Quest Journals
Journal of Research in Business and Management
Volume 2 ~ Issue 9 (2014) pp: 33-39
ISSN(Online) : 2347-3002
www.questjournals.org

Research Paper

Role of transportation in logistic management (A case study)

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Received 15 October, 2014; Accepted 30 October, 2014 © The author(s) 2014. Published with open access at **www.questjournals.org**

ABSTRACT: Operation Research is a scientific approach of decision making which seeks to determine how best to design a system that requires allocation of resources. Transportation is one of the techniques of optimization which minimizes the cost of distribution of a single commodity from different source to destinations. It occupies one-third of the amount in the logistics costs and transportation systems influence the performance of logistics system hugely. Transporting is required in the whole production procedures, from manufacturing to delivery to the final consumers. There has been little conceptual work that comprehensively examines the role played by the transportation function in the modern business environment. Transportation decisions plays a strategic role and acts as a long-term decisions for the overall supply chain . This paper aims to formulate and solve a transportation problem for a trading house with a view to suggests an appropriate route for the movement of cement from different warehouses to destination centers . In this paper an humble attempt is being made to evaluate the relevance of Modi's method to examine the transportation cost in cement trading.

KEYWORDS: modi's methyod, cement, trading

I. INTRODUCTION

Operation Research is also called OR for short and it is a scientific approach of decision making which seeks to determine how best to design and operate a system under conditions requiring allocation of resources. The terms OR and Management Science (MS) are often used synonymously. Transportation is one of the techniques of optimization which minimizes the cost of distribution of a single commodity from different source to destinations. It occupies one-third of the amount in the logistics costs and transportation systems influence the performance of logistics system hugely

"Logistics is that part of Operation Research that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements."

This definition conveys the idea that product flows are to be managed from the point where they exist as raw materials to the point where they are finally delivered. Logistics is also concerned with the flow of services as well as physical goods, an area of growing opportunity for improvement. It also suggests that logistics is a process, meaning that it includes all the activities that have an impact on making goods and services available to customers when and where they wish to acquire them.

Though logistics management is not a very old concept, in recent decades the importance of logistics management has been growing in various areas. For industries, logistics helps to optimize the existing production and distribution processes based on the same resources through management techniques for promoting the efficiency and competitiveness of enterprises. The key element in a logistics chain is transportation system, which joints the separated activities. Transporting is required in the whole production procedures, from manufacturing to delivery to the final consumers and returns. Only a good coordination between each component would bring the benefits to a maximum.

The paper focuses on formulation of a transportation problem for a trading house which deals with cement (50 kg a bag) and to derive a solution with a view to suggests an appropriate route for the movement of cement from different warehouses to destination centers which will optimize the transportation cost.

II. OPERATIONS RESEARCH & LOGISTICS

Operation Research and Management Science both describe a toolbox of mathematical and analytical method, with the aim to study system and activities with an operative focus. The goal is often to get a better support for important decisions concerning changes, improvements, investments, and other matters that can have a major impact.

Logistics

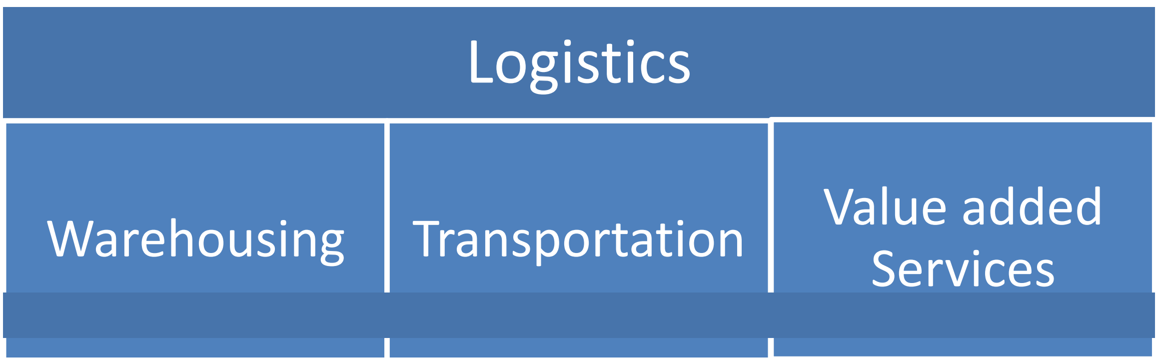
Logistics is a very wide concept that means different things depending on personal experience and viewpoint. At least the following variants of interpretation can be found.

