

A Study on Transshipment Model for Export of Rubber from Tripura to Bangladesh

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Abstract: Production of rubber in Tripura is the second largest after Kerala. But a less quantity is locally utilized compare to other rubber producing states. A large quantity of rubber is transported to different parts of the country. But transportation costs at present is not so much favourable for the firms or agencies due to frequent price hike of petroleum. Bangladesh is the neighbouring country of Tripura. Bilateral trading now a days is functioning smoothly. Industrialization in rubber sector in Bangladesh needs a sizable quantity of rubber. For exportation of rubber from Tripura to Bangladesh, a transshipment model is considered to minimize the transportation costs.

Keywords: Transshipment model, Vogel's Approximation Method, Optimal Solution etc.

I. Introduction:

Tripura, a beautiful green hilly state, surrounded by natural beauty, eye witness of birth of Bangladesh, turns dubious when debate for development takes place. Climate of Tripura offers wide range of opportunities for the cultivation of various food crops, fruits, vegetables and flowers and plantation crops. Rubber plantation in Tripura has gained its momentum at present. According to survey report by Rubber Board of India, one lakh hectares land area can be utilized for rubber plantation. At present 58 thousand hectares land area is covered where rubber plantation is taken place. In Tripura, rubber plantation and rubber related other activities has an important role for the development of the socio-economic status of the State.

Rubber is the important cash crops of the state. Tripura has been declared the Second Rubber Capital of India after Kerala. Good about Tripura is that it is located on strategically strong position. On three fronts, it is surrounded by Bangladesh. On one front it is connected with Assam and Mizoram which is linked with Myanmar. Tripura's strategic location can be exploited through bilateral trade, whether it is with Bangladesh, China, Myanmar, Nepal or Bhutan. On three sides, Tripura, in the past, had excellent transportation links with the then East Bengal. Many large towns in Bangladesh are within 150 kilometres of the towns in Tripura. Border trade with Bangladesh will effectively integrate the Tripura Economy to the rest of India as well as to the other countries in the Region. In fact, it will make Tripura 'Gate Way' to the "North East" and will give a great boast to the state economy. This would open up a vast market for the industrial units specially Rubber Industry units in Tripura. Facilitating cargo movement by using the land ports between Tripura and Bangladesh will cut down on transport cost for the producers who sell their product to the main land rubber goods industries.

II. Problem Statement:

Rubber has been identified as one of the thrust area in Tripura. Tripura is the second largest rubber producer in the country, after Kerala. The total area under rubber plantations in Tripura at present is nearly 58,000 hectares and produced nearly 28,000 tone of natural rubber. But merely 6-7% of total production is locally utilised. Several agencies working in Tripura export rubber to many states and also many countries. Neighbouring country Bangladesh is one of major rubber importer from Tripura. On the basis of available data collected from locally working agencies, a transshipment model is developed. 23 sub-divisions of Tripura are divided into 4 zones and we consider two land custom stations as buffer for transportation.

We consider Z_1, Z_2, Z_3, Z_4 for four zones, A(Akhaura) and B(Srimantapur) for land custom stations as transit centres and X(Dhaka), Y(Comilla) as destinations where rubber will be exported. Data collected from the source is given below:-

	A	B	X	Y	Supply
Z_1	2750	3500	----	----	1000
Z_2	2675	2500	----	----	700
Z_3	5400	2600	----	----	1200
Z_4	7600	9780	----	----	600
A	0	3400	9000	16750	
B	----	0	15650	1600	
X	-----	-----	0	7500	
Demand			2000	1500	

Transportation costs given in the table is in Rupees per 25 tons. On the Basis of the given data we construct a transshipment network between sources and destinations.

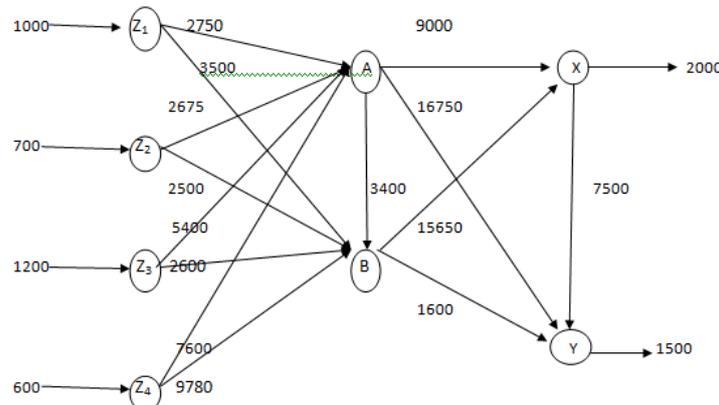


Figure 1: Transshipment Network between sources and destinations.

III. Model Formulation:

The transshipment model can be converted into a regular transportation model with seven sources ($Z_1, Z_2, Z_3, Z_4, A, B, X$) and four destinations (A, B, X, Y). The formulated model is

Minimize $Z = \sum \sum c_{ij} x_{ij}$ where $i=1,2,\dots,7 ; j = 1,2,3,4$
 Subject to $\sum x_{ij} = a_i, i = 1,2,\dots,7$ (Supply constraints), $j = 1,2,3,4$
 $\sum x_{ij} = b_j, j = 1,2,3,4$ (demand constraints), $i = 1,2,\dots,7$
 and $x_{ij} \geq 0$ for all i and j

where x_{ij} = number of units of the product in ton to be transported from source i ($i = 1,2,\dots,7$) to destination j ($j = 1,2,3,4$)

C_{ij} = cost of units (Rupees per 25 tons)

The amount of supply and demand different at the different nodes are computed :

Supply at a pure supply node (Z_1, Z_2, Z_3, Z_4) = Original supply

Demand at a pure demand node (X, Y) = Original demand

Supply at a transshipment node (A, B, X) = Original supply + Buffer amount

Demand at a transshipment node = Original demand + buffer amount.

