A case study on optimising transportation cost of a textile firm

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ABSTRACT

One of the major problems every textile and garment industry in India faces is establishing an effective supply chain. Due to this industry being a major contributor to India's GDP, Industrial Production, Export Income and Employment Provider, there is strong competition, and to ensure firms don't get trampled by this competition designing an effective supply chain is essential. In this paper, we have used a Transportation Problem, an operations research technique used to help minimize the cost of distributing a product from a number of sources or origins to a number of destinations, to help B-Series, a textile firm, to reduce its transportation costs. We have used the Modified Distribution Approach to identify the minimal cost route of transportation. We have used solver in Excel to compute the solution. A dummy column was added as the demand did not live up to the supply. From the solution, it is found that the Total Transportation Cost is Rs. 5,20,700. Sensitivity analysis is done to predict the outcome of a certain decision given a certain range of variables. It is the study of how the uncertainty in the output of a mathematical model or system can be apportioned to different sources of uncertainty in its inputs.

Keywords: Textile industry, transportation problem, solver, sensitivity analysis

INTRODUCTION

The textile and garment sector is one of the foremost industries in India having major contribution in GDP of the economy. The Indian textile and garment industry has its significance not handiest within the Indian marketplace however also has its recognized presence and high stature within the international marketplace, being one of the main industries globally. This industry is full of variability having the players at each stage in their supply chain with lot of structural, operational and overall performance variations. Presently, the Indian textile industry contributes approximately 14% to industrial production, 4% to the India's GDP, and 17% to the export income. It provides employment to more than 35 million people in India, being second largest employment provider after agriculture.

Although, the textile industry is one of the top industries of the sector inside the worldwide market, its shape in the Indian situations is full of diversities and it faces many infrastructural issues and differing structures of players concerned at every level. The basic supply chain demanding problems the garment industry in India is facing are mentioned later in the study. Those are the challenges which are faced more or less by every organization and contributing player within the industry. Supply chain frameworks are needed to be designed to be in line with the necessities of the precise organizations in order to make them effective, responsive and competitive.

The transportation problem is a special category of Linear Programming problem. It's been widely studied in Logistics and Operations management wherein distribution of goods and commodities from warehouses to locations is an essential issue. The task of distributor's choices can be optimized by reformulating the Distribution problem as generalization of the classical Transportation problem.

B-series Pvt Ltd is a Local company which operates in manufacturing, trading and export of sarees. It is situated in Surat, Gujarat and they export sarees to various cities like Kanpur, Jaipur, Kolkata, Chennai, Delhi, Kerala, Hyderabad, Bangalore, Ahmedabad, etc.

LITERATURE REVIEW

Mohammed N.A.R., Lahji A.A. and Syed J.K. (2013) have concluded in the given research paper the cost of transportation and breakages that occur during the transportation of eggs. We know that egg is a deteriorating item because after breakage or partial breakage the value of egg becomes zero and hence transportation plays an important role. In similar case Mr J.L Hine and S.D. Ellis[1] in their research study have shown the role that road transport has to play in maintaining rural development and food security. It is argued that transport costs play a critical role in identifying the link between accessibility and agricultural development. W. Ritha and J. Merline Vinotha[2] obtained that multi objective transportation problems have wide applications in logistics and supply chain for reducing the cost. In this study, Fuzzy geometric programming approach is used to determine the optimal solution of the problem. If this above mathematical model is adopted by the suppliers and wholesalers of eggs, it would not only minimize the transportation cost but will also minimize the breakages of eggs.

In the works of Dinesh C.S. Bisht, Pankaj Kumar Srivastava (2018)[13], two methods are combined to solve interval data based transportation problems (IBTPs). Considering a realistic scenario, parameters may be vague or uncertain with some limit (Zimmermann, 1978)[7]. This resulted in fuzzy transportation problem (FTP), where the parameters costs, supply and demand are fuzzy quantities. In this paper, IBTP is converted to FTP using trisectional approach and a new ranking technique based on in-centre concept is applied to convert it to crisp number. Gani and Razak minimized the transportation cost for demands and supplies using trapezoidal fuzzy numbers. Ritha and Vinotha (2009)[8] used fuzzy geometric approach to find the solution of FTPs. These type of problems are also investigated by Stephen Dinagar and Palanivel (2009)[9], Kumar and Kaur (2010) (2011)[10], and Ebrahimnejad (2014)[11] using concept of trapezoidal fuzzy numbers. The recent works include newly developed ranking techniques based on trapezoidal fuzzy numbers show betterment over classical methods (Mathur et al., 2016[12]; Bisht and Srivastava, 2017[13]). This new technique is compared to already established methods and is found to be more effective to solve such transportation problem, where the difference between production and supply is very high, proving its significance for solving interval data transportation problems.

