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Logistics Network Optimization in Distributing Critical Medical Supplies for a Pharmaceutical Company

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Abstract*: Operation cost plays an important role in most business as they strategize to minimize it to achieve maximum profit margin. The pace of contemporary shipping methods might eliminate complex distribution network design, which will strive hard for better service level to customers and value-added deliveries. However, with the constant cost pressure from the peers and with the increasing fuel and real estate cost, it is now a prime focus for any organization to reduce the warehousing cost with facilities consolidations and logistics network optimizations. Designing distribution network and locating a warehouse, is a substantial decision in managing an organization supply chain that influences every aspects of a business finding a balance between a convenient location and at a reasonable price. An optimum Distribution Centre location will directly contribute to the efficiency of the organization's profit as well as to the overall customer experiences. Keeping this as a prime objective now organizations are looking for an optimum Distribution Centre location for consolidating and expanding their logistics network. At this backdrop, this paper is being initiated to analyze and simulate data analytics models for identifying optimum number of Distribution center required for a Pharmaceutical company to cater its customers PAN India within a customer reach of 72hours (3days).The paper will be of great importance to decision makers in the manufacturing and service industry, as they will use strategic factors in determining Distribution Centre location, Warehouse numbers and logistics network design decisions in meeting target customers and corporate profitability.

Keywords*: Distribution Centre, Warehouse, Warehouse location, Logistics network design, Optimization, Logistics Network Optimization, Warehouse Consolidation, Data modelling.

I. INTRODUCTION

With the rise in foreign trade, increase in FDI in manufacturing and Real Estate sectors and emergence of organized retail, India is gearing up to witness high growth rates in its GDP (Source: IBEF, 2018). It would require sizable investments in Infrastructure, logistics space and policy support, so that the economic activities are accelerated and growth rates can be sustained. India spends about 13% of its GDP in logistics costs, which is higher than world average of about 11%. Compared to the development of logistics and supply chain in the developed countries, India's logistics and supply chain development has far more to achieve to reach the global standards (Source: CII, Institute of Logistics). Therefore, logistics as a sector is expected to grow at a very high rate in India. A major factor that gives boost to the demand for logistics growth is change in sales taxes and introduction of GST, which has already paved way for efficient supply chain management, and government investment in nationwide infrastructure development to facilitate increased logistics development. Key reasons cited by companies for outsourcing logistics are cost-reduction in logistics activity, focus on core competencies and therefore higher return on assets, increased customer services and efficient inventory management. Warehousing is an integral part of logistics and provides an essential ancillary service to the domestics and foreign trade, manufacturing and retail sectors. It also plays a very pivotal role in linking the entire Supply chain management. Thus, one can expect the warehousing industry to grow at a very high rate over the next three to five years. With the ongoing fierce competition, there is a compelling requirement for organization to locate and operate warehouse operations at a low cost. The ultimate objective of an organization is to be able to deliver the product / service that the customers want, whenever and wherever they want it at optimized cost. Only an efficient warehouse or distribution center can fulfil this objective. A distribution chain consists of interconnected components required to transform ideas into delivered products and services, i.e., Design to Delivery. The most important questions to be answered is at what cost?

II. LITERATURE REVIEW

The basic and foremost flows in Supply chain is achieved through Distribution management and are seen as an opportunity to improve operation optimization and information flows, to reduce inventory levels, to improve service levels to customers and to enable more agile distribution (Vrijhoef et Koselka, 2000). The focal purpose of a Distribution Centre is to provide a set of services that enables a smooth running of the other operating functions in any organization as raw materials, finished goods and spares needed in other section are holding in stock (Rita Makumbi, 2013). Identifying the location of a Distribution Centre, Logistics park or a Warehouse is a classic day to day logistics challenges that has been extensively covered in the logistics and operations research literature (Baumol and Wolfe, 1958; Ballou, 1968; Kaufman, Vanden and Hansen, 1977).

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In current logistics atmosphere, the focus may have shifted towards identifying the role of storage facility, such as a warehouse or distribution center in supporting the overall business strategy of a firm with a prime aspect to optimize the storage and distribution costs.(Yang and Lee, 1997).

The specific areas covered are overview of Distribution Centre location factor, challenges of warehouse location in logistics network design, Distribution Centre design and emerging issues related to data analytics and modelling.

