdocking/warehousing decision-making and the development of alternative plans for assigning products to crossdocking and warehousing activities. This paper outlines a method and model for evaluating a company's crossdocking distribution. The paper discusses a prototype system based on the method and provides a testing analysis.

Keywords **—cross-docking, inventory management, optimization, operations research, supply chain, logistics, fast-moving consumer goods, transportation problem, Vogel's approximation method.**

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INTRODUCTION

I. Cross docking is a logistics management strategy that entails unloading products from incoming delivery vehicles and loading them straight into outbound delivery vehicles, bypassing standard warehouse logistical practises and saving time and money. This simplified courier service can be beneficial in a variety of scenarios where time and money are limited. Cross docking enables businesses to speed shipments to clients, ensuring that they receive exactly what they want, when they want it.

The Vogel Approximation Method is used to develop a workable solution for goods transportation that is either optimal or close to being optimal. The Vogel's Approximation Method (VAM) is an iterative approach for determining the first feasible solution to a transportation problem. Like the Least Cost Method, the delivery cost is included here as well, but only in a relative sense. This strategy is used to lower transportation costs by interpreting the costs of transportation from one location to another in a mathematical table. The demand centres are represented by the column, while the supply sites are represented by the row.

When it comes to finding workable baseline solutions early on, Vogel's approximation method is a better method than the Least Cost and North West Corner methods. It basically entails allocating as many variables as feasible in the specified row or column with the lowest unit cost, adjusting supply and demand, and eliminating the rows or columns that have already been filled. As such, the transportation problem is a convenient and useful method to solve the problem of warehouses location choices so as to minimise costs and reduce time locked up when goods are in storage and total time taken in the transport chain.

Crossdocking activities shift the focus away from holding inventory and toward managing inventory through-flow as it travels from suppliers to customers. Retailers order products from suppliers, who aggregate orders and transport truckloads of merchandise to the cross dock in the FMCG crossdocking scenario. Workers shift merchandise to trailers intended for specific retailers, resulting in outgoing trucks containing products from multiple vendors for a single store. Because shipments in and out of the cross dock are in truckload numbers, transportation costs may be lower. Warehouses are converted from inventory repositories to delivery, consolidation, and pickup sites as cross docks during this process.

Crossdocking has been implemented by global corporations such as Walmart and UPS. Walmart's crossdocking success necessitates the coordination of 2000 specialised vehicles over a vast network of warehouses, cross docks, and retail locations. Material flow regulation becomes more complicated as a result of crossdocking activities. There might be a lot of transhipment locations and vehicles involved. This is especially true when a large number of vendors are involved in the process. In practise, a mix of cross docking and traditional storage takes place. It means that both traditional storage and crossdocking can exist side by side. Due to the features of FMCG, a model integrating both crossdocking and regular storage operations is very viable and cost effective in FMCG supply chains. However, product distribution plan selection is influenced by a variety of criteria, including product volume, product value, product life cycle, facility space constraints, and so on. Due to the complexities and constraints of crossdocking operations, the industry needs methods for assessing crossdocking application potential. Furthermore, with different cost structures and limited crossdocking and warehousing capacity, creating a plan to distribute products to crossdocking and storage activities is difficult.

LITERATURE REVIEW

"Fast Moving Consumer Goods" companies spend huge amounts of time and money researching how to achieve a competitive advantage over their peers in the same industry. FMCG products are relatively low cost and have low margins. When sold in large quantities, however, the cumulative profit on such products might be considerable. But at the same time companies have acknowledged the necessity of lowering distribution costs while satisfying client demand in order to increase revenue.

Choosing which and how many goods to cross dock can be a difficult decision, especially when considering product popularity, volume, demand volatility, and lift cycle, among other factors. With these difficulties, it's challenging for a cross docking management or operator to make the best selection.

