"Reduce Cost Optimization of Supply Chain Network"

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ABSTRACT

In this paper a review on three in-stock procedures – course through, local and single DC focal stock and built up a basic transportation-stock model keeping in mind the end goal to look at their aggregate expenses is finished. We have additionally portrayed a dissemination display proposed by in which the model is detailed as a non-straight whole number streamlining issue. Due to the non-linearity of the stock cost in the goal work, two heuristics and a correct calculation is proposed so as to take care of the issue.

The outcomes got from the transportation-stock models demonstrate that the single territorial focal stock systems are more cost-effective separately contrasted with the course through approach. It is prescribed to take the single DC and the territorial focal stock procedures for moderate moving and requesting items individually: Limiting stock and transportation cost of an industry: a store network improvement.

Keyword: Supply chain, Preliminary Distribution model, Cross-Dock and Direct Shipment Models LagrangianMethod.

I. INTRODUCTION

1.1 Supply chain managementSCM is the management of a network ofinterconnected businesses involved in the provisionof product and service packages required by the endcustomers in a supply chain. Supply chainmanagement spans all movement and storage of rawmaterials, work-in-process inventory, and finishedgoods from point of origin to point of consumption.According to (Berman et al [2006] there aretwo important issues in the supply chain area thatcontribute to the total cost of the supply chainnetwork namely transportation and inventory costs.That being said retail companies can achievesignificant savings by considering these two costs atthe same time rather than trying to minimize eachseparately.

As mentioned above in this paper the twodistribution strategies mainly direct delivery andshipment through crossdock are considered where agroup of products are shipped from a set of suppliersto a set of plants. The cost function consists of thetotal transportation, pipeline inventory, and plantinventory costs.The presence of the plant inventory cost hasmade the model to be formulated as a non-linearinteger programming problem. According to (Bermanet al [2006]) the objective function is highlynonlinear and neither convex nor concave; therefore, a greedy heuristic is suggested to find an initialsolution and an upper bound.And then a branch-and-bound algorithm is developedbased on the Lagrangian relaxation of the non-linearprogram. Before getting into the formulation portionof the model, I am going to provide a briefbackground of the two distribution strategiesdiscussed in the report and then briefly state theassumptions made by (Berman et al [2006]) in orderto have a solvable problem.For many retail companies products areshipped by suppliers through one of the followingshipment strategies. The first one is direct shipmentwhere products get shipped directly from the supplierto the DC/plant without stop. The second method ofshipment is milk-run (peddling) where trucks pick upproducts from different suppliers on their ways andfinally drop them at one or several DCs. The last butnot least is cross-dock where products get shipped toDCs through cross-dock by suppliers. Below is agraphical representation of the three distributionstrategies.

II. METHODOLOGY

2.1 Preparatory Distribution ModelBefore getting into the modeling portion ofmy work, I would like to briefly explain inventoryrequirements for each of the product groups and howthey vary according to different distribution channels(Shapiro [2005]).[4] As shown in Figure 2, productscan flow in three different paths. In the first path,

product is shipped through a cross dock to a store, meaning that no inventory is held in that place. Inventory is only held at a store. Costs associated with this path are transportation as well as fixed and variable processing costs at cross dock site.Cost of transportation is also related to the shipment volume (either truckload (TL) or less-than-truckload (LTL).

In the second path, product is directly shipped by the supplier to stores. The only costs associated with this path are the costs of transportation and inventory at stores. In the third path inventory is only held both at DCs and stores. Again transportation, inventory holding and fixed as well as variable processing costs are considered for this path.

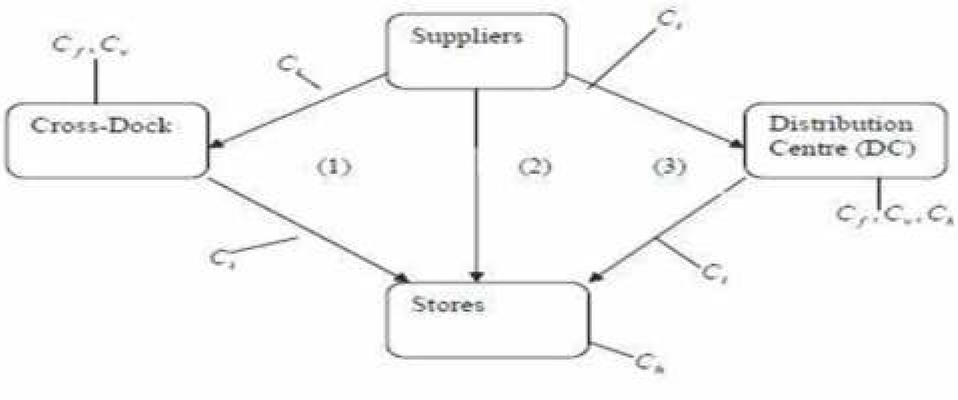


Figure 2 – Distribution strategies (Shapiro [2005])

In the modeling of the network, I have considered a supply chain in which suppliers ship product either directly to stores, or cross dock site or DCs as explained earlier. Location and capacity allocation decisions have to be made for distribution centre (DC). Multiple DCs may be used to satisfy demand at a market.

