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Location in terms of Logistics

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Abstract: Today's highly dynamic environment of market is leading enterprises to cost reduction in all operations empowered by effective automation. One of these operations is logistic management. Existing methods do not meet the needs of the multi-product enterprise and that there is a need for a new generation of logistic system that are more efficient and cost effective. This presentation focused on the application of facility location optimization techniques to minimize transportation cost and optimize mode of transportation and associated capacity. In particular, our focus is on describing efforts by industries and academic literature. Future scope of design and development of techniques to optimize logistics decisions using different location problem solving procedure also reported.

Keywords: Facility location, Facility layout, Optimization

INTRODUCTION

Globalization, population growth, rapid urbanization and a growing middle class are all driving competition for increasingly scarce resources—energy, water and raw materials (Sustainability on a Smarter Planet: Going Green and Beyond , 2009).Gibson B.R (2001) asserts that post Brundtland Commission Report (WCED, 1987, p. 8) sustainable development gained wider attention .He also points out that "Continuing environmental degradation was leading not only to local and regional resource depletion and damage to essential ecological functions, but also it led to cumulative global effects".So in the initial years, sustainability efforts were focused on environmental standards and degradation concepts and acts of philanthropy. Growing business complexity made it imperative for organizations to adopt new environmentally and socially conscious approaches to enhance profitability and reduce risks (Agnihotri&Tripathi 2015).Authors also claim that

Today's highly dynamic environment of market is leading enterprises to be more flexible and efficient in operations empowered by effective decision making. To keep business productively sustains in this challenging situation cost reduction and optimization of operations in every stage, staring form procurement to supply, becomes an unavoidable threat to the management personality. Logistic management is one of these challenges (Min and Zhou, 2002). Effective decision making in logistic scheme design for various types of logistics, such as Production logistics, Business logistics, Third party logistics, Military logistics, can result into significant cost reduction over the supply chain. Selection of proper combination of different mode of transportation and their capacity is challenge to the logistic manger. At the same time distance between different locations of facilities has an influence on distance travel as well as over all transportation cast in supply chain.

On the other hand problem of locating facilities and optimization of its different parameters, such as interaction between facilities, allocation of capacity to a particular facility or facilities, their location and locating new facility(s), is well addressed by the researchers in literature. In its most basic form, a facility location problem (FLP) is analytically formulated according to the Quadratic Assignment Problem (QAP), a classical model in discrete optimization which works by enumerating different location configurations until the best arrangement is obtained. Although mathematically elegant, QAP is an NP-hard problem, which implies it is computationally impractical for problems involving a large number of facilities. Due to the combinatorial aspects of

optimally solving the FLP, analysts have developed various heuristics to substitute for blind search methods.

Although computationally efficient, FLP heuristics are still far from meeting the constraints commonly found in daily tasks. Our objective to reveal current scenario and to enhance computationally problem solution technique for logistics using approaches of optimization of FLP. Application FLP approaches to optimize transportation distance as well as cost of transportation and allocation of capacity to different transportation modes sets up a future scope of research.

Benefits of Logistic management:

Logistic management offers the following benefits which can be further optimized to get better efficiency of the system.

1. Raw material acquisition:

Raw material acquisition is one of most important aspect for per production planning. This job includes material transport form the supplier end to the manufacturing unit or the corresponding plan. Heavy industry includes a high cost of transportation of raw material from mines to the plant. Hence location of plant is dependent on location of raw material availability to some significant degree.

2. Inventory management :

Each facility locations are associated with a definite limit of inventory capacity. Over flow and under flow of inventory introduces inefficient utilization of recourses. High fluctuation on demand some leads to stock out situation which leads to a business loss due to failure to deliver. In a high competitive market this kind of luxury cannot be admitted as operational inefficiency. Proper logistic planning helps to avoid these inefficiencies using proper schedule of transportation.

3. Warehousing :

Warehousing is also subjected to a high initial investment and hence cannot be put to an inefficient use. Each square feet of warehouse incorporates high amount of fixed cost. Since finished goods or the raw material used to preserve into warehouse, it is a general consideration to locate warehouse in such a location such that over all distribution should be minimized. Though this problem taken care of by the logistics management but optimization of warehouse location treated specially by the facility location problem solution techniques.

4. Packaging :

Finished goods are generally transported in a packed form. Size and shape of packets determines efficient allocation quantity to be transported into a trip. More no of trips required incur more transportation cost. Optimization of this parameter is also addressed by the study logistic management.

5. Transportation:

The most important part of logistic is transportation. Different modes of transportation associated with availability of the mode and cost per unit distance transport. So, the major parameter attached with this part is – distance between two location and mode of transport subjected to the availability. Proper selection of mode and path significantly improves the cost saving.

Different modes of Transportation:

a. Roadways :

Roadway transportation is a point to point mode of communication. The greater facility of this mode is to loading form factory premises to the exact destination address. This the lowest level of transportation.

b. Railways :

Railway transportation is a station to station mode of communication. The greater facility of this mode is to bulk movement. This mode is a limited service and subjected to the availability of nearest station of the exact destination location.

Fig. 1: Different mode of transportation.

c. Airways:
Airway transportation is a port to port mode of communication. The greater facility of this mode is fast transportations. This mode is a limited service and subjected to the high transportation cost and material type.

d. Waterways:
Waterway transportation is also a port to port mode of communication. The greater facility of this mode is bulk movement. This mode is subjected to the high transportation cost and material type.

e. Ropeway:
Ropeway transportation is a special case of communication, generally used in mining and coal industry, power plants. This mode is subjected to the high transportation cost and material type. Dedicated development of infrastructure includes high investment for this mode of transport.

f. Communication
In this discussion communication refers to the flow of information. Availability of information makes business processes easy and less error prone. Generally telecommunication and postal communication practiced in daily transaction of industry.