The goal of this study is to determine the optimal methods for allocating items to crossdocking and warehousing operations, as well as to build cross docking product allocation tools to aid logistics managers in their product distribution plans. The question here is how to distribute different items to cross docking and warehousing so that the facility's total operating costs are minimised while demand is met over a period of time.

Cross docking is a logistical method that allows items from many vendors to be combined into a single shipment. Cross docking allows products to be sent in Truck Load rather than Less Than Truck Load. Because the incoming goods will be loaded directly within, cross docking can also reduce or eliminate order picking and storage activities. (Ping Chena, 2006) In cross docking, only receiving and shipping activities take place. In contrast to a typical warehouse, the incoming items in this warehouse will be placed in the storage area and stored. The items will be chosen and sent to the client when the customer order arrives. Furthermore, due to its nature, cross docking is best suited for items with consistent demand and quick turnaround times. Hence, cross docking has multiple advantages when compared to the traditional warehouse. Cross docking minimises transportation and inventory holding costs while also increasing cycle time and customer satisfaction in the distribution network. (Dwi Agustina, 2010)

Crossdocking centric research has usually concentrated on system design, layout design, network design, and operations scheduling. Modelling methodologies and difficulties as they apply to crossdocking systems were examined by Rohrer (Rohrer, 1995) and Viswanathan explained how simulation aids in the design of cross docking systems by identifying the best hardware configuration and software control. (Apte, 2000) They presented a framework for comprehending and constructing crossdocking systems, as well as strategies for improving overall logistics and distribution network efficiencies. (Apte, 2000)

By evaluating the placement of receiving and shipping doors, the ideal shape for a cross dock can be identified. To save money on labour, a simulated annealing process can be employed to create an efficient layout. The impacts of different combinations of number of workers in receiving and shipping on throughput have also been researched, as has the staging of products in a cross dock to reduce floor congestion and boost throughout.

Treating cross docks as a network of distribution and transhipment stations is another major research field for cross-docking. Donaldson et al. investigated a network of cross docks for the United States Postal Service, in which 148 Area Distribution Centres act as cross docks, receiving, sorting, packing, and dispatching mail according to operating schedules. (Donaldson, 1998) When mail is not processed on time, it must be delivered by air, which incurs additional costs and "critical-entry" times, which are the periods when mail must arrive at the destination facility. To avoid exceeding stipulated cut-off times, this must be coordinated with transportation schedules. Every distribution centre acts as both an origin and a destination node, with mail delivery standards dictating times. Ratliff et al. (Dwi Agustina, 2010) looked at a load-driven network, where deliveries happen only when there are enough products waiting to be transported. Crossdocking network scheduling, taking into account delivery and pickup time frames were investigated. (Ping Chena, 2006)

Cross dock-handling expenses, which are used to penalise lateness, were also taken into consideration. In cross docking systems with temporary storage, the scheduling issue of inbound and outbound vehicles was investigated. When a temporary storage buffer to keep products temporarily is provided at the facility, the aim is to establish the best scheduling sequence for both inbound and outbound trucks to minimise total operation time.

To reduce the make span for goods passing through a cross docking facility, a polynomial approximation method and a branch-and-bound algorithm was proposed by researchers Wooyeon Yu and Pius J.Egbelu. (Yu, 2007)

There are presently no systematic techniques and no existing research to develop product allocation plans for crossdocking and warehousing operations at the strategic and tactical levels of planning. Despite the fact that there are several research papers on crossdocking operations, there is limited published research on methodologies for decision making on product allocation planning for crossdocking and warehousing operations, according to the aforementioned evaluations.

Hence, our paper aims to create a model to reduce costs involved in cross docking and warehousing operations using operations research techniques such as transportation problem, assignment problem and linear programming problems.

OBJECTIVE DESCRIPTION

The objectives of this paper are to determine the best methods for allocating items to crossdocking and warehousing operations, as well as to build crossdocking product allocation tools to aid logistics managers in their product distribution plans. The question here is how to distribute different items to crossdocking and warehousing so that the facility's total operating costs are minimised while demand is met over a period of time. We are assuming the following factors for our research.