III. PROBLEM DESCRIPTION

The stated company in this paper is located in the Indian state of Kerala and having around 19 Distribution centers spread across various geography in India. These 19 Distribution centers are increasing their operating cost and killing their profit margins. Their main constrain is serving their customer base within an agreed service level of 72hours. With the introduction of GST-Goods and Services Tax in 2017, there has been a complete revamping of taxation structures in India, which has enabled smooth -transactions of goods and services across the country. Apart from the tax structure, the main element that has seen a massive reform is on the Warehouse and Distribution network of any organization. GST paves way for consolidating warehouses in each state and designing an optimal number of warehouse or distribution center, which now serves a greater number of customer points or nodes in the distribution network design. Now comes a challenge for organization in locating a warehouse with bigger space at an optimum cost.

IV. RESEARCH OBJECTIVES

a) The study is to find out the optimum number of warehouses for the distribution of pharmaceutical products and reduce the current number of warehouses using Data analytics and modelling.

b) Determine the number of Distribution Centers with a set constrain to meet the service level for meeting the customer demand in 72 hours (3days) within the reach from the Warehouse/Distribution Centre.

V. DISTRIBUTION CENTRE LOCATION FACTORS

There are various factors needs to be considered while locating a warehouse geography. Some of them are availability of labour, proximity to customers, number of potential customers in the region, land cost, availability of modes and quality of transportations, time to serve etc. Thus, here the study focuses on the combination of qualitative and quantitative factors (Ada and Ozkan, 2005)

With the emergence of e-commerce industry, terminology like ‘Next day delivery’, ‘Same day delivery’ etc. have become very common. This has triggered the customer’s expectation for the product in a very short span of time.

Thus, organizations are gearing up to locate their warehouse or distribution center in a place, which can cater customer expectations in reaching larger numbers of audiences.

VI. RESEARCH METHODOLOGY

This paper is initiated to project the Pharmaceutical Company in Kerala (name of the company is not disclosed for maintaining Data Confidentiality) in locating an optimum number of warehouses required to meet their present customer service level, which is 72 hours. There are currently 19 warehouses located PAN India, which is catering to various customer locations. A Center of Gravity (COG) Analysis is considered in the study that generates a geographic point or points that:

- Considers the relative size (measured by weight, volume, or quantity of product) of each supply or demand point
- Minimizes the distance travelled to reach all the points in a supply or demand network to produce a point of equilibrium.

The time span considered for the study was 90days focusing on data gathering and modelling.

A. Area of the Study

The study area has been confined to the geography regions of Indian state (excluding Andaman and Nicobar Islands and Lakshadweep Islands). This would give a valid result for having a warehouse or distribution center compared in terms of time to serve.

B. Sources of Data

The study has mainly used secondary data, which has been directly collected from the mentioned organization. Data validation and fine-tuning is done through telephonic interview schedule method with the key stakeholders and decision makers in the warehousing industry. The study has also used Industry conferences and round table for data collection purposes.

C. Sampling Design and Tools for Analysis

For the purpose of the analysis and building data models, 1year shipment data was collected from the organization involving a data period of January,2018 to December,2018 with 82,457 records.

a) Data Cleansing is done on the collected Raw data to design the data in the required method to input into the data model.

b) Shipment level data is built by annualizing the demand going towards each destination nodes or cities

c) Basic data analysis is analyzed to view the baseline logistics network diagram, weight scattered across the network, concentration of customer points to be served etc.

d) Centre of Gravity method is used to determine the pin location for new placing the warehouse or distribution centre.

- Centre of Gravity method takes the input of the annualized demand for each of the destination city or nodes
- The output of the Centre of Gravity method will be in the form of Weighted distance of the Origin and Destination city distance with respect to the weight in that flow.
- Formula for calculating Centre of Gravity is given below reference;

$$COG = \frac{X_1W_1 + X_2W_2 + X_3W_3 + \ldots\ldots X_nW_n}{W_1 + W_2 + W_3}$$

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Where, COG – Centre Of Gravity
X1,2,3,n – Location 1,2,3,…n
W1,2,3,n – Weight 1,2,3,…n

- The allocation of Warehouse/ Distribution center to customers are purely based on the minimum distance between each nodes (Distribution centre and the Destination city)