The goal is to identify distribution locations as well as quantities shipped between various points that minimize the total fixed and variable costs. Define the following decision variable preliminary version of the problem.

The objective function minimizes the total fixed and variable costs of the supply chain network. The constraint in equation 1 specifies that the total amount shipped from a supplier cannot exceed the supplier's capacity. The constraint equation 2 enforces that amount stocked in the DC cannot exceed its capacity. The constraint in equation 3 states that the amount shipped out of a cross-dock site is exactly equal the amount received from the supplier. The constraint in equation 4 specifies that the amount shipped out of a DC site cannot exceed the amount received from the supplier. The constraint in equation 5 specifies that the amount shipped to a customer must cover the demand.

2.2. CROSS-DOCK AND DIRECTSHIPMENTMODELS

Before getting into the details of the final model that I developed and used for 1 supplier, 1 cross-dock and 2 distributions centers case as well as assumptions that I made in order to maintain the linearity of the objective function I would like to

briefly describe an optimization model suggested by

ObjectiveFunction.

Min

$$\sum_{i=1}^{n} [illegible] + \sum_{e=1}^{r} [illegible] + \sum_{i=1}^{l}\sum_{j=1}^{n} [illegible] + \sum_{i=1}^{l}\sum_{e=1}^{r} [illegible] +$$

$$\sum_{i=1}^{l}\sum_{j=1}^{m} c_{ij} * x_{ij} + \sum_{i=1}^{n}\sum_{j=1}^{m} c_{j} * x_{j} + \sum_{e=1}^{r}\sum_{j=1}^{m} c_{ej} * x_{ej}$$

Subject to

1. $\sum\sum\sum (x_{ij} + x_{ie} + x_{ij}) \le S_i$ for $i=1,\dots,l$

Total amount shipped from a supplier cannot exceed the supplier's capacity

2. $\sum x_{ij} \le K_i * y_i$ for $i=1,\dots,n$

Amount stocked in the DC cannot exceed its capacity

3. $\sum_{i=1}^{l} x_{ik} - \sum_{j=1}^{n} x_{kj} = 0$ for $k=1,\ldots,t$

The amount shipped out of a cross-dock site is exactly equal the amount received from the supplier

4. $\sum_{i=1}^{l} x_{ik} - \sum_{j=1}^{n} x_{kj} \geq 0$ for $k=1,\ldots,n$

The amount shipped out of a DC site cannot exceed the amount received from the supplier

5. $\sum_{i=1}^{l}\sum_{k=1}^{t}\sum_{j=1}^{n} x_{ij} + x_{ij} = D_j$ for $j=1,\ldots,n$

The amount shipped to a customer must cover the demand

(Berman et al [2006]) that is the solution to a distribution strategy selection problem where cost functions of both direct delivery and shipment through a cross-dock are modeled and compared.

There are two important issues in the supply chain area that contribute to the total cost of the supply chain network namely transportation and inventory costs. That being said retail companies can achieve

significant savings by considering these two costs at the same time rather than trying to minimize each separately. As mentioned above in this paper the two distribution strategies mainly direct delivery and shipment through cross dock are considered where a group of products are shipped from a set of suppliers to a set of plants.

The cost function consists of the total transportation, pipeline inventory, and plant inventory costs. The presence of the plant inventory cost has made the model to be formulated as a non-linear integer programming problem. The objective function is highly nonlinear and neither convex nor concave; therefore, a greedy heuristic is suggested to find an initial solution and an upper bound. And then a branch-and-bound algorithm is developed based on the Lagrangian relaxation of the non-linear program. Before getting into the formulation portion of the model, I am going to provide a brief background of the two distribution strategies discussed in the paper and then briefly state the assumptions made in order to have a solvable problem.

2.3 DESIGNOF MODEL

2.3.1 Distribution Strategies

\For many retail companies products are shipped by suppliers through one of the following shipment strategies. The first one is direct shipment where products get shipped directly from the supplier to the DC/plant without stop. The second method of shipment is milk-run (peddling) where trucks pick up

products from different suppliers on their ways and finally drop them at one or several DCs. The last but not least is cross-dock where products get shipped to DCs through cross-dock by suppliers.

