Analyze and Design an Efficient Logistics System: A Case Study of Mid-Size FMCG Company in India

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Abstract:
In today’s fast paced business environment, superior logistics performance is a prerequisite to become and stay competitive. An effective logistics system contributes immensely to the achievements of the business and marketing objectives of a firm. Thus any effort to optimize the logistics makes the supply chain more efficient and responsive. The challenges for midsize FMCG Company are immense, due to availability of limited resources which are to be used to cater to the intense distribution network. The challenge for management is to recommend an optimal network configuration that will allow for longer term optimal results despite of environmental turbulences. The logistics cost ranges between 10% - 30% of sales of FMCG companies in India. Designing a system to reduce this cost gives an edge to the company in this competitive scenario. This paper analyses the cost of distributing freight by truck from a supplier to many customers and suggests measures to bring down the outbound logistics cost by improving truck utilization to cater to demand of PAN India. The research is based on a case study of midsize FMCG Company located in Gujarat. A linear programming model is proposed for improving truck utilization for an efficient logistics system that improves order fulfillment and customer demand responsiveness.

Key-words: Mid-Size Company, Outbound Logistics, Cost reduction, LP model, Truck Utilization

1. Introduction:
Logistics, as defined by the Council of Supply Chain Management Professionals (CSCMP), is the process of planning, implementing, and controlling procedures for the efficient and effective transportation and storage of goods and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements. Logistics gained importance during the World War II in army operations covering the movement of food, medicines, men & equipment across the border. Today it has acquired a more so broader meaning and is used in the business for the movement of material from suppliers to the manufacturer and finally the finished goods to the consumers. With businesses becoming more customers centric, an efficient logistics system can give an edge to companies to stay ahead of the competition while remaining cost efficient.

Transportation cost represents approximately 40 to 50 percent of total logistic costs and 4 to 10 percent of the product selling price for many companies. (G.Santosh Kumar & P.Shirisha, 2014). Therefore, transportation decisions directly affect the total logistic costs. Transportation being an important component of supply chain competitiveness has also been a major focus area for this study. This paper aims to analyze some inherent inefficiency in the logistics system of firms by taking a live case study of a Mid-Size FMCG company based in Gujarat. This company is a manufacturer and distributor of mechanical cleaning products for residential and industrial use. In the past few months, the company
has been facing issue of increasing Freight/Net sales percentage. This research work studies in detail the transportation model used in the firm and contracts with their transporters. Past data was analyzed to identify the potential areas where we can cut down costs by optimizing their transportation model. Keeping in mind the limited resources and constraints of the firm to service customers spread across geographies, model is proposed to improve truck utilization. This report also mentions the key areas where the company can focus in future to save costs.

This paper is divided into four sections. First, a literature review summarizes the published research on logistics efficiency and related areas. Second section explains the methodology used to analyze the data and draw the findings. The third section presents the results and conclusion / recommendations of the study, along with managerial implications and also points out the research to be done in consequent phases

2. Literature Review:

The logistics performance of companies and the impact it has on supply chain efficiency and responsiveness has captured the attention of scholars worldwide and the research on the topic has proliferated. Michael Tracey, (1998), says that firms that do not develop and optimize their logistics efficiency will find themselves competitively handicapped. He argues that logistics strategy should not be considered as a supplement to manufacturing strategy but it must be regarded as an important component of overall business strategy. Though most of the firms hold the belief that logistics provides a competitive advantage but very few empirical studies have been done to establish how it creates value for the customer (Novack, Rinehart & Langley, 1994). Taking out cost of the logistics network and simultaneously maintaining or improving agreed levels of service is examined by (John Gattorna, 1992). He argues that firms that look at aspects of quality vis-à-vis logistics and follow an optimization model, have acquired means to ascertain strategic and tactical shifts in the direction of improved logistics performance.

Increasing competitiveness by reducing freight costs is a prime area of concern for developed and developing countries alike. (Schwartz et al. 2009). In Indian context, with vast geographical reach and higher industrial output, logistics efficiency is even a bigger challenge. Poor road infrastructure combined with the volatility in the oil price which is the key driver of transport cost indicate that logistics cost is a strategic resource which requires immediate attention. However, the review of literature points out the gap in research in this area especially in the context of small and mid-size FMCG companies. Logistics costs can be broken down into three direct elements, namely transport, storage and handling costs. (Jan Havenga Zane Simpson, 2014). These three elements have been further explored in the extant literature which suggests measures to bring down the costs associated with it.

