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OPTIMIZING THE MOVEMENT OF PEOPLE AND GOODS IN A LOCAL COMMUNITY USING TRANSPORTATION MODEL

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Abstract- Transportation problem is one of the real regions of utilization of linear programming, in this paper, we would take a gander at how to upgrade the separation and time taken to make a trip starting with one point then onto the next in a Local community, with Otta Local government area as our concentration, utilizing the transportation display. Having the capacity to accomplish this accomplishment would improve the development of individuals and merchandise inside the organization by sparing time and separation it takes to move starting with one point then onto the next. Google delineate used to figure the separation and time it takes to move from one intersection to the next and a manual test was completed to check the outcomes from google. The ideal arrangement demonstrated that time and separation can be lessened if certain intersections were utilized and if new street is to be made. Three methods would be utilized to locate the underlying achievable arrangement, they are: Northwest corner method, least cost method, Vogel method, Modi method and Best candidate method would be utilized to locate the ideal arrangement.

Keyword: Transportation Model, Optimal Solution, Best candidate method

1. Introduction

Transportation problem is an uncommon sort of direct programming issue. Transportation demonstrating is an iterative strategy for taking care of issues that include limiting the cost of delivery items from a progression of sources to a progression of goals (Sami Fethi,2015). In a transportation problem, we have certain birthplaces, which may speak to manufacturing plants where we deliver things also, supply a required measure of the things to a particular number of objectives.

The linear programming model has limitations for supply at each source and request at every goal. All limitations are equities in an adjusted transportation display where supply breaks even with request. Limitations contain imbalances in unequal models where supply does not equivalent request. Transportation models assume a vital part in coordination and inventory network administration for lessening cost and enhancing administration (Kamrul Hasan). Some past investigations have formulated arrangement system for the transportation issue with exact free market activity parameters.

Transportation problems are being faced in urban areas due to increase in human activities and most world class universities are like small cities because of their size and compositions. Also, today's campuses have become as complex as urban areas, because of their unique characteristics and inter-related influences, most main universities' campuses are planned as small cities/communities (Coulson. et al., 2011).

(F.L.Hitchcock,2013) firstly presented transportation problem in his paper "The Distribution of a Product from Several sources to numerous Localities" and after that it's presenting by T. C. Koopmans in his historic paper "Optimum Utilization of the Transportation System". These researchers' contributions helped in the development of transportation methods which involve a number of shipping sources and a number of destinations.

Transportation problem is specified by a set of *m* supply points from which a good/service is shipped. Supply point *i* can supply at most *si* units and a set of *n* demand points to which the good/service is shipped. Demand point *j* must receive at least *dj* units. Each unit produced at supply point *i* and shipped to demand point *j* incurs a variable cost of *cij*.

The target of this transportation demonstrate is to decide the sum to be delivered from each source to every goal to keep up the free market activity prerequisites at the least transportation cost.

2. Methodology

We are considering six different origins and six different destinations, they are:

	Origin		**Destination**
O1	Joju	D1	Oja
O2	Sango	D2	Bells
O3	Ojuore	D3	Davol
O4	Tollgate	D4	Babio
O5	Sango market	D5	Obasanjo

The Best Candidates Method (BCM):

BCM process incorporates three stages; these means are appeared as takes after:

Step1: Prepare the BCM network, if the framework uneven, at that point the lattice will be adjusted without utilizing the additional line or segment candidates in arrangement technique.

Step2: Select the best candidates, which are for limiting problems to the base cost, and expanding benefit to the most extreme cost. In this way, this progression should be possible by choosing the best two candidates in each column. On the off chance that the candidate rehashed in excess of two times, at that point the candidate ought to be chosen once more. And in addition, the sections must be checked to such an extent that on the off chance that it isn't have candidates with the goal that the candidates will be chosen for them. Be that as it may, if the candidate is rehashed in excess of one time, the choose it once more.

Step3: Find the mixes by deciding one candidate for each line and segment, this ought to be finished by beginning from the line that have the minimum candidates, and afterward erase that line and section. On the off chance that there are circumstances that have no candidate for a few lines or segments, at that point specifically choose the best accessible candidate.

Rehash Step 3 by deciding the following candidate in the line that began from. Figure and think about the summation of candidates for every blend. This is to decide the best mix that gives the ideal arrangement.

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THE FOLLOWING METHODS WERE USED

- North - west corner method
- Least cost method
- Vogel's approximation
- MODI method(Modified distribution)

Table 1: shows the distance of the various destinations from Joju (O_1) and the time it takes from Joju to the destinations.

