

Mathematical Modeling for Routes and Cost of Local Transports in Pune City



Sachin Ramesh Bhure, A. A. Warudkar

Abstract: Transportation problem is considered a vitally important aspect that has been studied in a wide range of operations including research domains. As such, it has been used in simulation of several real life problems. The transportation model is for the optimization of routes, cost and travelling of peoples with the help of public transport buses from the source to the destination by road. The data is collected which includes number of trips per day, cost of trips per trip, distance between source and destination etc. manually through the questionnaire interview with the conductors drivers and the regular travelling peoples travelling on that route as well as data collection from PMPML office and calculation for minimizing the transportation cost have been done. The result of the research with proper scheduling, proper routing of buses can save Rs. 48865.875 in a 1 day. The saving of the transportation cost increases the profit of the PMPML. The total saving amount profit percentage is about 18.15% increase from saving transportation cost. The parameters as discussed above are considered and collected manually with the help of survey sheet and transportation model is prepared and after that calculation for minimizing the transportation cost have been done. The methods used for minimization of transportation of cost are Northwest corner method, Least count method etc. The result of the research gives with proper scheduling, routing of buses can save generate so much of revenue with saving of cost.. The amount saved from the transportation cost is utilized for increase the facilities in bus such as A.C, Automatic door system, Air suspension, Good quality of seats etc.

Keyword: Least cost method, Minimum transportation cost, North West corner method, Transportation problem

I. INTRODUCTION

Transportation Problem is the problem which is used fundamentally to minimize the transportation cost for public transport systems, private transport with number of sources and number of destination with satisfying the demand and supply requirement. Public transport needs minimization of transportation.. The transportation models are connected with the demand and supply that is travelling of peoples from one station to another station in specific time period .The best possible route with optimum cost in which large number of peoples can travel on that route.

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The factors considered while minimization are accurate transportation cost, delivery time, Demand, supply, proper routing, capacity of buses etc. this study forces to minimization of transportation cost and routes which increase the efficiency and income of public transport system.

1.1 Aim

To design a suitable route, time schedule and cost by patrol survey for Pune bus public transport and provide suitable solution.

1.2 Objective

1. To study and conduct routes for survey purpose by reconnaissance survey.
2. To identify the existing routes for analysis of routes, time Schedule and cost.
3. To analyze the routes with survey which include parameters such as number of trips, number of peoples travelling, number of buses on route, money required per trip.
4. To design or suggest the solution for re-routing, re-scheduling.

1.3 Future Scope of study

1. Effective service
2. Feel safe
3. Effective guidance
4. Smart city
5. Less money, more comfort

1.4 Limitations of study

1. Bus availability
2. Route availability
3. Driver availability
4. Traffic in CBD of city
5. Conditions of bus
6. Conditions of roads
7. Expansive as compare to local transport that is train transport.

II. CHARACTERISTICS OF SURVEY

2.1 Reconnaissance Survey

Reconnaissance survey generates the basic but very efficient details about the survey field. The ideal method of this type of survey is Patrol survey.

In which overall information about the area is to be covered. This survey is carried out with the help of Google maps.

2.2 Actual visit to Routes and note down the scenario

After reconaissance survey actual visit to the routes is done. And note down the actual problem of that route such as availability of buses, cost per trip, and number of buses allocated for that route, time schedule etc.

2.3 Choose Complex route

Analyze the above collected data from reconnaissance survey and from that screening of that data is done on the basis of problems on that routes and selection of route is done further.

2.4 Preparation of survey sheet

A survey sheet is prepared on the basis of research papers for the tabular and compacted form of the survey data. A questionnaire prepared for the detailed information of the routs.

2.5 Field survey

Field survey is the further procedure and the core of the project. The actual work is implemented in this stage of survey.

2.6 Analysis of data by North West corner method

From above data collected from the survey analysis is done. The analysis is done with the help of North West corner method.

2.7 Suitable solution over existing problem

The suitable solution is given to all routs separately.

III. PREPARATION DATA SHEET FOR TRANSPORTATION MODEL

The city like Pune having big amount of population requires public transport system for the transport of the peoples from one station to another station with the help of buses available at that location. The buses are CNG buses, Ladies CNG buses and Electric buses etc. The transportation problem study for is destination located to the MANAPA,Pune and three sources are Nigdi Flyover Bus Station, Chinchwadgaon Bus Station and Hijewadi Bus Station.

3.1 The routes of road from source to the destination

The best routs are decided for the optimization of travelling of peoples from one place to another place that is source to destination. The routes decided must be convenient to the traveler, minimum transportation cost, delivered on time, less traffic route, minimum traffic signals and it must be with good quality of road.