VII. ANALYSIS AND FINDINGS

The prime focal of the project is to identify the number of Warehouse/Distribution center to cater the company's customer within the reach of 72hours (3Days). To meet the objective different Centre Of Gravity methods were simulated and data modelling is done to determine the customer reach and tabulated below;

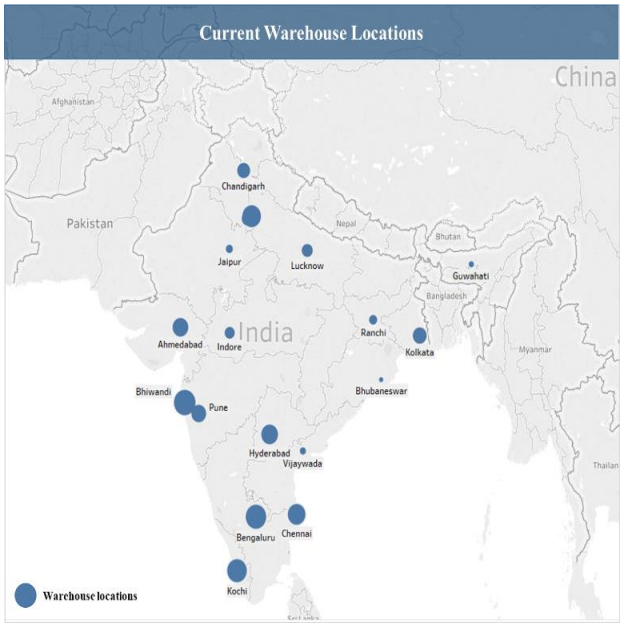

Fig. 1. Current Warehouse Locations

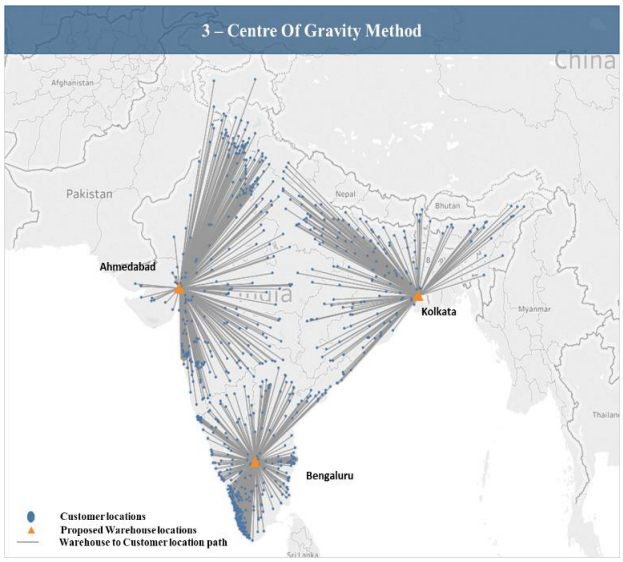

Fig. 2. Output_3 Centers of Gravity

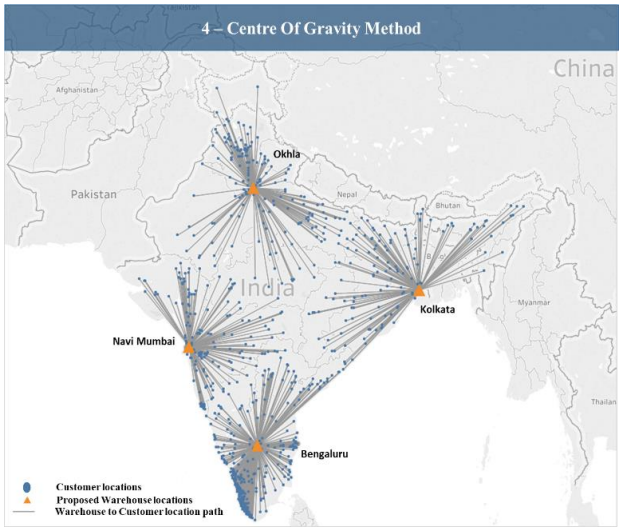

Fig. 3.Output_4 Centers of Gravity

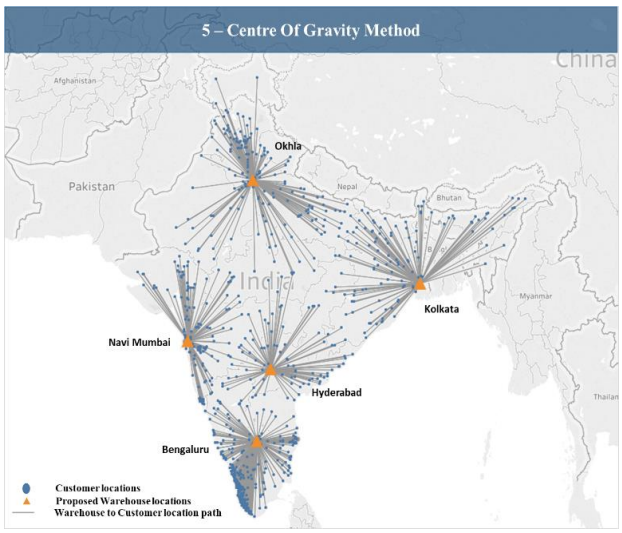

Fig. 4.Output_5 Centers of Gravity

Tableau - Data visualization tool is used for mapping the Distribution Centre and Customer location by creating an ID for each nodes and path between Distribution Centre to Customer locations. A Dual axis map is superimposed on each other to obtain the spider map for data visualization purposes, which is shown as above.

VIII. CONCLUSION

The major outcome of this study project is to identify the Distribution Centre locations within the reach of 72 hours (3Days). For this purpose different Centre of Gravity methods are simulated to obtain the desired result. Though some of the customer locations are in the terrain region and difficult to reach geography, it is not 100% reachable within the said 72hours. For this purpose an agreed SLA-Service Level Agreement of 98% is made with the company, which is also taken into consideration for this study.

Thus the above line chart depicts the Customer Reach Comparisons between different Centre of Gravity method and it is conclusive that in 5 COG – Centre Of Gravity method the maximum of 99% of Customers reach is obtained within 3 days.

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Thus this paper is giving a fair idea of Data analytics and how it is helping the Supply Chain Industry in determining different modelling and analysis. The result will be tabled to the Pharmaceutical company for further customization and fine tunings. (Assumption: 320Km as per day Driving Distance in India)

