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Demand assessment of electric vehicles in public transport: A case of NDMC Area

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ABSTRACT

The hypothesis states that the DTC buses do not suffice the need of passengers in Delhi. A few reports suggest that by 2025 all the buses from DTC might run out. At current only 3760 buses are running, which are in a dilapidated condition. The buses' condition and the average frequency of the buses are as high as 20.76 minutes. So, under the FAME scheme, NDMC has purchased 20 electric buses to run on a pilot project. So the objective of the study is to identify routes to run the electric buses in the NDMC area. The approach adopted was to perform boarding and alighting surveys at the selected bus stops in NDMC. To identify the passengers traveling within NDMC. Therefore, to identify the route for electric buses to ply on the most frequent route traveled by passengers.

Keywords: *Electric Vehicles, Public Transport, Route identification, DTC Buses, Electric Buses*.

1. INTRODUCTION

NDMC is a hub of the commercial and institutional area. Due to its geographical location and radial road pattern, it acts as a junction for east to westbound traffic. This area experiences massive traffic beyond peak hours. 60-70% of traffic that comes in NDMC is due to convergence. As per the Smart city mission, NDMC is promoting Non-motorised transport. Under the FAME scheme by the government of India, the promotion of Electric vehicles gave rise to the project Electric Vehicle (buses) in the NDMC area. Electric buses will run to promote last-mile connectivity, provide an alternative public transit to reduce the emission of carbon dioxide. Hence, the project had initiated to assess the demand and feasibility of electric buses in the NDMC area.

2. RATIONAL FOR THE PROJECT

We cannot stress more and more how important is public transport in the 21st century. There are many studies that have proven from time to time about the need and benefits of public transport. For instance, public transport not only helps in reducing the number of cars, but it also reduces the time of travel. Improves our health and makes us active. With the advancement in technology, we can see there are alternatives available for vehicles like CNG, hybrid, or recently evolving electric vehicles. Nowadays, CNG and hybrid vehicles are in use but they have their own merits and demerits. Therefore, the use of electric vehicles is promoted by the government of India in public transit by a scheme called the FAME scheme. The Smart City Mission focuses on the use of public transport and walkable places. Therefore, the project has been initiated to incorporate electric vehicles (buses) in the NDMC area. So to identify the demand for bus users is the key factor for the study. So the report will help the municipal council in determining the demand of users for the service and provide the service efficiently for the public welfare.

3. AIM AND OBJECTIVE

The aim is to assess the demand of bus users in NDMC area. There are three objectives of the study, i.e., to study existing bus transport system for NDMC. To assess bus users, demand in NDMC area and to propose based on survey analysis.

4. LITERATURE REVIEW

Passenger boarding refers to the number of passengers getting inside the bus at the bus stops or terminals. Passenger Alighting refers to the number of passengers getting down the bus at the bus stops or terminals. Frequency is the Maximum possible number of passes by a vehicle on any given route at a particular time. Passenger Load is the number of passengers traveling from one bus stop

to another or traveling between bus stops from a terminal. Headway is the time between consecutive buses leaving on each route. Connectivity is the linking and delinking of the roads in convergence or dispersion of traffic and making a network with existing and proposed routes. Waiting Time is the time that is spent by a passenger from arrival at the bus stop to reaching the bus stop. Modal Split is the percentage of trips taken by any possible mode for travel. It does not depend upon the number of trips taken by a mode but on what percentage of people use the various mode of transport. Trip Time is the time taken to travel from one terminal to another. The route consists of bus stops in sequence. It contains an origin which is the starting point and a destination which is the end of the sequence.

The paper explains the bus route designing and defining bus frequency for the city of Haifa. The assumption was that the no. of buses is directly proportional to the factors that determine the cost. The procedure the researchers have adopted was to divide the city into zones and the journey between the zones was then represented in a matrix. The main objective of this study was to reduce journey time and to penalize the discomfort to the passengers for not finding a seat.