Table 1: Distance and time of various destinations from joju

Destination	Time (Min)	Distance (km)
Oja	6	1.4
Bells	10	2.1
Davol	9	1.6
Babio	4	1.0
Obasanjo	7	2.0

Table 2 shows the distance of the various destinations from Sango (O_2) and the time it takes from Sango to the destinations.

Table 2: Distance and time of various destination from sango

Destination	Time (Min)	Distance (km)
Oja	4	1.9
Bells	8	2.0
Davol	4	1.8
Babio	5	2.8
Obasanjo	4	1.6

Table 3 shows the distance of the various destinations from Ojuore (O_3) and the time it takes from Ojuore to the destinations.

Table 3: Distance and time of various destination from ojuore

Destination	Time (Min)	Distance (km)
Oja	5	2.5
Bells	6	2.0
Davol	6	1.9
Babio	8	2.7
Obasanjo	6	2.1

Table 4 shows the distance of the various destinations from Toll gate (O_4) and the time it takes from Toll gate to the destinations.

Table 4: Distance and time of various destination from tollgate

Destination	Time (Min)	Distance (km)

Oja	7	1.8
Bells	9	1.4
Davol	8	1.3
Babio	6	0.8
Obasanjo	4	2.0

Table 5 shows the distance of the various destinations from Sango market (O_5) and the time it takes from Sango market to the destinations.

Table 5: Distance and time of various destination from sango market

Destination	**Time (Min)**	**Distance (km)**
Oja	5	1.9
Bells	7	2.4
Davol	6	2.8
Babio	2	2.6
Obasanjo	8	3.0

Table 6: Table for Distance

	D_1	D_2	D_3	D_4	D_5	**Available time**
O_1	1.4	2.1	1.6	1.0	2.0	36
O_2	1.9	2.0	1.8	2.8	1.6	25
O_3	2.5	2.0	1.9	2.7	2.1	31
O_4	1.8	1.4	1.3	0.8	2.0	34
O_5	1.9	3.4	2.8	2.6	3.0	28
Required time	27	40	33	25	29	

Table 7: Table for Time

	D_1	D_2	D_3	D_4	D_5	**Available time**
O_1	6	10	9	4	7	36
O_2	4	8	4	5	4	25
O_3	5	6	6	8	6	31
O_4	7	9	8	6	4	34
O_5	5	7	6	2	8	28
Available time	27	40	33	25	29	

3. Result and discussion

Table 8: For Distance using North West Corner Method

	D_1	D_2	D_3	D_4	D_5	**Available time**

O_1	1.4^{27}	2.1^{9}	1.6	1.0	2.0	36
O_2	1.9	2.0^{25}	1.8	2.8	1.6	25
O_3	2.5	2.0^{6}	1.9^{25}	2.7	2.1	31
O_4	1.8	1.4	1.3^{8}	0.8^{25}	2.0^{1}	34
O_5	1.9	2.4	2.8	2.6	3.0^{28}	28
Required time	27	40	33	25	29	

Total = 27*1.4+9*2.1+25*2.0+6*2.0+25*1.9+8*1.3+25*0.8+1*2.0+28*3.0

37.8+18.9+50+12+47.5+10.4+20+2+84=282.6

Step 1: Start with north-west corner (Uppermost left-hand corner) of the transportation table allocate maximum possible amount of it, so that either the capacity of row is exhausted or the destination requirement of the first column is satisfied.

Step II

a) If the supply for the first row is exhausted, then move down vertically to the cell in the second row.

b) If the demand for the first column is satisfied, then move right horizontally to the second cell in the first row.

c) If both supply in the row and demand in the column is satisfied, then, move diagonally.

Step III: Continuing this way till an allocation is made in the south-east corner cell of the transportation table.

Table 9: For Distance using Least Cost Method

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	1.4^{11}	2.1	1.6	1.0^{25}	2.0	36
O_2	1.9	2.0	1.8	2.8	1.6^{25}	25
O_3	2.5	2.0	1.9^{31}	2.7	2.1	31
O_4	1.8	1.4^{32}	1.3^{2}	0.8	2.0	34
O_5	1.9^{16}	2.4^{8}	2.8	2.6	3.0^{4}	28
Required time	27	40	33	25	29	

Total = 11*1.4+25*1.0+25*1.6+31*1.9+32*1.4+2*1.3+16*1.9+8*2.4+4*3.0

15.4+25+40+58.9+44.8+2.6+30.4+19.2+12=248.3

Step I: Select the cell with the lowest cost and allocate maximum possible amount of it; if there is a tie make an arbitrary selection.