Facility location Problem:
The Facility location Problem deals with physical location of facilities, which includes production plan, warehouse, suppliers, customer, and other supporting systems. Generally there are six elements used to classify this problem (Francis et al., 1992). They are based on

a. New facility characteristics:
Depending on no. of new facilities it is sub divided into two major classes. They are single and multiple new facilities. Both of them can be further classified into several sub classes depending on point & area, parameters and variants of analysis.

b. Existing facility locations:
Existing facilities are classified into two sub classes - static and dynamic.

c. New and existing facility interaction:
These interactions are generally classified as - qualitative and quantitative interaction, location dependent and independent, static and dynamic, and deterministic or probabilistic in nature.

d. Solution space characteristic:
This classification is based on solution space in terms of problem solution methodology and variable nature.

e. Distance measure:
There are two major measure found. They are Rectilinear and Euclidean distance measure. The next section advocated to the focus area. Existing technique, methodology to address logistics and location problem elucidated in Section2.An observation on these existing systems presented in Section3. Lastly Logistics and FLP possible system analogy proposed and future scope of minimization of transportation cost by means of optimization of transportation distance, combination of mode of transportation and capacity Section 4.

FOCUS AREA
The current choices of logistic mode selection and its capacity do not adequately address the above. The design criterion routinely used in most logistic scheme design procedures-a measure of long-term transportation cost efficiency, fails to capture the priorities of the flexible mode of transport. As a result, location performance tends to deteriorate significantly with fluctuation in material volumes, mix, or routings. Using a static measure of material handling/ transportation efficiency also fails to capture the impact of location configuration on operational performance such as goods accumulation ware house, queue times at unload and reload points over the chain. A review on facility location and Supply chain management carried out by Meloet al. (2009) in which they have established relevant inter relationship between optimization of supply chain and optimization facility location. Since logistic is a sub set of supply chain management, it can also be explored in terms of facility location problem.

Simulation has been requisitely used to incorporate many of these requirements into the facility location study. Furthermore location optimization and simulation are two tasks that are crucial to any facility planning and location study, and study of logistic management as well. Different special optimization technique used in this sector for generating better an better solution (Aboolian et al., 2007).

There are two major problem formulation method

found in literature for optimization of facility location problem (Francis et al., 1992). They are named as - Minisum location problem, and minimax location problem.

$$Z = \min \sum_{i=1}^{m} w_i * d_{ij} * c_{ij}$$

Minisum location problem:

It is based on the minimization of sum of all material transportation. This objective formulated in Eq.1.

$$Z = \min \sum_{i=1}^{m} max \{w_i * d_{ij}; j = 1,2,3\}$$

Where, Z= objective function,

Wi= numerical weight imposed to identify requirement of closeness with existing one.

dij= distance between two locations.

Cij= corresponding transportation unit cost/ distance.

Minimax location problem:

The main objective of this formulation is to minimize maximum distance travel or the maximum

The optimum facility location can be solved by using analytical approaches such as exact mathematical procedures, probabilistic model, graph theory, and heuristics methods. These problems can be classified as locating a new facility into existing old facilities, and allocation of new multiple facilities into existing facilities.

Application of different metaheuristic method like Genetic Algorithm, Tabu Search, Simulated Annealing, and AI techniques like Ant colony Optimization, Particle warm Optimization found significant in current literature of FLP. Hence application of these methods to optimize logistic problem parameter can also be done, if there is a co relationship in between these two domains. Relation between dynamic facility location in case of supply chain design explored by Thanh et al.(2008). But no significant literature focused on the same objective as we have found. In next section logical link between logistic and facility location established. In order to optimize transportation cost, mode of transport and capacity these two domains are mapped to each other.

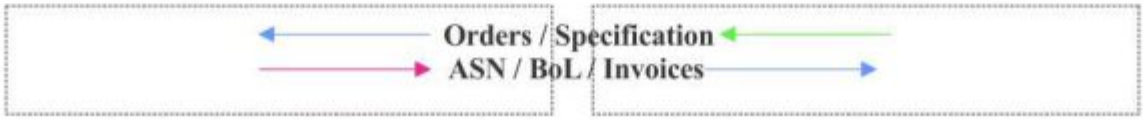
OBSERVATION

In this section logical analogy between logistic and

FACILITIES

Material Flow

Information Flow



facility location problem discussed. This analogy is pictorially represented in figure2. In this figure supply chain nodes are analogous to the facilities. Flow of information between supplier/ vendor and manufacturer, or manufacturer and customer can by compared with transportation of raw material , good and ,semi finished part

In this case capacity of each facility can be mapped with capacity allocated to the different mode of transportation. Hence the optimization objectives of logistic can be reformulated as optimization of facilities location and capacity problem. Application of metaheuristic methods can further improve solution due its inherent nature of global optimal searching property.

FUTURE SCOPE

In lieu of conclusion facility location problem are systematically mapped with logistic optimization problem. Different type of formulation for suitable optimization objective can be developed as per problem definition and a scope of application of metaheuristic approaches can also be noted. This can be thought that we are in some small measure successful in provoking thought and laying out possibilities for future directions.

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