The model is applied to a distribution centre that does both crossdocking and warehousing, but has limited crossdocking and warehousing capacity.

The factory processes a wide range of items and the items are packed in pallets containing a single product each. A container can hold numerous pallets containing various products, and the expenses of warehousing and crossdocking per unit product are well-known.

The situation in hand can be illustrated in the following way. A retailer M sells 3 products: Product R, Product S and Product T. The demand space required for each product of R, S and T are 150, 300 and 750 respectively. Retailer M's distribution centre has both warehouse and cross dock facilities with limited capacity. The supplied capacities of warehousing and crossdocking are 700 and 300 respectively. Unit product processing costs could be calculated. In this example, we assume that the cost of 1 unit of space through warehouse for products R, S, T are 20, 60 and 100 respectively. The cost of 1 unit of space through cross dock for products R, S, and T are 40, 80 and 100 respectively. The problem for the same can be formulated as follows:

Min Z= 20*Xr(W) + 60*Xs(W) + 100*Xt(W) + 40*Xr (C) + 80*Xs (C) + 100*Xt (C)

Z refers to the minimum cost of distributing problems.

DESIGNING AND DEVELOPING OPTIMAL CROSSDOCKING-WAREHOUSING MODEL

The following methods are used to develop an appropriate crossdocking/warehousing allocation plan with the lowest cost while still satisfying demand for all items based on product operational costs:

To begin, data on product qualities is gathered. Product type, client, destination, time, packing qualities, and historical demand data are all examples. Second, unit product expenses based on inventory, storage, material handling, and product obsolete costs might be determined using product information. If a large-volume item is stored, for example, the cost of warehousing may be significant. Then, using trade-offs between cross-docking and storage costs, facility capacity might be given to items, and a product allocation plan could be created. Finally, the ideal allocation plan's overall cost would be computed.

A. Unit product cost for crossdocking and warehousing operations

A product's suitability for crossdocking can be determined by a variety of factors, including popularity, cubic movement, demand variation and product value, and product life cycle (Li, Sim, Low, & Lim, 2008). The number of times a product appears on consumer orders is referred to as its popularity. If a product is more popular, it will be moved through the facility more frequently and in larger quantities. The total volume of a product that is moved through the facility is referred to as cubic movement. Given a facility's limited capacity, designating a product with a high cubic movement through a cross dock would significantly reduce inventory costs. As a result, crossdocking should be limited to goods with a higher cubic movement. The demand patterns of a product are referred to as demand variation. A product with a consistent demand is more suited for crossdocking since it makes the process more efficient. In addition, inventory risk and cost will be higher for products with higher values and shorter life cycles than for products with lower values and longer product life cycles. Because products with short life cycles become obsolete more quickly, it's critical to get them on the sales floor as soon as feasible. It is appropriate to distribute these products through a cross dock.

The processing cost of a product is related to its suitability for crossdocking. Because a product is well-suited for crossdocking, the relative unit processing cost for this product via crossdocking may be low (Li, Sim, Low, & Lim, 2008). For crossdocking and warehousing, the unit product cost is the sum of the many cost aspects for processing a unit of product, such as inventory, transportation, material handling, storage, and order-lost cost. It could be the entire processing cost divided by the total number of units produced over a given time period. We assume in this work that the average unit crossdocking and storage costs can be estimated and assumed to be known.