Step II: Delete the row or column or both which are satisfied by the allocation.

Step III: Again, search for the next lowest cost empty cell for which demand and supply are not exhausted and make the allocations. Repeat step I and II until all supply and demand conditions are satisfied.

Table 10: For Distance using Vogel's Approximation Method

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	1.4	2.1^{36}	1.6	1.0	2.0	36
O_2	1.9	2.0	1.8	2.8^{25}	1.6	25
O_3	2.5^{27}	2.0^{4}	1.9	2.7	2.1	31
O_4	1.8	1.4	1.3^{5}	0.8	2.0^{29}	34
O_5	1.9	2.4	2.8^{28}	2.6	3.0	28
Required time	27	40	33	25	29	

Total = 35*2.1+25*2.8+27*2.5+4*2.0+5*1.3+29*2.0+28*2.8

73.5+70+67.5+8+6.5+58+78.4=361.9

Step I: Calculate the penalty cost i.e. the difference between the lowest and the second lowest cost values for each row and each column.

Step II: Enter the penalty cost of each row to the right of corresponding row and the penalty cost of each column under the corresponding column.

Step III: Select the row or column with the largest penalty and allocate maximum possible amount to the cell with the minimum cost in the selected row or column. If there are more than one largest penalty rows or columns we select any of them arbitrarily.

Step IV: Cross out the particular row or column on which the requirement is satisfied.

Step V: Recompute the penalty cost for each row and column for the reduced transportation table and go to the previous steps.

Step VI: Repeat step I to V until all the requirement are satisfied.

Table 11: Using Modi Method to find the Optimal Solution

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	1.4^{11-}	2.1	1.6	1.0^{25+}	2.0	36
O_2	1.9	2.0	1.8	2.8	1.6^{25}	25
O_3	2.5	2.0	1.9^{31}	2.7	2.1	31
O_4	1.8	1.4^{32}	1.3^{2}	0.8	2.0	34
O_5	1.9^{16+}	2.4^{8}	2.8	2.6^{-}	3.0^{4}	28
Required time	27	40	33	25	29	

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	1.4^{10}	2.1	1.6	1.0^{26}	2.0	36

O_2	1.9	2.0	1.8	2.8	1.6^{25}	25
O_3	2.5	2.0	1.9^{31}	2.7	2.1	31
O_4	1.8	1.4^{32}	1.3^{2}	0.8	2.0	34
O_5	1.9^{17}	2.4^{8}	2.8	2.6^{-}	3.0^{4}	28
Required time	27	40	33	25	29	

Total = 10*1.4+17*1.9+26*1.0+25*1.6+31*1.9+32*1.4+2*1.3+8*2.4-1*2.6+4*3.0

14+32.3+26+40+58.9+44.8+2.6+19.2-2.6+12=247.2

Step I: To compute the values for each row and column, set Di + Oj = Cij but only for those squares that are currently used or occupied. For example, if the square at the intersection of row 2 and column 1 is occupied, we set D2 + O1 = C21.

Step II: After all equations have been written, set O1 = 0.

Step III: Solve the system of equations for all D and O values.

Step IV: Compute the improvement index for each unused square by the formula improvement index (Iij) = Cij _ Di _ Oj.

Step V: Select the largest negative index and proceed to solve the problem as you did using the stepping-stone method.

Table 12: For Time using North West Corner Method

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	6^{27}	10^{9}	9	4	7	36
O_2	4	8^{25}	4	5	4	25
O_3	5	6^{6}	6^{25}	8	6	31
O_4	7	9	8^{8}	6^{25}	4^{1}	34
O_5	5	7	6	2	8^{28}	28
Available time	27	40	33	25	29	

Total = 27*6 + 9*10 +25*8+6*6+25*6+8*8+25*6+1*4+28*8

162+90+200+36+150+64+150+4+224= 1080

Table 13: For Time using Least Cost Method

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	6^{11}	10	9	4^{25}	7	36
O_2	4	8	4^{25}	5	4	25

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O_3	5^{16}	6^{7}	6^{8}	8	6	31
O_4	7	9^{5}	8	6	4^{29}	34
O_5	5	7^{28}	6	2	8	28
Available time	27	40	33	25	29	