- *Physical logistics* – This is simply the work needed to move or store products and other entities (the types of tasks where you can drop something on your toes and it hurts!) – and companies in this field are often described as working with logistics.
- Transport Logistics – Many automatically relate the concept to pure movements and the transports needed (with truck, train, plane, boat or other means) to fulfill them – as well as analyses in this field.
- *Production Logistics* – This is sometimes used as something of a synonym of Operations Research but with a bit more limited span (the producing activities, of products or services).
- *Internal logistics* – Is often used to describe movements – and usually storage – within a building (typically a plant). Can often be seen as a subset of Production logistics.
- Strategic Logistics – Finally logistics mean "the big picture" and see it as something that describes all the processes that are needed to secure that products are taken from an early customer interest/order to delivery. This way of using the word automatically connects to concepts like Supply chain management (SCM) and there are direct links to *Operative strategy* .

All these interpretations of the word 'logistics' (except possibly the pure physical one), have needs for analyses of various kinds and tools to conduct these. To a large extent, the same toolbox as in Operations research is used – and the two concepts are therefore very much related!

Operations management **and** ***Operations strategy***. 'Operations management' focuses upon methods and procedures to operate, handle, and manage an operational activity, limited in space (typically a plant), whereas 'Operations strategy' considers how to best handle several – organizational and/or geographically separated – operative activities and fields like Supply Chain Management and Logistics from the transportation perspective can be placed here.

The logistics value chain consists of three main segments, namely, Transportation, Warehousing and Value Addition Services, as below:



Logistics is a critical component relevant across agriculture, manufacturing and service sectors and has to be optimally managed for smooth functioning of production and distribution operations.

Additionally, logistics cost accounts for a major component of the input costs in all sectors, more so in the case of sectors such as cement, steel, automobiles, FMCG, retail, pharmaceuticals etc. With rising competition in the sectors that use logistics services, it has become even more important to enhance the efficiency of the system and use the cost-benefit in increasing the company's competitiveness.

Besides, with increasing globalization a larger number of multi-national companies (MNCs) are sourcing, manufacturing and distributing goods on a global scale, and thus need more complex supply chains to be managed. Given such developments, the Transportation, Logistics, Warehousing and Packaging Sector is expected to become a more specialized and niche expertise area where high premium will be charged for increased quality and quantity of service delivered by logistic service provider.

Review of literature

Sreenivas, Alluri Institute Of Management Sciences Warangal, A.P., India and Dr. T. Srinivas Department Of Mathematics Kakatiya University (Role of transportation in logistics chain)

Have analysed the role of transportation in logistics for the reference of further improvement. The research was undertaken to define and comprehend the basic views of logistics and its various applications and the relationships between logistics and transportation.

Mesut Kumru, Pınar Yıldız Kumru (Analytic hierarchy process application in selecting the mode of transport for a logistics company), journal of advanced trsansportation

In this paper a multi-criteria decision-making (MCDM) method, the analytic hierarchy process (AHP) has been used considerably to solve hierarchical or network-based decision problems in socio-economic fields. Following an in-depth explanation of the transport function in logistics and an overview of the MCDM methods, the AHP model is employed in the paper for a logistic company in selecting the most suitable way of transportation between two given locations in Turkey. The criteria used in the selection of transportation modes are identified as the cost, speed, safety, accessibility, reliability, environmental friendliness, and flexibility. Several cost parameters (transportation, storage, handling) are incorporated into the decision-making process.