In this problem buffer amount = Total supply (or demand)

$$100+700+ 1200+600(\text{or } 2000+1500) = 3500 \text{ tons.}$$

In this present problem, transportation from certain sources to certain destinations is not possible. We can handle the problem by assigning very large cost by M.

IV. Solution:

To find out the solution of the present problem, we apply more desirable solution method, Vogel's approximation method.

Vogel's Approximation Method (VAM)

	A	B	X	Y	Supply
Z_1	2750 1000	3500	M	M	1000
Z_2	2675 400	2500 300	M	M	700
Z_3	5400	2600 1200	M	M	1200
Z_4	7600 600	9780	M	M	600

A	0	3400	9000	16750	3500
	1500		2000		
B	M	0	15650	1600	3500
		2000		1500	
X	M	M	0	7500	3500
			3500		
Demand	3500	3500	5500	1500	14000

Initial basic solution ---

$X_{11} = 1000, X_{21} = 400, X_{22} = 300, X_{32} = 1200, X_{41} = 600, X_{51} = 1500, X_{53} = 2000, X_{62} = 2000, X_{64} = 1500, X_{73} = 3500$.

$$\begin{aligned} \text{Min Cost} &= \text{Rs.}(2750 \times 1000 + 2675 \times 400 + 2500 \times 300 + 2600 \times 1200 + 7600 \times 600 + 0 \times 1500 + 9000 \times 2000 + \\ & 0 \times 2000 + 1600 \times 1500 + 0 \times 3500) / 25 \\ &= \text{Rs.}13,02,000/- \end{aligned}$$

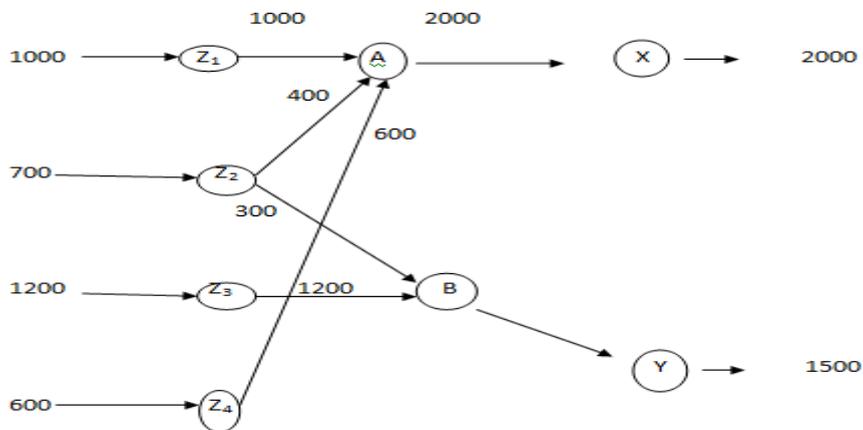


Figure 2: Solution of the transshipment model.

V. Optimality Test-MODI Method:

The quantities $(u_i + v_j)$ for the unoccupied cells are displayed in the circles.

Optimality test table

	A	B	X	Y	Supply	u_i
Z_1	2750 1000	(2575) 3500	M	M	1000	$u_1=2750$
Z_2	2675 400	2500 300	M	M	700	$u_2=2675$
Z_3	(2775) 5400	2600 1200	M	M	1200	$u_3=2775$
Z_4	7600 600	(7425) 9780	M	M	600	$u_4=7600$
A	0 1500	(-175)	9000 2000	(1425)	3500	$u_5=0$

		3400		16750		
B	M	0	2000	1600	3500	$u_6=175$
			9175	1500		
			15650			
X	M	M	0		3500	$u_7=-9000$
			3500	-7575		
				7500		
Demand	3500	3500	5500	1500	14000	
v_j	$v_1=0$	$v_2=-175$	$v_3=9000$	$v_4=1425$		

We compute $\Delta_{ij} = c_{ij} - (u_i + v_j)$, the cell evaluations, for the unoccupied cells.

	925		
2625			
	2355		
	3575		15325
		6475	
			15075

$$\Delta_{12} = 925, \Delta_{31} = 2625, \Delta_{42} = 2355, \Delta_{52} = 3575, \Delta_{54} = 15325, \Delta_{63} = 6475, \Delta_{74} = 15075$$

Since all $\Delta_{ij} > 0$, the solution under test is optimal. Thus the optimal solution is

$$X_{11} = 1000, X_{21} = 400, X_{22} = 300, X_{32} = 1200, X_{41} = 600, X_{51} = 1500, X_{53} = 2000, X_{62} = 2000, X_{64} = 1500, X_{73} = 3500.$$

$$\begin{aligned} \text{Min Cost} &= \text{Rs.}(2750 \times 1000 + 2675 \times 400 + 2500 \times 300 + 2600 \times 1200 + 7600 \times 600 + 0 \times 1500 + 9000 \times 2000 + 0 \times 2000 \\ &+ 1600 \times 1500 + 0 \times 3500) / 25 \\ &= \text{Rs.}13,02,000/- \end{aligned}$$

VI. Conclusion:

In this paper, we consider two land custom stations to transport rubber sheet from Tripura to Bangladesh. The optimal solution obtained in this present investigation is same with initial basic feasible solution which we obtained by applying Vogel's approximation method. This model can be applied also for more than two transit points. Our motto is to minimize the transport cost. This model is useful in other sectors also.

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