One of the constructs to improve logistics efficiency is to look at truck utilization. (Joris van de Klundert, Bernhard Otten, 2011) explore different models to improve the Less than Truckload (LTL) utilization. The argue that the motive is to increase the vehicle utilization of already scheduled road transportation activities which not just benefits the freight sender by reducing costs but also reduces congestion and pollution for the society at large. Given the pressure on supply chains to have green supply chains, companies can reduce their carbon footprints by reducing vehicular traffic (Jaya Banik, Kyle Rinehart, 2006). They explore the opportunities of improving truck utilisation by mixing SKU’s that belong to different density categories. They propose an algorithm which can be used to better mix SKU’s to fill trucks to the maximum possible extent. The bin packing problem is an important tool in operation research area which finds its application in logistics decision making. Bin packing problem helps to load the freight by loading a finite number of items with least no of bins (Liu, Tan, Huang, Goh, Ho, 2007). This problem can be extended to our case of improving truck utilisation with constraints like floor space, weight capacity of vehicles.

Another construct explored to cut down logistics cost is vehicle routing. Viswanathan and Mathur (1997) considered vehicle routing problems when designing a logistic system. C. Sateesh, Pradip K. Ray, (1992) says that in recent times when the transportation cost has become a major expense for firms due to escalating fuel prices and higher capital costs for the replacing vehicles, vehicle routing becomes increasingly important. Vehicle Routing Problem not only saves cost but also helps serve the customers in shorter time, thus enabling better customer relationships. (P. Toth, D. Vigo, 2002). Most research on vehicle routing problems focuses on decreasing the transportation time and increasing cost efficiency; that is, to search for the best routing, scheduling or loading which will meet customer demand and give the organization the maximum profit. (Tzong-Ru Lee, Ji-Hwa Ueng, 1999). Different variations of vehicle routing problems arise because of different scenarios and case objectives. In some cases, VRP may aim to minimize the total distance travelled whereas in other it might be driven to balance load. Applying shortest path theory in vehicle routing problems to minimize distance travelled was proposed by Lee et al. (1998) and Lee and Ueng (1998).
An integer programming model to determine optimal vehicle size and the best distribution center was used by Lee (1997). According to Bramel & Simchi-Levi, the deterministic vehicle routing problems (DVRP) can be classified into different groups, depending on the customer demands and time window constraints. Given customer demands and corresponding geographical attributes, the typical DVRP algorithms intend to find a set of routes with minimal routing costs and penalties so as to satisfy the given customer demands subject to corresponding resource constraints. José Brandão (2011) presented a Tabu search algorithm for the heterogeneous fixed fleet (HFF) VRP. Jiuh-Biing Sheu (2007) presented a hybrid fuzzy-optimization approach to customer grouping-based logistics distribution operations. Tung-Lai Hu & Jiuh-Biing Sheu (2003) presented a fuzzy-based customer classification method for demand-responsive logistical distribution operations. They presented an approach that can be employed to cluster customers before executing fleet routing in logistical operations. Thus, Literature gave the idea of conducting study into two parts first clustering and then routing.

Opening new distribution centre or depots at the right location can help achieve order aggregation, thus reducing logistics cost. During the process of strategic planning in performing these operations, as mentioned earlier, one of the fundamental issues for these logistics companies is the selection of the location for distribution centres. This construct was explored and methodology in previous research was examined that helps locate the new facility. Vinh Van Thai Devinder Grewal, (2005), gives a conceptual framework to locate the distribution centre for better logistics performance. This framework is a three stage methodology to be adopted to reach the final result. At the first stage, a general geographical area for distribution centre is identified based on the Centre of Gravity principle, taking into consideration socio-economic factors. The second stage of the selection process involves the identification of alternative locations for the distribution centre and the air ports and sea ports to be used for in-bound and out-bound cargo flows within the defined general geographical area. The third stage focuses on specific site selection among the identified alternative locations for the DC based on the quantitative approach. Analytical Hierarchical Process is also one of the commonly used techniques for location allocation problems. Jiaqin Yang, Huei Lee, (1997) propose an analytical decision model for facility location selection from the view of organisations that are contemplating locations of new facility. This model analyses various location factors, locating site alternatives and then making final location selections. Location factors have been also addressed based on the uniqueness of industry type, facility type, and product life-cycle stage (HBS, 1989).