2.3.2 Model Assumptions

As mentioned earlier to have a solvable problem, a couple of assumptions have been made in this paper

1. It is assumed that the product quantities are infinitely splittable, in other words a product can be shipped in any quantity within a vehicle shipment.
2. Delivery frequency can be any positive number and is not limited to a set of potential members.
3. Products are always available for shipping at suppliers, no matter which distribution strategy is chosen
4. Inbound-outbound coordination at the cross-dock is ignored.
5. All units of the same flow (a flow is a combination of supplier, plant and, product) are assigned to the same transportation option, i.e., direct or through the same cross-dock.
6. Each truck is fully loaded. Only the volume of products is concerned when calculating truck capacity usage. The transportation costs are only determined by the source and destination, regardless of the weight.

	PROCESS	Mr SANDEEP	Mr ASHUTOSH	Mr DEEPESH	Mr RAHUL	Mr AIAY
RUN	DELIVERY TIME	M	M	S	M	M
	DELIVERY FREQUENCY	S	M	M	M	M
	INVENTORY COST(PLANT)	S	M	M	M	M
	INVENTORY COST(PIPE LINE)	M	S	M	M	M
DIRECT	DELIVERY TIME	S	M	S	S	S
	DELIVERY FREQUENCY	S	S	M	S	S
	INVENTORY COST(PLANT)	M	H	H	H	M
	INVENTORY COST(PIPE LINE)	M	S	S	M	S
CROSS DOCK	DELIVERY TIME	M	H	H	H	H
	DELIVERY FREQUENCY	H	M	H	H	H
	INVENTORY COST(PLANT)	S	S	M	S	S
	INVENTORY COST(PIPE LINE)	H	M	H	H	H

Table: 1.Delivery Time, Deliver Frequency, InventoryCost of Varies Distribution Strategy

DATA COLLECTED THROUGH QUSTIONAIRE THROUGH VARIOS DOMAIN EXPERTS

DISTRIBUTION	PROCESS	Mr SANDEEP	Mr ASHUTOSH	Mr DEEPESH	Mr RAHUL	Mr AJAY
MILK RUN	INVENTORY	96500	98630	97560	96800	97200
	TRANSPORTATION	150760	135900	125800	150500	140200
DIRECT	INVENTORY	963005	986000	110006	120500	160050
	TRANSPORTATION	105006	110560	125308	106008	986200
CROSS DOCK	INVENTORY	105100	125000	130500	963200	952000
	TRANSPORTATION	125000	135000	126500	114000	115800

III. DATA ANALYSIS

3.1 Computation OF Stock and TRANSPORTATION COST Utilizing LAGRANGIAN Technique

Table 1b

Parameters for network in figure 1.

F	Fixed order cost	10
$g_j, \forall j \in J$	Fixed shipping cost from supplier to DC	1
$a_j, \forall j \in J$	Unit shipping cost from supplier to DC	1
β	Transport weight	1
z_α	Service level parameter	1.96
θ	Inventory weight	1
L	Lead time	1
h	Unit holding cost	2
χ	Days per year	1

3.2 FOR MILK RUN

Lagrangian Method to n-dimensional case we find and optimum of a differentiable function

$$Z = f(x),\ x = (x_1, x_2 \ldots\ldots x_n) \in R^n$$

Whose variable are subject ot the M (£*n*) constaints

$gi(x)=0, i=1, 2 \dots m$ and $x \geq 0$

Where the $gi(x)$ are also differentiable. We form the Lagrangian Function

$$L(x, \lambda) = f(x) - \sum_{i=1}^{m} \lambda i \, gi(x)$$

Involving the Lagrangian multiplier

$$\lambda = (\lambda_1 \lambda_2 \dots \lambda_m)$$

These necessary condition for max (or min.) of $f(x)$ are the system of (m + n) equation

$$\frac{dl}{dxi} = \frac{df}{dxi} - \sum_{i=1}^{m} \lambda i \frac{dgi}{dxj} = 0 \; j = 1, 2 \dots n$$

Parameter	Value
Maximum number of iterations	400
Minimum alpha multiplier	0.00000001
Maximum number of iterations before halving alpha	12
Crowder's damping factor	0.3
Initial Lagrange multiplier value	$10\bar{\mu} + 10 f_j$

$y = (y_i, y_e, v_i, v_e, x_{ih}, x_{eh}, x_m, x_n)$ $g_1(y) = x_{hl} + x_{ij} + h_{ij} - 50 = 0$