Mohamed Azizi, Mahdi Birafane and Hamza Boueddine in their given research paper have stated that BioPharma industry requires a problem solving approach to help solve their transportation problem and make appropriate decisions. The mathematical model was formulated from a linear programming model and was used to solve the transportation model. In this paper the mathematical model formulated has adopted the concept of a new capacitated transportation model as the company's shipments are directly from a supply area to a place where it is demanded. Winston(1998)[3] said that a company produces products at a supply point and transports them to a customer location called demand points. It is common for each supply point to have a limited amount that it can ship and each customer must receive a required quantity of the product (Bertsekas DP, 1998). The report has hence outlined a transportation model that can be applied to minimize the transportation cost of the Biopharma company.

Sherif A. Masoud and Scott J. Mason have deduced from their research that the automotive industry has been trying to enhance its efficiency, competitiveness and sustainability by improving its supply chain operations. They studied the transportation problem involving short term automotive supply chain planning. They considered multiple modes of transportation that offered cost and delivery time option to the manufacturer. The literature on sustainable supply chain management in 191 papers published from 1994 to 2007 is reviewed by Seuring and Muller [5]. Integration of economic and environmental aspects in sustainable supply chain management is reviewed by Darom and Hishamuddin [6]. The goal of this research is to support decision makers of a tier-1 automotive supplier while considering the effect of multiple modes of transportation which enhances supply chain sustainability

on the total integrated cost. Thus this research highlights the impact of the additional transportation mode lead time on reducing the total integrated cost by reducing the inventory holding and transportation costs over the single transportation mode case.

METHODOLOGY

B-Series is a textile firm that manufactures and exports wholesale sarees at reasonable prices.

The traditional transportation problem can be represented as a mathematical structure which comprises of an objective function subject to certain constraints. In classical approach, transportation costs from M sources or wholesalers to N locations or clients are to be minimized.
Our objective for this work is clearly twofold;

- ➢ To reduce the transportation costs of transporting items from plants to customers
- ➢ To meet the company's clients.

After taking a cautious look at of the business enterprise's facts through our sources of information, we discover that, the products are transported immediately from the plant to the market. Consequently, the enterprise would benefit from the 'transportation problem model' which is about shifting products as a minimum cost from warehouses to destination.
There are 10 sources of supply with respective supply potential and there are 10 demand locations as well. Consequently, there is transportation fees associated with such network flow and our objective is to minimize the transportation costs with respect to the supply quantity from beginning to end i.e. customers.

Basically, the solution for the transportation problem includes the following phases:

- ➢ Phase 1: Mathematical system of the transportation problem.
- ➢ Phase 2: finding an initial fundamental feasible solution.
- ➢ Phase 3: Optimize the initial simple feasible solution which is acquired in section 2.

To find the feasible cost, there are various methods to calculate feasible cost like:

- North West Corner Method (NWCM)
- Row Minimum Method (RMM)
- Column Minimum Method (CMM)
- Least Cost Method (LCM)
- Vogel's Approximation Method (VAM)
- Extremum Difference Method (EDM)
- Highest Cost Difference Method (HCDM)
- Average Cost Method (ACM)
- TOCM-MMM Approach
- TOCM-VAM Approach
- TOCM-EDM Approach
- TOCM-HCDM Approach.

After finding the feasible cost of transportation, we need to find the optimal cost of transportation. Transportation problems can be solved using Excel Solver.Excel Solver and TORA can be used for solving different forms of transportation problem. Excel Solver can only compute the least transportation cost without giving credence to its computation using three methods: Least Cost Method, North West Corner Method and Vogel Approximation; which are
exemplified by TORA. This is made possible because the problem is first changed to a LP problem and solved using the simplex method. TORA handles all necessary computations in the background using the simplex method and uses the transportation model format only as a screen 'veneer'". The two methods, however, do not solve transportation problems using the MODI method.[14]

DATA

Table1-

(in metres)

