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A COMPARATIVE STUDY ON TRANSSHIPMENT MODEL FOR EXPORT OF RUBBER SHEET FROM TRIPURA TO BANGLADESH

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ABSTRACT

Production of rubber in Tripura is the second largest in India 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 are not so much favorable for the firms or agencies due to frequent price hike of petroleum. Tripura's strategic location can be exploited through bilateral trade, whether it is with Bangladesh, China, Myanmar or Bhutan. Industrialization in rubber sector in Bangladesh needs a sizable quantity of rubber. In this present paper a comparative study has been carried out transshipment network for exportation of rubber from Tripura to Bangladesh.

KEYWORDS: Transportation model, Transshipment Network, Transportation Cost, Vogel's Approximation Method, Optimization

1. INTRODUCTION

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 hectare land area can be utilized for rubber plantation. At present 85,453.63 hectares land area is covered where rubber plantation is taken place. In Tripura, rubber plantation and rubber related other activities have an important role for the development of the socio-economic status of the State. Rubber is the important cash crops of the state. 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, in the past, had excellent transportation links with the then East Bengal. Many large towns in Bangladesh are within 150 kilometers 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. Industrialization in rubber sector in Bangladesh needs a sizable quantity of rubber. 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.

2. PROBLEM STATEMENT

The total area under rubber plantations in Tripura at present is nearly 85,000 hectares and produced nearly 53,000 tone of natural rubber. But merely 7-8% of total production locally utilized. Several agencies working in Tripura export rubber to many states and also many countries. Neighboring country Bangladesh is one of major rubber importer from Tripura. On the basis of available data collected from one locally working agency, a transshipment model is developed. 23 sub-divisions of Tripura are divided into 4 zones. In this present study, two different cases have been studied changing transit points but without altering destination points and comparative study has been carried out. For each case, two land custom stations have been considered as buffer for transportation.

We consider Z_1(West), Z_2(South) , Z_3(Central) ,Z_4(North) as four zones, A(Akhaura) and B(Srimantapur) for land custom stations as transit centres and X(Dhaka), Y(Comilla) as destinations for first case and A_1(Raghna) and B(Srimantapur) for land custom stations as transit centres and X(Dhaka), Y(Comilla) for second case where rubber will be exported. In the paper of Sen & Nandi (2012), they considered only one transshipment network. Here, two network systems are adopted.

3. MODEL FORMULATION

One of the most important and successful applications of quantitative analysis for solving business and management problems has been in the physical distribution of products, generally referred to as transportation problems (Reeb and Leavengood, 2002).

The transportation problem is one of the oldest applications of linear programming problems.In the paper of Campbell (1992), it is found that locating transshipment facilities and allocating origins and destinations to transshipment facilities are important decisions for many distribution and logistics systems. Miao et al. (2012) studied transshipment problem to find the optimal schedules with minimum total costs including transportation cost. Sen et al. (2010) formulated OR model from collected data concerning with the transportation of an essential good from different suppliers of Silchar to different destinations in Mizoram and analyzed the optimal solution with basic feasible solutions obtained using conventional methods and also used objected oriented programming.

The transshipment model can be converted into a regular transportation model with different m supply centres or sources and n different demand centres or destinations. The formulated model is

Minimize Z = $\sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$

Subject to the constraints

$\sum_{j=1}^{n} x_{ij} = a_i,\ i = 1,2,\ldots,m$ (supply constraints)

$\sum_{i=1}^{m} x_{ij} = b_j,\ j = 1,2,\ldots,n$ (demand constraints)

$x_{ij} \geq 0$ for all i,j

Where x_{ij}= Number of units of the product to be transported from source i(i=1,2,…,m) to destination j(j=1,2,….,n) and c_{ij}=Cost of units.

4. DIFFERENT CASES

For comparative study, two different cases have been studied taking different transit points and beneficial rout has been identified.

4.1 CASE I

In the first case, two land custom stations, Akhaura(A) and Srimantapur(B) are considered as transit points for exportation of rubber to two destinations, one is Dhaka(X) and other is Comilla(Y).