A planned phased method for development was adopted. Firstly, all desired routes were added to the initial routes then the sets which need to be augmented were pointed. A route was determined with four zones having restricted boundaries. Whereas, in the other stage frequency was determined for the routes with a limited number of buses. The method adopted was gradient.

A study for bus routes was carried out by DTC (Delhi Transport Corporation) for the distance from Janakpuri D block to Jai Mata Market. It was found that the time taken by a bus to travel depends upon boarding and alighting of passengers. Also, it depends upon the closing and opening of the doors. These were clarified through regression analysis. To check the time model a sensitivity analysis was carried.

The methodology they adopted was first to evaluate the existing route of the DTC on the designated path. Then survey was carried to collect data from bus stops at peak and non-peak hours, where passenger data onboarding and alighting was recorded. In step three a general development model was carried out on weekly, working days and working days were compared with both trips (inbound and outbound). Then in the fourth step, a sensitivity analysis was carried out to under general model's performance.

In the end, it can be said that the model was quite useful because in the regression analysis the R square value is larger than 0.5 in all cases. Hence, the model is the best fit and can be used by transport planners.

5. METHODOLOGY

Survey methodology includes a listing of all bus stops in CP and India Gate. Surveying at the 56 bus stops for boarding and alighting of CP and India Gate was performed. It included the Origin and Destination of the bus users in that area. The surveys were conducted in two parts, peak and non-peak hours. At each surveyed bus stop, 10 people at peak and non-peak hours were surveyed. That is equal to 20 people at each bus stop. The methodology was conducted with the limitations that an area-based approach due to time constraints to be adopted. Few surveys like the Origin-Destination survey, Time Speed Distance, Distance Delay, etc. transport surveys will not be conducted to assess the demand due to constraints in human resources and funding. Under the scope of the project, survey to use proposed socio-behavioural study for the willingness of users which can further be applied to other parts of the NDMC area.

6. STUDY AREA

DTC has a total of 265 bus routes that passes through NDMC area. Out of which falls under CP and India Gate are surveyed because these places are the hub of institutional areas, commercial space and government buildings. These places cater to maximum traffic in NDMC area. Approximately 60-70% of daily traffic passes through CP and India Gate. The total road distance that was calculated was 155 km of road network with NDMC area. The total number of bus stops within NDMC is 196 in number.

The survey was conducted at the bus stops of CP and India Gate. Where 56 bus stops lies and the survey was conducted in two phases, one in peak and another in non-peak hour, i.e. 6 am to 10 am and 4 pm to 8 pm. In both the time slots, 10 people were selected at each bus stand at both peak and non-peak hour. Therefore, 56 bus stands were surveyed, with 20 people on each bus stop.

7. ANALYSIS

The analysis was carried out on the basis of survey conducted at the various bus stops and also with secondary data available.

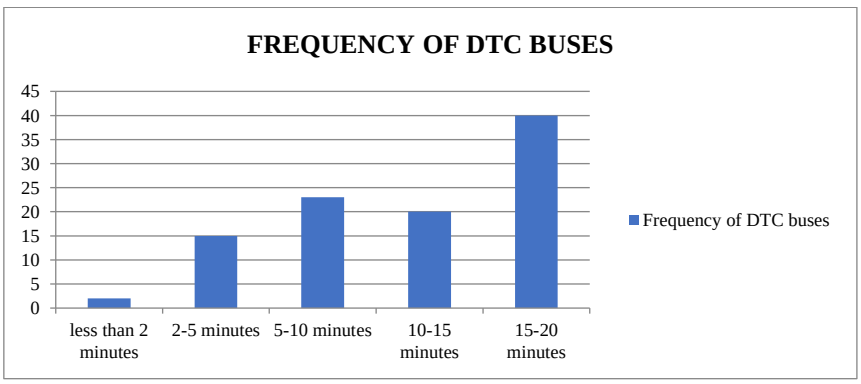

Figure 1- Frequency of DTC Buses

The average frequency of DTC buses are 20.76 mins. That means on an average it takes 20.76 mins for a bus to arrive at a bus stop. Therefore, there is a need to reduce in the timings of DTC bus service or provide an alternative to support the DTC service.