Based on the literature review, there is a lack in academic research in challenges faced by mid-size FMCG companies when it comes to increased logistics expenditure. Also missing is the research in the area of practical guidelines that can be adopted by mid-size companies to improve their logistics performance with reduced costs, especially in the Indian sub context. The focus of our research is then to understand and analyze the reasons or issues faced by such companies which leads to higher logistics cost. We aim to do so by analyzing the case of an FMCG company based in Gujarat. We then propose a framework that can be employed by mid-size FMCG’s to improve their logistics performance. This is detailed in the following sections where tools and techniques explored in the extant literature are then used to suggest measures to overcome the challenges and improve logistics and distribution efficiency.

**The company under consideration**

A company under study is a leading supplier of cleaning products in India. Products for daily domestic use and for the professional cleaning sector are produced and marketed by them. The identity of the company is not revealed for maintaining confidentiality.

**3. Data collection & Methodology adopted**

The research paper required identifying the problem areas and finding out a realistic & practical solution. Hence, the methodology adopted was as follows:

1. The data was collected through interviews with company representatives and the technical documents / data of the company. The data from period Jan 2014- April 2014 was analysed to present the findings and draw results. The current transportation practices followed by company were studied to understand the supply chain system.

2. Literature was reviewed to understand the developments in logistics efficiency and related areas. Based on the literature and own expertise, all possible practical solutions were analysed. Optimum solution is suggested which is viable and within the resource constraints.
3.1 Analysis & Problem identification

In the recent past, it had been observed by the company that the company’s Freight / Net sales percentage has been increasing. It was required to identify the reasons for increased freight cost and provide viable and practical suggestions.

Figure 1 indicates the entire logistics system of the company. The company has its own manufacturing unit in Gujarat, which manufactures around 20 % of products. It has one ‘Dispatch center’ in Gujarat, to cater to the needs of North & East region. It outsources the remaining 80 % products from third party units in Maharashtra; hence it has set up a second ‘Dispatch center’ in Maharashtra, to cater to the needs of South & West region. The company ships to any region from decided dispatch centers with the use of third party transporters, who are appointed through contracts. It caters to three main types of customers, namely:

1. Modern Trade (Super-market retail chains)
2. General Trade (Super stockiest and distributors)
3. Professional Party (B2B customers)

The said customers place an order with the company as per their market needs. The orders received from any regions are shipped from respective dispatch centers by third party transporters. To fulfill the demands of various customers from any region, the movement of products from one dispatch center to other for its compiled forward shipment is also required.

The analysis of the past company data indicates that the Freight Out domestic component i.e. total freight incurred in dispatching products from two dispatch centres to Pan India distributors has increased largely. Thus, the primary focus of the study will be to identify the root causes for this increase.

The data for Freight out percentage was collected for each of the customers of the firm. The customers having Freight out domestic percentage more than 3% (which is more than average) were identified. When the reason for higher percentage was investigated, it was found that maximum shipments for these customers were less than truckload (LTL). But it was also observed that for some customers even though shipments were full-truckload (FTL), the freight out percentage was higher. This revealed the problem of poor truck utilization. For e.g. a major customer in Bangalore which was replenished 83 times in a year all through FTL shipments also fell into this category indicating towards an issue of low truck utilization.

It is inferred that the company was facing the problem of freight increase in primary transportation. Thus, there was a need to minimize the LTL shipments as well as increase the truck utilization by optimal product mix.

3.2 Discussion & Results

The analysis of the current practices had provided an insight into current logistics system & it also identified & cited reasons for the problem. It indicated that, the problem of increasing the efficiency of truck utilization in primary transportation should be the key focus area.