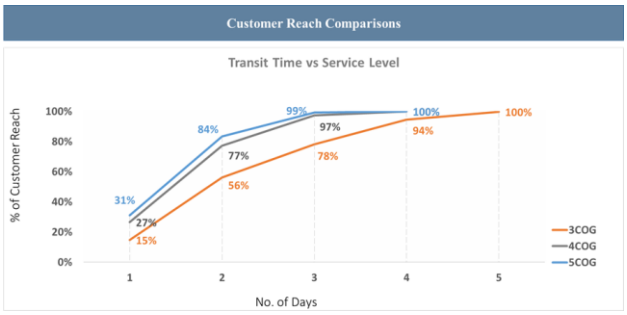

Fig. 5. Transit Time/ Customer Reach Comparisons

DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Authors Contributions:** The authorship of this article is attributed equally to all participating authors.

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Arivalagan R is an Electronics & Communication Engineer and holds Masters in Business Administration. He has an overall experience of around 11years in the field of Supply Chain and Logistics Management. After graduation, he has started his career as a Procurement Engineer in China-Shenzhen for 4years where he has gained knowledge on Global Sourcing, Logistics, and Export-Imports. Later he has joined Accenture Services ltd as a Business Advisor in Global procurement. Later he joined CII-Confederation of Indian Industry as a Supply Chain Consultant. He has designed Supply Chain Maturity Model for assessing Indian Industries and audited more than 85 warehouses across India. His core strength includes Warehouse optimization and designs, Network Optimization, Inventory Optimization etc.

Dr. Anand V.A is an Assistant Professor in Alagappa University, Karaikudi in Department of Logistics Management. He comes with an industry experience of more than 4 years working for a major IT organization in India and supporting various project both in India and abroad. He is a veteran in Systems and Entrepreneurship management. With that as a background, he has joined Alagappa University, Karaikudi in 2016 and passing on his knowledge and experience by teaching Logistics to various students. Dr Anand is having more than 9 years of teaching experience. He is also mentoring and providing guide ship to various part time Ph.D. scholars and helping them in their research activity. His core strength includes Network Optimization, Designing Warehouse and Logistics parks etc.