Zewei Miao[†], Yogendra Shastri[†] Tony E. Grift[*], Alan C. Hansen „K.C. Ting (Lignocellulosic biomass feedstock transportation alternatives, logistics, equipment configurations, and modeling) Biofuels, Bioproducts and Biorefining Volume 6, Issue 3, pages 351–362, May/June 2012

This paper explains how Transportation and associated logistics account for a major portion of the total feedstock supply cost and energy consumption, and therefore improvements in transportation can substantially improve the cost-competitiveness of the bioenergy sector as a whole. The biomass form, intended end use, supply and demand, locations, and equipment and facility availability further affect the performance of the transportation system. The sustainability of the delivery system thus requires optimized logistic chains, cost-effective transportation alternatives, standardized facility design and equipment configurations, efficient regulations, and environmental impact analysis. These issues have been studied rigorously in the last decade. It is therefore prudent to comprehensively review the existing literature, which can then support systematic design of a feedstock transportation system. The paper reviews the major transportation alternatives and logistics and the implementation of those for various types of energy crops such as energy grasses, short-rotation woody coppices, and agricultural residue. It emphasizes the importance of performance-based equipment configuration, standard regulations, and rules for calculating transport cost of delivery systems.

Michael R. Bartolacci[1],Larry J. LeBlanc[2], Yasanur Kayikci[3], Thomas A. Grossman[4]Article first published online: 13 JUN 2012 (Optimization Modeling for Logistics: Options and Implementations) Journal of Business Logistics Volume 33, Issue 2, pages 118–127, June 2012 have described the fact that Logistic optimization has significantly grown in popularity over the last few decades. Improvements in computing power , modeling software, and the willingness of companies to invest time in the modeling effort have allowed models that were once too unwieldy to solve to optimality to be solved quickly. This has led to a more wide-spread recognition by logistics managers of the potential advantages of using optimization. The scope of logistics optimization in companies and organizations has expanded to address strategic, tactical, operational, and collaborative decision making Spreadsheets, an analytical tool familiar to managers, have played a crucial role in the expanded modeling efforts of companies. Although optimization's role in logistics has grown tremendously, there still are areas that remain to be explored that will allow it to achieve an even larger and more successful role in the management of companies. Additionally, there are some models that are still too large or too complex to currently solve to optimality, despite the advances in computing power and modeling/solving software.

Statement of the problem

A cement trading company XYZ limited has 5 source from which cement is distributed in it's operational area. The sources where cement is available are:

Jagatpur ……. 150 tons
Samantarapur ………..50 tons
Mancheswar ……..90 tons
Jharsuguda…… 12 tons
Manguli ……..12 tons

Each month the company meets the requirement of it's 7 distribution centres . Cement requirement at each centre are as follows:
Munduli ……30 tons
Khandagiri……20 tons
Rasulgarh …….10 tons
Banra ……..50 tons
Cuttack city ……. 150 tons
CDA ……..30 tons
Naraj…….10 tons

Cost of shipping one unit of cement (50 kg a bag) from each source to destination is given in the following table.

Table-1

Source\Destination	**Munduli**	**Khandagiri**	**Rasulgarh**	**Banra**	**Cuttack city**	**CDA**	**Naraj**	**Supply**
Jagatpur	**14**	**14**	**12**	**15**	**7**	**8**	**10**	**150**
Samantarapur	**15**	**8.50**	**7**	**15**	**12**	**12**	**12**	**50**
Mancheswar	**14**	**8**	**5**	**14**	**12**	**12**	**12**	**90**
Jharsuguda	**45**	**40**	**40**	**40**	**35**	**35**	**35**	**12**
Manguli	**15**	**17**	**15**	**16**	**10**	**10**	**12**	**12**
Demand	**30**	**20**	**10**	**50**	**150**	**30**	**24**	

The company wishes to determine as to how much should be the shipment from which source to which destination centre so that the total cost of the shipment is minimum.

Objectives

The trading house has 5 source and 7 destination centres. Each source has a certain capacity and each destination has a certain requirement associated with a certain cost of shipping from the sources to destinations.
The objective is to find out

(i) Number of units to be transported from specified source to destinations
(ii) To minimize the overall transportation cost

Research methodology

Secondary data is collected regarding the transportation of cement of a trading house which is situated in cuttack on a monthly basis. Modi's method is used to find the solution.