Literature review provided the understanding of the developments in logistics efficiency and related areas. A paper published by Jaya Banik & Kyle Rinehart (2006), had developed a model to improve the truck utilization. The said model was adopted to increase the truck utilization for improving logistics efficiency. Past data was analyzed to identify the potential areas where we can cut down costs by optimizing their transportation model. Keeping in mind the limited resources and constraints of the firm to service customers spread across geographies, model was used to improve truck utilization.
3.3 Linear Programming Model

There are several constraints when deciding the product mix that has to be shipped in one truck load. These are the constraints of weight, volume and floor space. For e.g. in a 24 feet truck used by the firm in consideration has a weight carrying capacity of 7 tons and the volume capacity of 1536. Similarly a 32 feet truck can carry 7 tons of weight with 2048 cubic feet volume capacity. Weight and volume capacities for different trucks are shown in Table 1.

<table>
<thead>
<tr>
<th>Truck Size</th>
<th>Weight Capacity (Kgs)</th>
<th>Volume Capacity (Cubic Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Feet</td>
<td>7000</td>
<td>1280</td>
</tr>
<tr>
<td>22 Feet</td>
<td>7000</td>
<td>1408</td>
</tr>
<tr>
<td>24 Feet</td>
<td>7000</td>
<td>1536</td>
</tr>
<tr>
<td>32 Feet</td>
<td>7000</td>
<td>2048</td>
</tr>
</tbody>
</table>

*As maximum products for FMCG under study were voluminous, so all the trucks used for transportation were single axle (7 tonners) irrespective of the size of the truck.

We could expect lower weight utilization for products that are more voluminous and take up more floor space. A linear programming model is one of the effective tools than can improve truck utilization w.r.t weight, floor space and volume while simultaneously working with various variables and constraints.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Truck capacity (feet)</th>
<th>Cube Utilization (%)</th>
<th>Weight utilization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>81%</td>
<td>79%</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>97%</td>
<td>110%</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>83%</td>
<td>89%</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>96%</td>
<td>33%</td>
</tr>
<tr>
<td>5</td>
<td>24</td>
<td>58%</td>
<td>55%</td>
</tr>
<tr>
<td>6</td>
<td>24</td>
<td>73%</td>
<td>67%</td>
</tr>
<tr>
<td>7</td>
<td>24</td>
<td>83%</td>
<td>96%</td>
</tr>
<tr>
<td>8</td>
<td>24</td>
<td>46%</td>
<td>41%</td>
</tr>
<tr>
<td>9</td>
<td>24</td>
<td>88%</td>
<td>85%</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
<td>70%</td>
<td>65%</td>
</tr>
<tr>
<td>11</td>
<td>24</td>
<td>19%</td>
<td>19%</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
<td>81%</td>
<td>65%</td>
</tr>
<tr>
<td>13</td>
<td>22</td>
<td>91%</td>
<td>81%</td>
</tr>
<tr>
<td>14</td>
<td>22</td>
<td>66%</td>
<td>49%</td>
</tr>
<tr>
<td>15</td>
<td>22</td>
<td>85%</td>
<td>66%</td>
</tr>
<tr>
<td>16</td>
<td>22</td>
<td>86%</td>
<td>66%</td>
</tr>
<tr>
<td>17</td>
<td>22</td>
<td>75%</td>
<td>67%</td>
</tr>
<tr>
<td>18</td>
<td>22</td>
<td>76%</td>
<td>52%</td>
</tr>
<tr>
<td>19</td>
<td>22</td>
<td>40%</td>
<td>36%</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>59%</td>
<td>52%</td>
</tr>
<tr>
<td>21</td>
<td>20</td>
<td>55%</td>
<td>42%</td>
</tr>
</tbody>
</table>

To highlight the savings of this process, we chose a customer that had maximum shipments in the past. In first four months of 2014, maximum shipments (a total of 21) were sent to a customer in Bangalore. Also, because of the large business from Bangalore customers; altering the product mix in a shipment will be lot easier to improve truck
utilization. So, first we analysed the past shipment data of this customer in Bangalore for its cube and weight utilization.

We can note from Table 2 that the trucks were utilized only 70% of truck w.r.t. cube and 60% of truck w.r.t. weight. This indicates a lower weight utilization as could be expected with the product offering of the FMCG firm that are more voluminous but lighter in weight. Next, we designed a linear programming model which can help us estimate the scope of improvement and interpret the least possible trucks required for shipping the same amount of SKUs in same duration but by changing product mix. We first define the decision variables, objective function and constraints.