LOCATION	Jazzu Sarees	Jawaharlal Jagannath Prasad	Ankit Traders	Shree Ram Synthetics	Amit Textiles	Dummy	SUPPLY
Nilofar Fabrics	2	3	4	9	4	0	50000
Dhyan Enterprises	11	2	4	7	2	0	46000
Mahalaxmi Silk Mills	17	8	2	5	3	0	42000
Raj Silk Mills	7	16	3	16	2	0	40000
Hamman Enterprises	13	5	2	4	3	0	37600
DEMAND	46000	44500	44000	42000	36000		

LOCATION	Jazzu Sarees	Jawaharlal Jagannath Prasad	Ankit Traders	Shree Ram Synthetics	Amit Textiles	Dummy		SUPPLY
Nilofar Fabrics	46000	0	900	0	0	3100	50000	50000
Dhyan Enterprises	0	44500	0	0	1500	0	46000	46000
Mahalaxmi Silk Mills	0	0	37600	4400	0	0	42000	42000
Raj Silk Mills	0	0	5500	0	34500	0	40000	40000
Hamman Enterprises	0	0	0	37600	0	0	37600	37600
	46000	44500	44000	42000	36000	3100		
DEMAND	46000	44500	44000	42000	36000	3100		

TOTAL COST	**520700**

ANALYSIS

The above table is the solution of the transportation problem. All the suppliers are located in Surat and the customers are located in various parts of the country. Following are the cities where each customer is located:

1. Jazzu Sarees – Hyderabad
2. Jawaharlal Jagannath Prasad – Kanpur
3. Ankit Traders – Kanpur
4. Shree Ram Synthetics – Kolkata
5. Amit Textiles – Surat

The Total quantity of cloth supplied by the suppliers is 2,15,600 metres and the total demanded quantity is 2,12,500 metres. The Demanded Quantity is less than the Supplied Quantity and hence a dummy column is added.

The cost of the cloth is in per metre terms.

The solution of this transportation problem is computed using solver:

- The 6 demand locations are written vertically in columns (including dummy demand location)

- The 5 supply locations are written horizontally in rows
- There are 30 decision variables, i.e. the individual transportation cost from each demand location to each supply location
- There are 11 constraints, i.e. the maximum quantity demanded by each demand location and the maximum quantity supplied by each supply location
- The table has been copied and pasted with as changes in dummy column's demand (3100m) to match the total quantity demanded to the total quantity supplied
- Now, we will insert an extra column and row which would be the sum of the respective rows and columns.
- And we will use the function of 'Sum product' to calculate the sum product of the allocations i.e.,second table and the per metre cost of transportation i.e.,first table which would be the optimum total cost.
- Now we will use the solver function, where the objective function would be to minimise the total cost.
- The variables we will change will be the table of allocations i.e., part of second table.
- The constraints we would select would be:
  A. The extra column that we made earlier (sum of each row) should be less than or equal to the respective supply.
  B. The extra row that we made earlier (sum of each column) should be equal to respective demand.
- Check 'Make Unconstrained Variables Non-Negative' and select 'Simplex LP'
- Finally, click solve.

These are the following allocations achieved using solver:

Nilofar Fabrics – Jazzu Sarees (46000m)

Nilofar Fabrics – Ankit Traders (900m)

Nilofar Fabrics - Dummy (3100m)

Dhyan Enterprises - Jawaharlal Jagannath Prasad (44500m)

Dhyan Enterprises - Amit Textiles (1500m)

Mahalaxmi Silk Mills - Ankit traders (37600m)

Mahalaxmi Silk Mills- Shree Ram Synthetics (4400m)

Raj Silk Mills - Ankit Traders (5500m)

Raj Silk Mills - Amit Textiles (34500m)

Hanuman Enterprises - Shree Ram Synthetics (37600m)

The Solution is non-degenerate.

The Total Transportation Cost is Rs. 5,20,700.

One of the major problems every textile and garment industry in India faces is establishing an effective supply chain. Due to this industry being a major contributor to India's GDP, Industrial Production, Export Income and Employment Provider, there is strong competition, and to ensure firms don't get trampled by

this competition designing an effective supply chain is essential. In this paper, we have used a Transportation Problem, an operations research technique used to help minimise the cost of distributing a product from a number of sources or origins to a number of destinations, to help B-Series, a textile firm, to reduce its transportation costs. We have used Vogel's Approximation Method to find the Initial Feasible Cost after which we have used the Modified Distribution Approach to identify the minimal cost route of transportation. A dummy column was added as the demand did not Live up to the supply. From the solution, it is found that the Total Transportation Cost is Rs. 5,20,700.