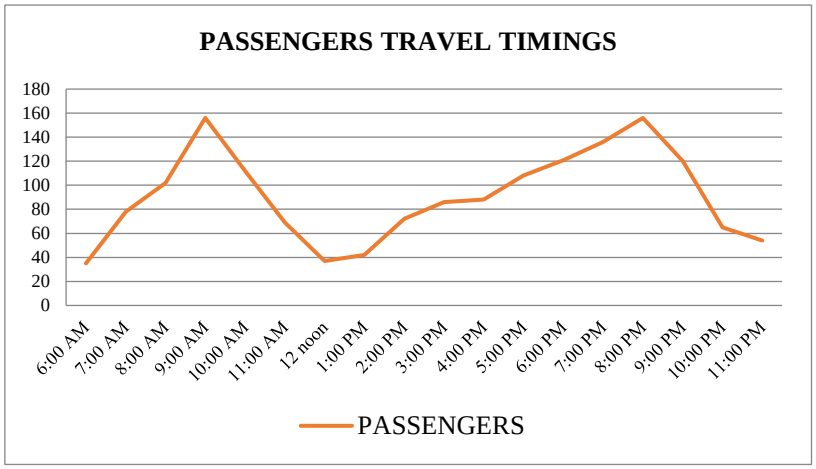

Figure 2- Passenger travel timings

There is a change in number of passengers that are travelling within NDMC. In peak hours the passengers travelling within NDMC goes as high as 156 and in non-peak hours they are as low as 35.

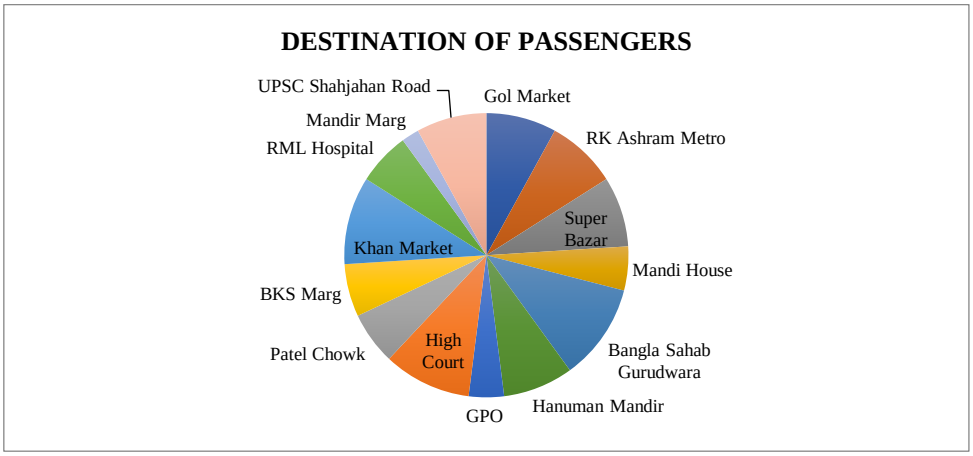

Figure 3- Destination of passengers

Table 1- Origin and destination zone wise

Zonal ID	Zones	New Delhi	Percentage
A	**Old City**	107	9.55
B	**City Extension**	105	9.37
C	**Civil Lines**	49	4.38
D	**New Delhi**	45	4.01
E	**Trans Yamuna**	68	6.07
F	**South Delhi-1**	95	8.48
G	**West Delhi-1**	24	2.14
H	**North West Delhi-1**	5	0.44
J	**South Delhi- 2**	104	9.28
K	**South West Delhi**	25	2.23
L	**West Delhi- 3**	52	4.64
M	**North West Delhi-2**	84	7.5
N	**North West Delhi-3**	40	3.5
P	**North**	71	6.33
M, N, P	**Narela Sub City**	246	21.96

To rationalise the survey conducted, the data for zonal division was taken from Delhi Master Plan 2021. In the master plan, the NCT of Delhi has been divided into 15 zones, in table 1. Then according to the survey the data is represented in the tabular form. The

people travelling from different zones and to New Delhi are represented. It can be seen that only 4% of the passengers are travelling within NDMC.