Analysis & Discussion

Transportation method has it's major application in solving problems involving several product sources and several destination of products. The two common objectives of such problems are either

(1) minimize the cost of shipping
(2) maximize the profit of shipping

There are 5 sources supplying 7 destinations. Source capacities, destinations requirements and costs of cement shipping from each source to each destination are given . The transportation problem is described using following linear programming mathematical and usually it appears in a transportation tableau.
The transportation matrix for this case appears in the following table where supply availability at each source is shown in the far right column and the demands are shown in the bottom row. The unit shipping costs are shown within the cells. It is important at this step to make sure that the total supply availabilities and total demand requirements are equal. In this case
Total supply………314 tons
Total demand……314 tons

Initial basic Feasible Solution

Initial allocation entails assigning numbers to cells to satisfy supply and demand constraints and to achieve the initial basic feasible solution vogel's approximation method is used. The following Table shows the **VAM assignments**.
Total cost: 7*150 tons + 15*20 tons + 12*18 tons +12*12 tons+ 14*30tons +8*20 tons + 5*10 tons +14*30 tons + 35*12tons + 10*12 tons

Total cost= 7*3000 bags + 15*400+ 12*360 bags +12*240 bags+ 14*600 bags +8*400 bags 5*200 bags +14*1000 bags + 35*240bags+ 10*240 bags
= 21000+6000+4320+2880+8400+3200+1000+14000+8400+2400
=Rs71,600

Table-2

Source\Destination	Munduli	Khandagiri	Rasulgarh	Banra	Cuttack city	CDA	Naraj	Supply
Jagatpur	14	14	12	15	7 150	8	10	150
Samantarapur	15	8.50	7	15 20	12	12 18	12 12	50
Mancheswar	14 30	8 20	5 10	14 30	12	12	12	90
Jharsuguda	45	40	40	40	35	35	35 12	12
Manguli	15	17	15	16	10 Ɛ	10 12	12	12
Demand	30	20	10	50	150	30	24	

Table "VAM Assignment"
Develop Optimal Solution
Optimal solution is developed using Modi's method or (u,v) method.

Basic cells (X_{ij})	$U_i+V_j=C_{ij}$	Put $U_2=0$
X_{15}	$U_1+V_5=7$	$U_1= -5$
X_{24}	$U_2+V_4=15$	$V_4=15$
X_{26}	$U_2+V_6=12$	$V_6=12$
X_{27}	$U_2+V_7=12$	$V_7=12$
X_{31}	$U_3+V_1=14$	$V_1=15$
X_{32}	$U_3+V_2=8$	$V_2=9$
X_{33}	$U_3+V_3=5$	$V_3=6$
X_{34}	$U_3+V_4=14$	$U_3= -1$
X_{47}	$U_4+V_7=35$	$U_4= 23$
X55	$U_5+V_5=10$	$U_5= -2$
X56	$U_5+V_6=10$	$V_6 =12$

Table-3

Source\Destination	Munduli	Khandagiri	Rasulgarh	Banra	Cuttack city	CDA	Naraj
Jagatpur $U_1= -5$	14 (-4)	14 (-10)	12 (-11)	15 (-5)	7 150	8 (-1)	10 (-3)
Samantarapur $U_2=0$	15 (0)	8.50 (0.50)θ	7 (-1)	15 20- θ	12 (0)	12 18	12 12
Mancheswar $U_3= -1$	14 30	8 20- θ	5 10	14 30+ θ	12 (-1)	12 (-1)	12 (-1)
Jharsuguda $U_4= 23$	45 (-7)	40 (-8)	40 (-11)	40 (-2)	35 (0)	35 (0)	35 12
Manguli $U_5=-2$	15 (-2)	17 (-10)	15 (-11)	16 (-3)	10 Ɛ	10 12	12 (-2)