SENSITIVITY ANALYSIS

Table

Microsoft Excel 16.0 Sensitivity Report
Worksheet: [Sensitivity Analysis.xlsx]Sheet1
Report Created: 16-10-2018 13:52:43

VARIABLE CELLS

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
E16	Nilofar fabrics Jazzu sarees	46000	0	2	6	1E+30
F16	Nilofar fabrics Jawaharlal Jagannath Prasad	0	0	3	1E+30	0
G16	Nilofar fabrics Ankit traders	900	0	4	0	1
H16	Nilofar fabrics Shree ram synthetics	0	2	9	1E+30	2
I16	Nilofar fabrics Amit textiles	0	1	4	1E+30	1
J16	Nilofar fabrics Dummy	3100	0	0	1	1E+30
E17	Dhyan enterprises Jazzu sarees	0	10	11	1E+30	10
F17	Dhyan enterprises Jawaharlal Jagannath Prasad	44500	0	2	0	1E+30
G17	Dhyan enterprises Ankit traders	0	1	4	1E+30	1
H17	Dhyan enterprises Shree ram synthetics	0	1	7	1E+30	1
I17	Dhyan enterprises Amit textiles	1500	0	2	1	0
J17	Dhyan enterprises Dummy	0	1	0	1E+30	1
E18	Mahalaxmi Silk mills Jazzu sarees	0	17	17	1E+30	17
F18	Mahalaxmi Silk mills Jawaharlal Jagannath Prasad	0	7	8	1E+30	7
G18	Mahalaxmi Silk mills Ankit traders	37600	0	2	1	1
H18	Mahalaxmi Silk mills Shree ram synthetics	4400	0	5	1	1
I18	Mahalaxmi Silk mills Amit textiles	0	2	3	1E+30	2

J18	Mahalaxmi Silk mills Dummy	0	2	0	1E+30	2
E19	Raj Silk Mills Jazzu sarees	0	6	7	1E+30	6
F19	Raj Silk Mills Jawaharlal Jagannath Prasad	0	14	16	1E+30	14
G19	Raj Silk Mills Ankit traders	5500	0	3	1	0
H19	Raj Silk Mills Shree ram synthetics	0	10	16	1E+30	10
I19	Raj Silk Mills Amit textiles	34500	0	2	0	1
J19	Raj Silk Mills Dummy	0	1	0	1E+30	1
E20	Hanuman enterprises Jazzu sarees	0	14	13	1E+30	14
F20	Hanuman enterprises Jawaharlal Jagannath Prasad	0	5	5	1E+30	5
G20	Hanuman enterprises Ankit traders	0	1	2	1E+30	1
H20	Hanuman enterprises Shree ram synthetics	37600	0	4	1	1E+30
I20	Hanuman enterprises Amit textiles	0	3	3	1E+30	3
J20	Hanuman enterprises Dummy	0	3	0	1E+30	3

CONSTRAINTS

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
E21	Jazzu sarees	46000	2	46000	0	46000
F21	Jawaharlal Jagannath Prasad	44500	3	44500	0	900
G21	Ankit traders	44000	4	44000	0	900
H21	Shree ram synthetics	42000	7	42000	0	900
I21	Amit textiles	36000	3	36000	0	900
J21	Dummy	3100	0	3100	0	3100
K16	Nilofar fabrics SUPPLY	50000	0	50000	1E+30	0
K17	Dhyan enterprises SUPPLY	46000	-1	46000	900	0
K18	Mahalaxmi Silk mills SUPPLY	42000	-2	42000	900	0
K19	Raj Silk Mills SUPPLY	40000	-1	40000	900	0
K20	Hanuman enterprises SUPPLY	37600	-3	37600	900	0

From the sensitivity analysis report obtained from excel, we observe that:

- The optimal solution is represented by final values in the objective i.e.,variable cells.So. the optimal objective function can be found by plugging the optimal solution into the objective function to obtain Rs 5,20,700.
- Allowable Increase and decrease values specify how much the objective coefficients can change before the optimal solution will change.
- Excel usually represents very large values with 1E+30.
- Now,The bottom part of the table, titled CONSTRAINTS , addresses the range of feasibility.
- That is,the range of Right Hand Side of a constraint where the shadow price remains unchanged.
- Shadow price here refers to the amount of change in the optimal objective function value per unit increase in the RHS of a constraint.
- For Slack and surplus values, we simply take the difference between the final values (left side of constraints) and RHS of constraints.
- Where the final value < or = to the RHS of constraints ,are termed as slack variable.
- Final value > or = to the RHS of constraints, are termed as Surplus Variable.
- Binding constraints are the ones where the final value = RHS of contraints i.e., That have 0 slack or surplus variable.