Sources	Actual Distance in KM	Optimized route in KM
Nigdi Flyover Bus Station	19.00	26.80
Chinchwadgaon Bus Station	17.50	20.90
Hinjewadi Bus Station	17.00	27.35

Table 1 Optimized Route Distances

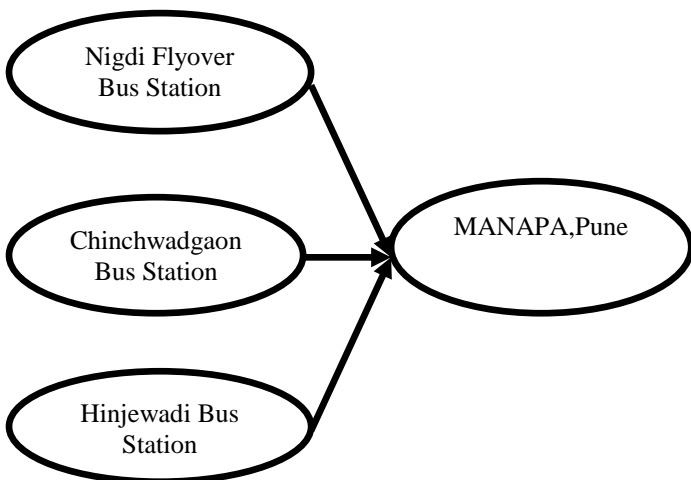
3.2 Data collection

1. Number of trips done in one day from Nigdi to Manapa are 112 trips/day.
2. Number of trips done in one day from Chinchwadgaon to Manapa are 172 trips/day
3. Number of trips done in one day from Hinjewadi to Manapa are 74 trips/day.
4. Number of trips can one driver and conductor can do in one day are 8 trips/day.
5. Number of buses for route Nigdi to Manapa are 14.
6. Number of buses for route Chinchwadgaon to Manapa are 22.
7. Number of buses for route Hinjewadi to Manapa are 10.
8. Number of CNG buses for route Nigdi to Manapa are 10.
9. Number of Ladies CNG buses for route Nigdi to Manapa are 2.
10. Number of Electric buses for route Nigdi to Manapa are 2.
11. Number of CNG buses for route Chinchwadgaon to Manapa are 15.
12. Number of Ladies CNG buses for route Chinchwadgaon to Manapa are 4.
13. Number of Electric buses for route Chinchwadgaon to Manapa are 3.
14. Number of CNG buses for route Hinjewadi to Manapa are 5.
15. Number of Ladies CNG buses for route Hinjewadi to Manapa are 3.
16. Number of Electric buses for route Hinjewadi to Manapa are 2.
17. Cost of CNG bus per Kilometer is Rs.35/Km
18. Cost of Ladies CNG bus per Kilometer is Rs.35/Km
19. Cost of Electric bus per Kilometer is Rs.5/Km

3.3 Vehicle condition

The condition of vehicle must be good enough that the bus will sustain load of the travelers. Sometimes the number of travelers is more in number of capacity of vehicle so that bus can sustain that much of weight as well.

Also good condition of bus can increase the revenue of public transport system and it will be good enough for the passengers. If the bus having low quality then it requires large amount of fuel, more maintenance required and less passengers comfort will ultimately lowers down the profit of public transport system. The bus drivers and conductors wages are fixed per day wise.



Source Destination
Schematic diagram of simple transportation problem

If the condition of the bus is good so the transport of the people is more than more in a day. Above data collection gives all the parameters which is collected from the drivers, conductors, regular bus travelers and bus depot staff.

Cost per trip = money required per kilometer x type of bus

		Nigdi	Chinchwad	Hinjewadi
CNG Bus	Total cost per trip	938	731	955
	Demand in trips	80	120	40
Ladies CNG bus	Total cost per trip	938	731	955
	Demand in trips	16	32	24
Electric Bus	Total cost per trip	134	104	136
	Demand in trips	16	24	16

Table 2 Data sheet for Transportation cost per trip and Destination

IV. METHODOLOGY

The travelling of the peoples with CNG Bus, Ladies CNG bus and Electric bus from the three different sources to the common destination MANAPA. Data sheet for transportation cost per trip and demand evaluated with questionery interview with bus drivers, bus conductors and regular travelers is as shown in the table. The data sheet gives an overview to make the transportation model Value of the data sheet of transportation cost helps to make a transportation model to minimize the transportation cost. The transportation model is a special case of linear programming problem. The simple algorithm method that is three equations three unknown problem is used to solve any linear programming problem. For this reason whenever possible we try to simplify the calculations. The transportation model is one of the simplified models. It deals with the situation in which commodity is transport from origins sources to destinations. The main objective of the transportation model is to minimize the transportation cost as well as optimization of route to reduce the transportation cost with satisfying both the demand as well as supply limits.