$V_1=15$ $V_2=9$ $V_3=6$ $V_4=15$ $V_5=12$ $V_6 =12$ $V_7=12$

<u>Non-Basic Net Evaluation</u> $Z_{ij}- C_{ij} = U_i+V_j-C_{ij}$

$Z_{11}- C_{11}$ =-4 $Z_{12}- C_{12}$ =-10 $Z_{13}- C_{13}$=-11
$Z_{14}- C_{14}$ =-5 $Z_{16}- C_{16}$=-1 $Z_{17}- C_{17}$=-3
$Z_{21}- C_{21}$ =0 $Z_{22}- C_{22}$=0.50 $Z_{23}- C_{23}$=-1
$Z_{25}- C_{25}$=0 $Z_{35}- C_{35}$=-1 $Z_{36}- C_{36}$=-1
$Z_{37}- C_{37}$= -1 $Z_{41}- C_{41}$ =-7 $Z_{42}- C_{42}$ =-8
$Z_{43}- C_{43}$ = -11 $Z_{44}- C_{44}$ =-2 $Z_{45}- C_{45}$=0
$Z_{46}- C_{46}$=0 $Z_{51}- C_{51}$ =-2 $Z_{52}- C_{52}$=-10
$Z_{53}- C_{53}$=-11 $Z_{54}- C_{54}$=-3 $Z_{57}- C_{57}$=-2

Since all the **<u>Non-Basic Net Evaluation</u>** are not less than equal to zero ,the current solution is not the optimum solution. so a LOOP is constructed from the cell with most positive net evaluation that is from X_{22}. An unknown value θ is assigned to the starting cell of the loop and is alternatively subtracted and added to the corner points of the loop.

Value of θ =20 table-4

Source\Destination	Munduli	Khandagiri	Rasulgarh	Banra	Cuttack city	CDA	Naraj
Jagatpur U_1= -4.5	14 (-4.5)	14 (-10.5)	12 (-11.5)	15 (-5.5)	7 150	8 (-1)	10 (-3)
Samantarapur U_2=0.5	15 (-0.5)	8.50 20	7 (-1.5)	15(-0.5)	12 (0)	12 18	12 12
Mancheswar U_3= 0	14 30	8 Ɛ	5 10	14 50	12 (-0.5)	12 (-0.5)	12 (-0.5)
Jharsuguda U_4= 23.5	45 (-7.5)	40 (-8.5)	40 (-11.5)	40 (-2.5)	35 (0)	35 (0)	35 12
Manguli U_5=-1.5	15 (-2.5)	17 (-10.5)	15 (-11.5)	16 (-3.5)	10 Ɛ	10 12	12 (-2)

V_1=14 V_2=8 V_3=5 V_4=14 V_5=11.5 V_6 =11.5 V_7=11.5

Since all the **<u>Non-Basic Net Evaluation</u>** are less than equal to zero ,the current solution is the optimum solution with allocation as follows.

X_{15}=150 X_{22}=20 X_{26}=18 X_{27}=12
X_{31}=30 X_{33}=10 X_{34}=50 X_{47}=12
X_{56}=12

Total cost= 7*150 tons + 8.50*20 tons + 12*18 tons +12*12 tons+ 14*30tons +5*10 tons +14*50 tons + 35*12tons + 10*12 tons

Total cost= 7*3000 bags + 8.50*400bags + 12*360 bags +12*240 bags+ 14*600 bags +5*200 bags +14*1000 bags + 35*240bags+ 10*240 bags
=21,000+3400+4320+2880+8400+1000+14000+8400+2400
=Rs65,800

Findings

From the above Analysis it is found that the trading house should follow the below mentioned schedule for the transportation of cement so as to minimize the transportation cost.

<u>From</u>	**<u>To</u>**	**<u>Number of units</u>**
Jagatpur	Cuttack City	150tons
Samantarapur	Khandagiri	20tons
Samantarapur	CDA	18 tons
Samantarapur	Naraj	12 tons
Mancheswar	Munduli	30 tons
Mancheswar	Rasulgarh	10 tons
Mancheswar	Banra	50 tons
Jharsuguda	Naraj	12 tons
Manguli	CDA	12 tons

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