	A	B	X	Y	Supply
Z_1	275	350	----	----	1000
Z_2	267.5	250	-----	-----	700
Z_3	540	260	-----	-----	1200
Z_4	760	978	----	-----	600
A	0	340	900	1675	
B	----	0	1850	160	
X	-----	-----	0	750	
Demand			2000	1500	

Table 1: Summary of relevant data of case-I

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

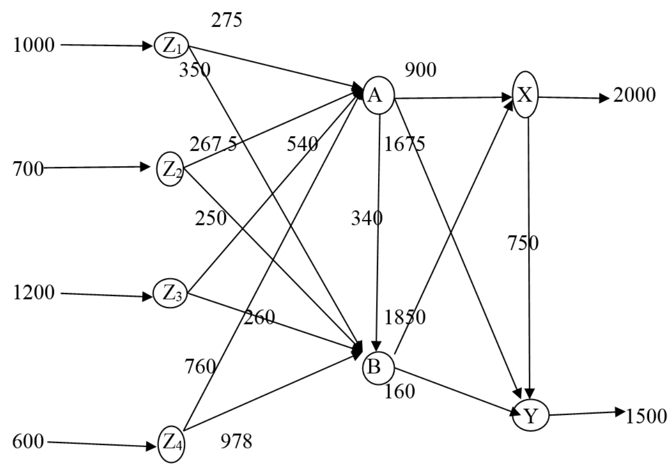

Figure 1: Transshipment Network between sources and destinations.

4.1.1 Model Formulation of Case-I

The transshipment model is converted into a 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 = $\sum_{i=1}^{7}\sum_{j=1}^{4} c_{ij}x_{ij}$

Subject to the constraints

$\sum_{j=1}^{4} x_{ij} = a_i,\ i = 1,2,\ldots,7$ (Supply constraints)

$\sum_{i=1}^{7} x_{ij} = b_j,\ j = 1,2,3,4$ (Demand constraints)

$x_{ij} \geq 0$ for all i,j

Where x_{ij}= Number of units of the product to be transported from source i(i=1,2,…,7) to destination j(j=1,2,3,4) and c_{ij}= Cost of units (per ton).

The amounts 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) 1000+700+ 1200+600(or 2000+1500)

= 3500 tones.

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

4.1.2 Solution of Case-I

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

	A	B	X	Y	Supply
Z_1	275 1000	350	M	M	1000
Z_2	267.5 400	250 300	M	M	700
Z_3	540	260 1200	M	M	1200
Z_4	760 600	978	M	M	600
A	0 1500	340	900 2000	1675	3500
B	M	0 2000	1850	160 1500	3500
X	M	M	0 3500	750	3500
Demand	3500	3500	5500	1500	14000

Table 2: Initial basic feasible solution by Vogel's approximation method for Case-I.

Initial basic 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.

Min Cost = Rs.(275X1000 +267.5X400 +250X300 +260X1200 + 760X600 + 0X1500 + 900X2000 + 0X2000 + 160X1500 + 0X3500)

= Rs.3265000/-

The solution of the transshipment network is

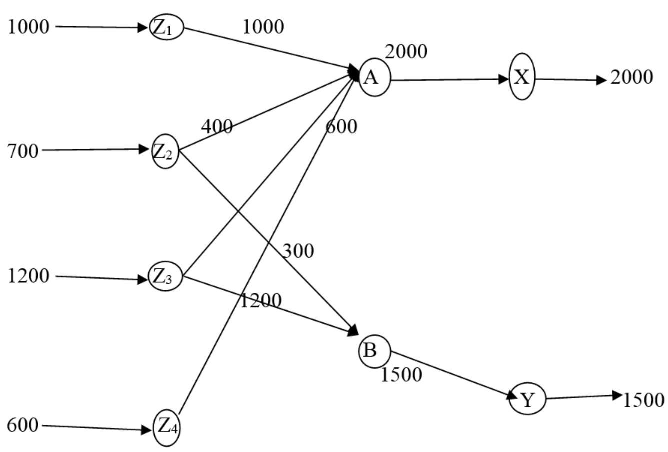

Figure 2: Solution of the transshipment model.

4.2 Case-II

In the first case, two land custom stations, Raghna(A1) and Srimantapur(B) are considered as transit points for exportation of rubber to two destinations, one is Dhaka(X) and other is Comilla(Y).