$g_2(y) = x_{ij} - 3.4 = 0$

$g_3(y) = x_{hl} - x_{ij} - 10$

$g_4(y) = x_{hl} - x_{ij} - 18 = 0$

$g_5(y) = x_{ij} + x_{iy} - 12.5 = 0$

We constaints the Lagrangian function for multiplying $f(y)$

$f(y) - \lambda_1 g_1(y) - \lambda_2 g_2(y) - \lambda_3 g_3(y) - \lambda_4 g_4(y) - \lambda_5 g_5(y)$

This gives the following necessary condition :

$$\frac{\partial l}{\partial y} = 2x_1 - \lambda_1 - \lambda_2 = 0 \quad \frac{\partial l}{\partial y} = 3x_1 + \lambda_1 - \lambda_3 = 0 \quad \frac{\partial l}{\partial y} = x_{ij}\lambda_1 - \lambda_3 - \lambda_5 = 0 \quad \frac{\partial l}{\partial y} = x_{ij} - y_{ij} - \lambda_5 = 0$$

$$\frac{\partial l}{\partial y} = x_i - \lambda_5 + \lambda_3 - \lambda_4 = 0$$

DISTRIBUTION STRATEGY	INVENTORY COST	TRANSPORTATION COST
MILK RUN	98760.60	178950.56
DIRECT	109865.32	196563.82
CROSS-DOCK	98560.71	146892.62

$$y_i = \frac{2\lambda_1 + \lambda_2}{4}$$

DISTRIBUTION STRATEGY	INVENTORY COST	TRANSPORTATION COST
MILK RUN	94343.512	114075.135
DIRECT	98798.677	152533.377
CROSS-DOCK	93798.673	142533.324

$$y_e = \frac{2\lambda_5}{4}$$

$$x_m = \frac{\lambda_1 + 2\lambda_3}{2}$$

$$x_{ij} = \frac{\lambda_1 + \lambda_2 + 3\lambda_4}{5}$$

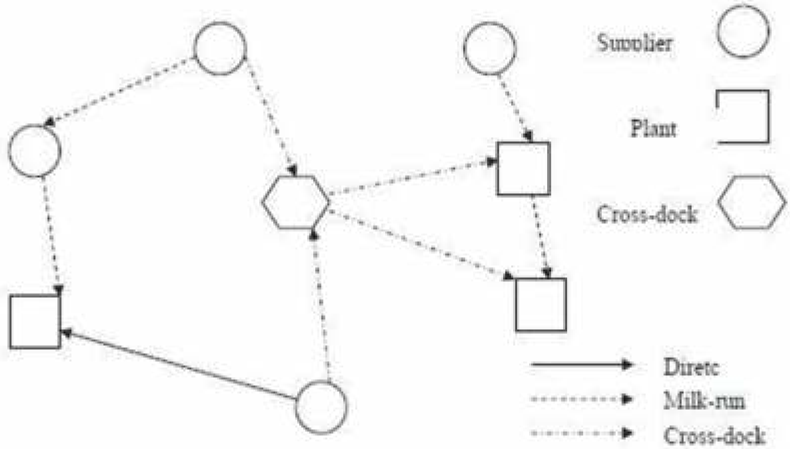
$$\lambda^* = (\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5) = \frac{40}{9}, \frac{51}{9}, \frac{314}{3}, \frac{127}{2}, \frac{413}{17}$$

By substituting the values of $\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5$

then get transportation cost and inventory cost. Transportation Cost = 114075.1358 Inventory Cost = 94343.512

IV. RESULT

4.1 -Developed a distribution strategy model Developed a table of three distribution of strategy with the help of questionnaire through domain experts of various organization



Developed two objective function for transportation and inventory and transportation model and reduce the cost of transportation and inventory by lagrangian methods for different strategies.

4.2-COMPARISON BETWEEN DATA GIVEN BY EXPERTS AND DATA CALCULATED FROM LAGRANGIAN METHOD

4.2.1 Comparison By Experts

Table – 3 Comparison By Experts

4.2.2 - Comparison By Lagrangian Method

Table – 3 Comparison by Bylagangian Method

V. CONCLUSION

- Achievement of significant cost savings and improvements in profitability requires a typical retail company to make long-termdecisions regarding the structure of its supply chain network and bringing its facilities, suppliers and customers closer together under the strategic supply chain planning.
- As part of my study I have developed a transportation-inventory model for a single source to multiple distribution strategy. I have also studied the distribution model proposed by(Berman) that can be used for transportationsystem.

- We will develop a questionnaire we get furtherinformation for objective functionand tominimize the transportation cost and inventory cost and reduce the cost of transportation andinventory by lagrangian methods for different strategies.
- Developed a table of three distribution ofstrategy with the help of questionnaire through domain experts of various organization.

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