**Linear Programming Model:**

*Objective function:* To maximize the weight of each truck in progressive sequence. More weightage is assigned to first shipments and linearly decreasing weights to the consequent shipments.

$$21(\sum \text{Truck 21 } \times \text{weight}) + 20(\sum \text{Truck 20 } \times \text{weight}) + 19(\sum \text{Truck 19 } \times \text{weight}) + \ldots \ldots + 2(\sum \text{Truck 2 } \times \text{weight}) + 1(\sum \text{Truck 1 } \times \text{weight})$$

Note: $X_i$ are SKU decision variables and $X_i$ is binary with 1 representing that a SKU has been selected for a shipment, or 0 representing that that SKU has not been selected for a shipment.

*Constraints:*

- Weight of each shipment: $\sum W_i \times X_i \leq 7000$ kgs (As all capacity trucks used were 7 tonner only)
- Volume of each shipment: $\sum \text{Cube}_i \times X_i \leq 1280,1408,1536,2048$ CFT (depending upon truck size 20,22,24,32 feet)
- Each SKU is allocated to only one shipment: $\sum X_j = 1$

Note: $j$ is the number of shipments (twenty one in this example)

Here the objective function maximizes the weight shipped as the products are more volume heavy. But in this model, the objective function can be to maximize volume and floor space as well, depending upon the product physical characteristics.

### 3.4 Findings of the model:

The model which was used has taken all possible constraints which can affect the transportation cost. The implementation was initiated only for one destination from a distribution center. Inspite, it has indicated that the company can save 19% on transportation cost. This is a substantial saving on transportation cost for a mid-size company. The original no of shipping assignments were 21. Using above model it was found that same amount could have been shipped using 17 trucks i.e. a savings of 4 trucks. This is 19% in terms of associated revenue for a single destination (Bangalore) in a four months period.

After recognizing the potential of improvement in truck utilization, we have suggested ways to improve product mix. An algorithm for SKU mixing is detailed below.

### 3.5 Algorithm for SKU Mixing:

The linear programming model gave us the findings that it is feasible to decrease the frequency of trucks. However, the products of the company are having multiple SKUs with varying size & density of units. The linear programming model does not give any indication of how should be the breakup of various SKUs for different capacity of truck. Based on the data analysis for truck utilization for different customers, it is evident that most shipments are not optimally mixed. If a shipment carries more volume-heavy products, it may reach cube-fill but may be very inefficient on weight fill. So to overcome this problem of poor truck fill, we developed an algorithm that will help the company to decide SKU mix to achieve better truck utilization.

A detailed analysis of the company data was done about the various products’ volume and density. The products were categorized into three categories.

1. Cube constrained (1.11 to 4.0 Kg/CFT)
2. Neutral (4 to 5 kg/CFT)
3. Weight Constrained (Above 5 Kg/CFT)
Based on the above analysis, to achieve the optimum capacity in terms of cubic fill & weight fill, the mixing of SKUs in terms of percentage were suggested as given in Table 3.

<table>
<thead>
<tr>
<th>Category</th>
<th>% of Truck Volume (24 Feet truck)</th>
<th>% of Truck Volume (32 Feet truck)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cube</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>Neutral</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Weight</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Table 3: Categorization of SKU’s

Based on the findings, we suggest a basic algorithm for mixing SKU’s to form a truck-load with better utilization. It is understandable, that the cube-constrained SKU’s need to be mixed with weight constrained SKU’s in order to balance high weight utilization with low cube utilization. The SKU’s falling in the neutral category need to be mixed with each other to achieve the ideal truck utilization.

3.6 Limitations of the model

Though the first model and algorithm promise improved truck utilization, but for every order to mix products in a given ratio is not practically possible for a single customer. Although this can be achieved if some orders for multiple customers are combined on a route where suggested algorithm will be useful.

4. Conclusions

This study reveals the inherent problem of low truck utilization in the FMCG companies dealing with voluminous products. Therefore the model proposed in the analysis can help companies choose floor position, cube capacity or weight capacity as their optimization criteria. In order to implement this, person at the operational level should be trained in the usage of this tool. Companies can also look for opportunities arising from mixing SKUs in different density categories to improve vehicle utilization. For further improving the utilization, they should look for ordering pattern of their high volume customers. They can also combine the customers (ordering majorly from different categories) on the same route to effectively utilize a truck.

5. References