	A_1	B	X	Y	Supply
Z_1	760	350	----	----	1000
Z_2	980	250	-----	-----	700
Z_3	365	260	-----	-----	1200
Z_4	240	978	----	-----	600
A_1	0	1105	1340	2420	
B	----	0	1850	160	
X	-----	-----	0	750	
Demand			2000	1500	

Table 3: Summary of relevant data of case-II

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

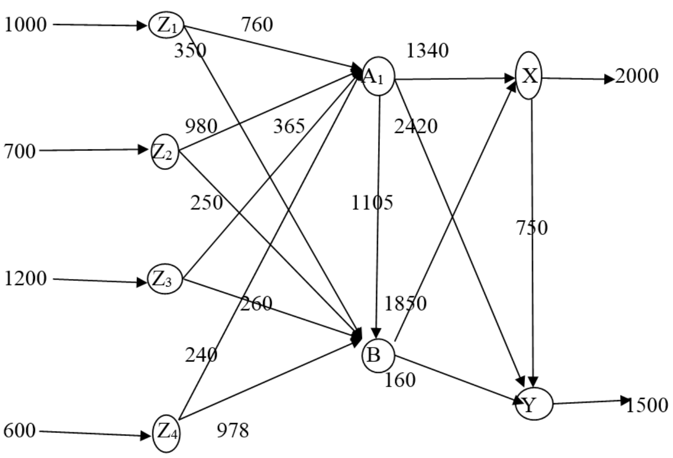

Figure 3: Transshipment Network between sources and destinations of case-II.

4.2.1 Model Formulation of Case-II

The transshipment model is converted into a transportation model with seven sources (Z_1, Z_2, Z_3, Z_4, A_1, B, X) and four destinations (A_1, B, X, Y). The formulated model structure is same as case-I.

4.2.2. Solution of Case-II

To find out the solution of the present problem that is for case-II, Vogel's approximation method is applied.

	A_1	B	X	Y	Supply
Z_1	760 $\boxed{200}$	350 $\boxed{800}$	M	M	1000
Z_2	980	250 $\boxed{700}$	M	M	700
Z_3	365 $\boxed{1200}$	260	M	M	1200
Z_4	240 $\boxed{600}$	978	M	M	600
A_1	0 $\boxed{1500}$	1105	1340 $\boxed{2000}$	2420	3500
B	M	0 $\boxed{2000}$	1850	160 $\boxed{1500}$	3500
X	M	M	0 $\boxed{3500}$	750	3500
Demand	3500	3500	5500	1500	14000

Table 4: Initial basic feasible solution by Vogel's approximation method for case-II

Initial basic solution is
X11 = 200, X12 = 800, X22 = 700, X31 = 1200, X41 = 600, X51 = 1500, X53 = 2000, X62 = 2000, X64 =1500, X73 = 3500.
Min Cost = Rs.(760X200 +350X800 +250X700 +365X1200 + 240X600 + 0X1500 + 1340X2000 + 0X2000 + 160X1500 + 0X3500) = Rs.4109000/-

The solution of the transshipment network is

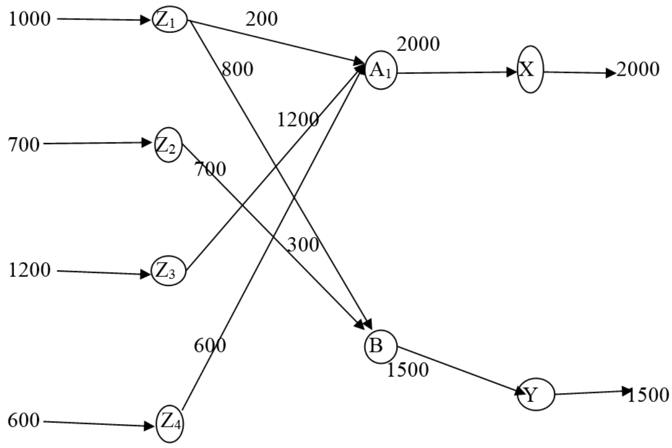

Figure 4: Solution of the transshipment model of case-II

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5. OPTIMALITY TEST (MODI METHOD) FOR CASE-I

The quantities (ui + vj) for the unoccupied cells are displayed in the circles.