CONCLUSION

Using the Transportation Problem of Linear Programming Model, we can conclude that B-Series Pvt. Ltd. Company will achieve minimum transportation cost of **Rs. 5,20,700** using the following combinations of supply and demand locations:

SENDERS OF SAREES

- **Nilofar Fabrics** should supply 46000m to Jazzu Sarees, 900m to Ankit Traders, and 3100m will not be supplied (as it is allocated to a dummy column)
- **Dhyan Enterprises** should supply 44500m to Jawaharlal Jagannath Prasad, and 1500m to Amit Textiles
- **Mahalaxmi Silk Mills** should supply 37600m to Ankit Traders, and 4400m to Shree Ram Synthetics
- **Raj Silk Mills** should supply 5500m to Ankit Traders, and 34500m to Amit Textiles
- **Hanuman Enterprises** should supply 37600m to Shree Ram Synthetics

RECEIVERS OF SAREES

- **Jazzu Sarees** should demand 46000m completely from Nilofar Fabrics
- **Jawaharlal Jagannath Prasad** should demand 44500m completely from Nilofar Fabrics
- **Ankit Traders** should demand 900m from Nilofar Fabrics, 37600m from Mahalaxmi Silk Mills, and 5500m from Raj Silk Mills
- **Shree Ram Synthetics** should demand 4400m from Mahalaxmi Silk Mills, and 37600m from Hanuman Enterprises
- **Amit Textiles** should demand 1500m from Dhyan Enterprises and 34500m from Raj Silk Mills
- **Dummy column** is demanding an excess, unrequired 3100m from Nilofar Fabrics.

BIBLIOGRAPHY

1 Bertsekas DP, (1998) Network Optimization: Continuous and Discrete Models

2 Bisht and Srivastava, 2017

Bisht, D., Srivastava, P.K., 2017. A unique conversion approach clubbed with a new ranking technique to optimize fuzzy transportation cost. In: AIP Conference Proceedings, vol. 1897, p. 020023.

3 Darom, N.A.M.; Hishamuddin, H. Integration of economic and environmental aspects in sustainable supply chain management: A review. In Proceedings of the 6th International Conference on Industrial Engineering and Operations Management in Kuala Lumpur, Kuala Lumpur, Malaysia, 8–10 March 2016.

4 Dinagar and Palanivel, 2009

D.S. Dinagar, K. Palanivel The transportation problem in fuzzy environment, Int. J. Algorithms Comput. Math., 2 (3) (2009), pp. 65-71

5 Ebrahimnejad, 2014

A. Ebrahimnejad A simplified new approach for solving fuzzy transportation problems with generalized trapezoidal fuzzy numbers, Appl. Soft Comput., 19 (2014), pp. 171-176

6 Ezeokwelume Obinna Vincent, 2016

7 Hine J.L. and Ellis S.D. (2001) Agricultural Marketing and Access to Transport Services, Rural Travel and Transport Program, 1-11.

8 Kaur and Kumar, 2011

A. Kaur, A. KumarA new method for solving fuzzy transportation problems using ranking function, Appl. Math. Model., 35 (12) (2011), pp. 5652-5661

9 Mathur et al., 2016

N. Mathur, P.K. Srivastava, A. Paul Trapezoidal fuzzy model to optimize transportation problem, Int. J. Model. Simul. Sci. Comput., 7 (03) (2016), p. 1650028

10 Ritha W. and Merline Vinotha J. (2009) Journal of Physical Sciences, 13, 107-120.

11 Ritha and Vinotha, 2009

Ritha, W., Vinotha, J.M., 2009. Multi-objective two stage fuzzy transportation problem

12 Seuring, S.; Müller, M. From a literature review to a conceptual framework for sustainable supply chain management. *J. Clean. Prod.* **2008**, *16*, 1699–1710. [CrossRef]

13 Winston & Albright (1998) Practical Management Science

14 Zimmermann, 1978

H.-J. Zimmermann Fuzzy programming and linear programming with several objective functions, Fuzzy Sets Syst., 1 (1) (1978), pp. 45-55