Zones of Delhi Master plan 2021, are Old City, City Extension, Civil Lines, New Delhi, Trans Yamuna, South Delhi-1, West Delhi-1, North West Delhi-1, South Delhi- 2, South West Delhi, West Delhi- 3, North West Delhi-2, North West Delhi-3, North, Narela Sub City

Table 2: DTC buses database

No. of routes passing through NDMC	265
Total Number of hours DTC buses run (Excluding night shift)	18 hours or 1080 minutes
Average occupancy of DTC buses	35 people
Average Frequency of DTC bus	20.76 min/bus
Total Route Length of NDMC	155 Km

Source: DTC Office

Let, number of people passing through NDMC= N, No. of routes passing through NDMC be R, Average occupancy be O, Total Number of hours DTC buses run be T, Average Frequency of DTC buses be F.

Therefore, N= R*O* (T/F)

Hence,

= 265*35* (1080/20.76)

=265*35*52.02

4, 82, 485 passengers travelling through NDMC everyday

So, trips made within NDMC is 4% of total people travelling within NDMC 4% 4, 82, 485 is 19, 299 people every day.

Table 3: Specification for type of electric bus

Vehicle Type	Electric buses
Price	1.6 Crore
Subsidy	INR 7,500,000 to 10,000,000 (60% of the total cost)
Seats	35
Length	12 m
Width	2.55 m
Height	3.55 m
Charging Time	6 hours
Battery Type	Li-ion battery
Speed of running	20-30 km/hr
Coverage Km with one full Charge, C	100 km.

With the help of table 2 and 3, scenario building has been done, to come up with total number of buses required to run within NDMC. In Scenario building,

Let, the distance covered within NDMC be L,

Let, Route, Ri = 1 for the one stretch of distance,

Let, no. of buses required for 1 way, B = 2

No. of buses required for to and from, BN = Ri*B*2

L = L/1, L/2…… L/n, for getting consecutive distances to cover within NDMC.

No. of trips, Tp = distance covered / coverage of electric bus on full charge; Tp = L/ C

Table 4: Scenario Building

Distance Covered (Km)	Route	No. Of Buses (One Way)	No. Of Buses (To And Fro)	No. Of Trips
155	1	2	4	0.45
78.5	2	4	16	1.21
51.6	3	6	36	1.96
38.75	4	8	64	2.22
31	5	10	100	3.09
25.83	6	12	144	3.69
22.14	7	14	196	4.11
19.37	8	16	256	5.03
17.22	9	18	324	5.13
15.5	10	20	400	6.07
14.09	11	22	484	7.01
12.91	12	24	576	7.09
11.92	13	26	676	8.04
11.07	14	28	392	9.00
10..33	15	30	900	9.07

To calculate Scenario Building,

Let, distance covered be D,

Route be Ra,
No. of buses on one way be Ba,
No. of buses to and fro be Bt,
No. of trips be Tn,

Take, D and divide in into number of expected routes,

The number of buses on one way Ba = 2* Ra,

The number of buses to and fro, Bt = 2*Ba

No. of trips, Tn = D/100, where 100 km/ hr is expected efficiency of electric buses

We can say that, driving electric buses in entire NDMC may not be successful. Since, only 20 numbers of buses are being purchased under FAME scheme and the distance to travel is 155 kms. This is difficult to cover the entire NDMC.