	A	B	X	Y	Supply	ui
Z_1	275 1000	257.5 350	M	M	1000	u_1=275
Z_2	267.5 400	250 300	M	M	700	u_2=267.5
Z_3	277.5 540	260 1200	M	M	1200	u_3=277.5
Z_4	760 600	742.5 978	M	M	600	u_4=760
A	0 1500	-17.5 340	900 2000	142.5 1675	3500	u_5=0
B	M	0 2000	917.5 1850	160 1500	3500	u_6=17.5
X	M	M	0 3500	-757.5 750	3500	u_7= -900
Demand	3500	3500	5500	1500	14000	
v_j	v_1=0	v_2= -17.5	v_3=900	v_4=142.5		

Table 5: Optimality test table of Case-I

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

	92.5		
262.5			
	235.5		
	357.5		1532.5
		647.5	
			1507.5

Table 6: Cell evaluation table for case-I

Δ_{12} = 92.5, Δ_{31} = 262.5, Δ_{42} = 235.5, Δ_{52} =357.5, Δ_{54} = 1532.5, Δ_{63} = 647.5, Δ_{74}= 1507.5.Since all $\Delta_{ij} > 0$, the solution under test is optimal. The optimal solution obtained in this present investigation is same with initial basic feasible solution which we obtained by applying Vogel's approximation method. 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.

Min Cost = Rs.(275X1000 +267.5X400 +250X300 +260X1200 + 760X600 + 0X1500 + 900X2000 + 0X2000 + 160X1500 + 0X3500)

= Rs.3265000/-

6. OPTIMALITY TEST (MODI METHOD) FOR CASE-II

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

	A_1	B	X	Y	Supply	ui
Z_1	760 200	350 800	M	M	1000	u_1=760
Z_2	660 980	250 700	M	M	700	u_2=660
Z_3	365 1200	-45 260	M	M	1200	u_3=365
Z_4	240 600	-170 978	M	M	600	u_4=240
A_1	0 1500	-410 1105	1340 2000	-250 1675	3500	u_5=0
B	M	0 2000	1750 1850	160 1500	3500	u_6=410
X	M	M	0 3500	-1590 750	3500	u_7= 1340
Demand	3500	3500	5500	1500	14000	
v_j	v_1=0	v_2= -410	v_3=1340	v_4=-250		

Table 7: Optimality test table of Case-II.

We compute Δij = cij – (ui + vj), the cell evaluations, for the unoccupied cells.

320			
	305		
	1148		
	1515		2670
		100	
			2340

Table 8: Cell evaluation table for Case-II

Δ_{21} = 320, Δ_{32} = 305, Δ_{42} = 1148, Δ_{52} =1515, Δ_{54} = 2670, Δ_{63} = 100, Δ_{74}= 2340.Since all $\Delta_{ij} > 0$, the solution under test is optimal. The optimal solution obtained in this present investigation is same with initial basic feasible solution which we obtained by applying Vogel's approximation method. Thus the optimal solution is

X_{11} = 200, X_{12} = 800, X_{22} = 700, X_{31} = 1200, X_{41} = 600, X_{51} = 1500, X_{53} = 2000, X_{62} = 2000, X_{64} =1500, X_{73} = 3500.

Min Cost = Rs.(760X200 +350X800 +250X700 +365X1200 + 240X600 + 0X1500 + 1340X2000 + 0X2000 + 160X1500 + 0X3500) = Rs.4109000/-

7. RESULT AND DISCUSSION

For the first case when Akhaura land custom station is considered as a transit point, the minimum transportation cost for exportation of rubber is Rs. 3265000/-. But when Raghna land custom station is considered as transit point instead of Akhaura, transportation cost becomes much higher than the first one and minimum cost is Rs. 4109000/-. Results of both the cases clearly show that due to alteration of transit point, transportation cost varies and one can easily select suitable rout for transportation.

Fluctuation rate of fuel may vary the actual cost of transportation for shipment. If railways and water rout are connected between Tripura and Bangladesh, cost of transportation will be minimum and it will be more beneficial for companies as well as rubber planters.

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