B. Cross-docking/Warehousing allocation Decision-making

To create a trade-off model for assigning products to crossdocking/warehousing activities, we employ Vogel's Approximation Method (VAM) and UV techniques. The Vogel Approximation Method (VAM) and the UV Approach are a mixture of two strategies for solving linear programming issues (Winston, 2004). VAM could be used to identify a viable good answer, but it isn't guaranteed to be the best. VAM solves a linear programming problem, therefore the time it takes to run the VAM module does not grow exponentially as additional products and facilities are added, making the optimization process more efficient. The UV Method is used to verify for optimal solution and make any necessary modifications to the solution. In general, the UV Method checks if it is essential to change a fundamental feasible solution (BFS) to reach an optimal solution by using shadow pricing of each cell's cost and space limitations. VAM offers a solution package that enables a product to utilise both facilities. The UV technique is used to verify for and iterate to optimality once the algorithm finds a BFS using the VAM.

C. Modelling and Solution using VAM in Excel

We are using Vogel's Approximation Method (VAM) in order to achieve our objective of minimising costs while transporting goods to the retailers. We are using Microsoft Excel for the same.

VAM calculates a penalty when it is unable to assign space to the remaining cells in a row or column with the lowest cost, and instead chooses the cell with the second lowest cost. The essential concept is to calculate the opportunity cost of each alternative assignment. The opportunity cost of a product is the difference between the highest and lowest facility costs. This entails assigning space to the product with the greatest impact (opportunity cost) on the total cost, as well as allocating space to the cell with the lowest.

D. Modelling and Solution by UV Method

After utilising VAM to find a BFS, it's critical to verify if the BFS is optimum. If the BFS is found to be less than ideal, it is necessary to make adjustments to the allocation solution. UV Technique is used to verify and adjust the BFS in order to achieve the best possible result. The UV Method works by checking for the best solution using the changeable cost attribute.

CONCLUSIONS

Due to the features of FMCG distribution, a model integrating both crossdocking and regular warehouse operations is very practical and cost effective. However, deciding which distribution tactics to use for the products is influenced by a variety of circumstances. We examined existing research and applications on crossdocking planning and operations in this work, and provided a method and solution for allocating items to crossdocking and warehousing activities as efficiently as possible. The optimization model considers the objective of determining the lowest cost of distribution for the items. As a consequence, a high-level plan has been created, with most of the same product categories being assigned to crossdocking or warehousing separately. At the operational level, the timing of items entering and departing should also be considered when allocating products to crossdocking and storage.

Actual product costs depending on the suitability for crossdocking would be included in future

development. Several cost elements would be examined, including material handling costs, inventory costs, and storage costs, among others. More study would be done in the area of product mixing and matching for loading into trucks and containers.
The scheduling of operations for a crossdocking and warehousing scenario will also be explored.

LIMITATIONS

Logistic service providers capable of offering crossdocking services are not as widely available and there is a huge scope for development in the IT to make the management of crossdocking operations more convenient. Nevertheless, formal standards on product allocation planning for crossdocking/warehousing operations are still lacking.

Furthermore, a complex problem involving the selection and allocation of warehouses to facilitate cheaper transportation chains includes several variables such as product volume, product value, product life cycle, facility space constraints, and others that are difficult to factor into a transportation problem. This further complicates the situation and reduces the chances of finding a feasible solution.

RECOMMENDATIONS

We used the VAM method in order to ascertain the minimum cost for cross docking. However, our scope was limited to the FMCG sector, thus if there are any future researches on the said topic, it could be well focused on other allied sectors. As it is a very less known method, we had little to no accurately available data, due to which we took an example of our own. However, had it been available, it would have helped us get a better insight into the ever-developing model of transportation.

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The purposeof carrying out this research was to apply our knowledge in the field of Operations Research and obtain a result that can be applied in practice world to save costs and resources by companies. In today's world with cutting edge competition, even a penny saved makes a lot of difference of companies to fuel their growth. Applying this model can help companies with achieving their goals.
We would like to extend our gratitude to our dean Ms. Sangeeta Kher and our professor Ms. Richa Saxena for guiding us through the course of our research and the International Journal of Scientific Research and Engineering Developmentfor helping us publish our report.To see the list of contributors, please refer to the top of the file.

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