Source	CNG Bus	Ladies CNG Bus	Electric Bus	Supply
Nigdi Flyover Bus Station	955	955	136	112
Chinchwadgaon Bus Station	938	938	134	176
Hinjewadi Bus Station	731	731	104	80
Demand	56	72	240	

Table 3 Transportation Model

The transportation problem is solved by the help of the North West corner method (NWCM) and Least cost method (LCM) to finding the optimal solution of the transportation problem. The NWCM method is gives the accurate optimal solution to

minimized transportation cost. Also with the help of LCM method gives accurate optimal solution to minimize the transportation cost. The transportation problem solved manually calculations to find the optimal solution with minimum cost for the supply from source to destination

V. RESULT AND DISCUSSION

5.1 Transportation model solving manually calculation

The transportation model is solving manually calculated the actual transportation cost for the supply to the destination.

Total transportation cost=
(938*80)+(731*120)+(955*40)+(938*16)+(731*32)+(955*24)+(134*16)+(104*24)+(136*16)

Rs. 269096

Manual calculation

Objective Function,

Minimization $Z = 2046P+2010Q+1566R+\dots\dots\dots$ (a)

$955P+955Q+136R \geq 112\dots\dots\dots$ (1)

$938P+938Q+134R \geq 176\dots\dots\dots$ (2)

$731P+731Q+104R \geq 80\dots\dots\dots$ (3)

$P, Q \text{ \& } R \geq 0$

Where, P = Number of trips on route of Nigdi

Q = Number of trips on route of Chinchwadgaon

R = Number of trips on route of Hinjewadi

Solving the above equation (1), (2) and (3) we get the values of the P, Q, and R

$P = -22.20895$

$Q = 10.02985$

$R = 156.77611$

Then,

Put the value of P, Q and R in equation (a) objective function

Minimization

$(Z) = 2046*(-22.20895)$

$+2010*(10.02985)+1566*(156.77611)$

Minimization transportation cost (Z) = Rs.220231.875

5.2 Transportation model solving by different methods

5.2.1 North West Corner method

Minimum Transportation Cost =

$(56*955)+(56*955)+(16*938)+(160*134)+(80*104)$

Rs. 151728

5.2.2 Least Cost method

Minimum Transportation Cost =

$(40*955)+(16*938)+(72*955)+(16*134)+(80*104)$

Rs.151728

5.2.3 Amount Saved

With the help of optimization of transportation cost some of the amount is saved. The amount saved is calculated as the difference between the actual transportation cost and the optimization transportation cost by minimization with linear programming problem are,

Save amount = Actual transportation cost - Optimization transportation cost

= 269096-220231.875

Save amount (Rs.) = 48865.875

Saving transportation cost percentage %

= $\{[(\text{Actual transportation cost} - \text{Optimized transportation cost}) / \text{Actual transportation cost}] \times 100\%$

= $\{[(269096-220231.875) / 269096] \times 100\%$

= $(48865.875 / 269096) \times 100\%$

Saving transportation cost percentage = 18.15%



The transportation cost is saved up to the 18.15% of the actual transportation cost known as profit in 1 day.

VI. CONCLUSION

A. The transportation model is used to minimize the cost of travelling of peoples from one place to another place by road. Cost of transportation is the main and important constraint of the public transport system. The transportation model is one of the simple and accurate method of solving transportation cost of the transportation of people from source to the destination.

B. All the parameters such as number of trips, cost per trip, bus timings, distance between source and destination is collected manually to form a data sheet from the three sources. The three ways are Nigdi flyover bus station, Chinchwadgaon bus station, Hinjewadi bus station to the destination of Manapa, Pune and for the preparation of the data sheet for evaluating transportation cost which also include the fuel consumption, wages to the drivers, wages to the conductors etc. from above data the preparation of the transportation model is done and also the calculation of transportation cost is to be done.

C. The transportation model for the feasible solution with help of the NWCM, LCM and the manual linear programming problem found the optimum cost for the transportation of peoples from one place to another place. The optimization with the help of above methods gives Rs. 220231.875 and the actual transportation cost is Rs. 269096 which is calculated manually calculation.

D. The output of the research gives that proper routing, scheduling of buses can save Rs.48865.875 in 1 day.

E. The total saving of the cost of the transportation is 18.15% of the actual transportation cost which is use for further development of buses or other thing to increase the new facilities such as A.C, Automatic Doors, Comfortable seats, Air suspension etc. from the saving amount.

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