Total = 11*6+25*4+25*4+16*5+7*6+8*6+5*9+29*4+28*7

66+100+100+80+42+48+45+116+196=793

Table 14: For Time using Vogel's Approximation Method

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	6	10^{36}	9	4	7	36
O_2	4	8^{4}	4	5^{21}	4	25
O_3	5	6	6^{27}	8^{4}	6	31
O_4	7^{27}	9	8^{6}	6	4^{1}	34
O_5	5	7	6	2	8^{28}	28
Available time	27	40	33	25	29	

Total = 36*10+4*8+21*5+27*6+4*8+27*7+6*8+1*4+28*8

360+32+105+162+32+189+48+4+224= 1156

Table 15: Using Modi Method to find the Optimal Solution

	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	6^{11}	10	9	4^{25}	7	36
O_2	4	8	4^{25}	5	4	25
O_3	5^{16-}	6^{7+}	6^{8}	8	6	31
O_4	7	9^{5}	8	6	4^{29}	34
O_5	5^{+}	7^{28-}	6	2	8	28
Available time	27	40	33	25	29	
	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**Available time**
O_1	6^{11}	10	9	4^{25}	7	36
O_2	4	8	4^{25}	5	4	25
O_3	5^{15}	6^{8}	6^{8}	8	6	31
O_4	7	9^{5}	8	6	4^{29}	34
O_5	5^{1}	7^{27}	6	2	8	28
Available time	27	40	33	25	29	

Total = 11*6+25*4+25*4+15*5+8*6+8*6+5*9+29*4+1*5+27*7

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66+100+100+75+48+48+45+116+5+189=792

Table 16: Using **BCM** to find Optimal solution.

The matric is balanced, row equals column.

	D_1	D_2	D_3	D_4	D_5	Available time
O_1	6	10	9	4	7	36
O_2	4	8	4	5	4	25
O_3	5	6	6	8	6	31
O_4	7	9	8	6	4	34
O_5	5	7	6	2	8	28
Available time	27	40	33	25	29	

Table 17: Elect the best candidate

	D_1	D_2	D_3	D_4	D_5	Available time
O_1	6	10	9	4	7	36
O_2	4	8	4	5	4	25
O_3	5	6	6	8	6	31
O_4	7	9	8	6	4	34
O_5	5	7	6	2	8	28
Available time	27	40		25	29	

Table 18: Find the combination

	D_1	D_2	D_3	D_4	D_5	Available time
O_1	6	10	9	4	7	36
O_2	4	8	4	5	4	25
O_3	5	6	6	8	6	31
O_4	7	9	8	6	4	34
O_5	5	7	6	2	8	28
Available time	27	40	33	25	29	

Table 19: Find the combination

	D_1	D_2	D_3	D_4	D_5	Available time
O_1	6	10	9	4	7	36
O_2	4	8	4	5	4	25
O_3	5	6	6	8	6	31

O_4	7	9	8	6	4	34
O_5	5	7	6	2	8	28
Available time	27	40	33	25	29	

Combination 1: A3,B1,C2,D5,E4= 4+4+6+4+6= 14

Combination 2: A1,B3,C2,D5,E4= 6+4+6+4+2= 12

4. Discussion

The transportation problem from origin to various destinations is computed by estimation but the data collected were calculated and the results were obtained. More accurate results were equally obtained using most transportation problem solution method that gave the optimal solution for time and distance.

Based on these results, it is recommended that the local government chairman should allocate people to always carryout survey periodically to find out if there are variations in the distributions of passengers in their routes. Data obtained in surveys should be analysed with this method to obtain current optimal solution for the current transportation situation and compare it with previous one. If any alteration is made to the number of routes, then the system will need to be modified to meet the specified routes.

The BCM (Best Candidate Method) based on election the best candidates and the alternative in each row and cover all columns with at least one candidate, then we can obtain the combinations that must be have no any intersect means, one candidate for each row and column.

5. Conclusion

This study on enhancing the movement of people and goods in a Local Community was carried out mainly to identify the transportation routes and then structure the system to obtain a model that will enable the management and individuals to operate at minimal cost and reduced distance travelled so that transportation of people would be at a reduced cost and time to reach the destination would also be reduced and furthermore if new roads are to be constructed some of this junctions would be considered to reduce cost and time. As a result of this the community can operate at a minimum cost.

We have established the uniqueness and existence of optimal solution of the transportation problem for Otta Local community. This has been brought out through developed transportation problem into linear programming problem and applying the discuss methods in paper which yields an initial feasible solution and an optimal solution and have stated the optimality conditions of the problem. And we found out that the BCM method gives the optimal solution.

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