Therefore, these buses should run in shorter distances, which should be based upon survey findings.

8. RECOMMENDATIONS

Route 1: Pragati Maidan- Sikander Road- Copernicus Road- India Gate C- Hexagon- Shershah Suri Road – Mathura Road- Pragati Maidan. The total distance covered is 5.5 kms in the entire route. There are 6 existing bus stands in the route.
Route 2: Super Bazar- Connaught Circle- PVR Rivoli- Hanuman Mandir- Gurudwara Bangla Sahab - GPO Post Office- Baba Kharak Singh Marg. The total distance covered is 2.5 kms on one side and 5 kms in the entire route. There are 14 existing bus stands in the route

Route 3: Gol Market – Bangla Sahab Gurudwara – Patel Chowk – Reserve Bank of India – Shashtri Bhawan - Central Secretariat – Udyog Bhawan – The Taj Mahal Hotal – Khan Market. The total distance covered is 5.5 kms on one side and 11 kms in the entire route. There are 30 existing bus stands in the route

Route 4: RK Ashram Metro Station – Gol Market – GPO – BKS Marg – RML Hospital – Sheikh Mujibur Rahman Road – Mandir Marg – Punchkuian Road - RK Ashram Metro Station. The total distance covered is 5.4 kms in the entire route. There are 8 existing bus stands in the route.

There are 2 parking spots designated for parking the electric buses i.e. Talkatora stadium and Shivaji Stadium. In figure 14, the distance from Shivaji stadium to Origin bus stands for proposed route are marked. In figure 1, the distance from Talkatora stadium to Origin bus stands for proposed route are marked.

From the above figures it is clearly evident that, Shivaji Stadium is the most suitable place to park these electric buses. As all the distances from Shivaji Stadium are lesser than that of Talkatora stadium.

Table 5: Total Time and Distance for each route

Route	Distance (km)	Total distance (km)	No. of bus stands	Avg waiting time per station (in min)	Total waiting time (in min)	Total time to complete one trip (in min)	Total no. of trips	Total distance (in km)
1	5.5	5.5	6	2	12	26	34	187
2	2.5	5	14	2	28	40	23	115
3	5.5	11	30	2	60	87	11	121
4	5.4	5.4	8	2	16	30	30	162

Let, no. of bus stands be Nb,

Let, average waiting time be Wa,

Total waiting time be Wt, Wt = Nb*Wa

Let, Distance be D,

Let, average speed of bus be Sb,

Total Time to complete one trip be, T1, T1 = (D/Sb) + Wt

No. of hours a bus service runs, rB = 15 hours or 900 mins

Total number of trips, TT, TT = rB / T1

Total Distance, Dd = TT*D

9. CONCLUSION

In the end, we can say that, as these buses can only run on shorter distances due to their limited operating capacity. Therefore, these should be used for shorter distances like the above proposals or any other route, if identified. Following the successful implementation, more buses could be purchase. For strengthening public convenience, the buses should be more frequent and less expensive than the DTC buses. It will lure the public to choose Electric buses as a preferred mode of travel.

The next step is to determine the frequency of these buses. The frequency is to be determined by two parameters i.e., for peak or non-peak hours and weekend or weekdays. The frequency will be high in peak hours due to the higher number of passenger's travel than that of the non-peak hour. Similarly, on weekends the frequency of buses may change in lieu of passenger travel behaviour.
It is recommended to do a socio-behavioural survey half-yearly to identify gaps and challenges in the proposed routes. Hence, improvement in the service. The routes can also be altered every year after doing surveys to identify alternate routes.

A satisfactory survey for the passengers is highly recommended. Also, the smart card system of Delhi Metro should also be incorporated to travel in the electric buses. So as to increase the ease of passengers while traveling and also to attract more users for the buses. Upon successful implementation, can augment public transport (Bus). O&M of buses suggested being carried out by the private contractor under the PPP model.

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