INFLUENCE OF VARIATION IN TRAVEL COST FOR WORK AND EDUCATIONAL TRIPS IN A METRO CITY-A CASE STUDY OF MUMBAI

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Abstract: India has observed rapid increase of motorization, which has accelerated in the past two decades. This can be controlled with a balanced use of public transport mode for travelling. The desirable share of public transport is around 80%. However literature has shown that there exist gap between actual share and desired share of public transport as mode of travelling. The study is to estimate the travel behavior by dividing individual travelers into groups based on their characteristics. The study area is restricted to Mumbai city. Public transport systems in Mumbai city have not been able to keep pace with the rapid and substantial increases in demand over the past few years. Thus the purpose of the study is to provide an improved mode choice considering parameters such as age, gender and income group of the travelers for various purposes of travel by home interviews.

IndexTerms - Travel behavior, mode choice, personal characteristics.

I. INTRODUCTION

Urban transport is an urban service that imparts efficiency to the city by providing mobility to the workforce and hence best productivity. The transport policy can contribute to poverty reduction both through its impact on the city economy and hence on economy growth and through its direct impact on the daily needs of the economically backward population.

The use of desirable modes such as walk, bicycle and public transport is declining and the use of undesirable modes i.e. car and two-wheeler are growing. Thus the congestion is increasing, mobility is reducing and pollution, use of fossil fuel and accidents are rising.

To manage sustainable development in most developed countries, transport modeling is used as an effective tool. The forecasting needs to incorporate the designing of transport systems by making use of the global infrastructure and understanding the travel behavior of the residents of the study area and develop a system that can accommodate the travel demands for the future. Mode choice models form a critical part in analyzing the travel demand of a study area. It has been estimated to determine the current mode shares of the population for different trip purposes. The study of mode choice behavior will help the authority to forecast the future travel conditions and guide them in framing transport policies such as Bus Rapid Transit System, Light Rail Transit System, Monorail System, Metrorail System etc. thereby improving the transportation within the city.

II. LITERATURE REVIEW

Mode choice analysis is the third step in the four-step transportation forecasting model, following Trip Generation and Destination Choice. While trip distribution's zone interchange analysis yields a set of origin-destination tables which tells where the trips will be made, mode choice analysis allows the modeler to determine what mode of transport will be used. To analyze the diversion from auto modes to park and ride and park and walk modes it is common to develop mode choice models based on discrete choice theory.

Relevant works on Mode choice Analysis:
R. Ashalatha(2013) et al. have been conducted a study on Mode Choice Behaviour of Commuters in Thiruvananthapuram City. They were used multinomial logistic regression to analyze the mode choice behavior of commuters in Thiruvananthapuram city. It was aimed at identifying the various factors that contribute to the selection of a particular mode in the city of Thiruvananthapuram and the factors which influence the commuters to use public transport, and those factors that stand in their way in using public transport. Their study was restricted to work trips only. Revealed preference survey, the technique used to study the travel pattern in an actual situation, was adopted in the study to determine the travel patterns of all available modes in the city.

MNL modeling was adopted in the study because of its capability in estimating the mode shares where more than two choices of modes of travel are available for a commuter. The questionnaire covered areas of socioeconomic and trip information of commuters.

Zhang Junyi (2008) et.al. also attempted to analyze the mode choice behavior based on a stated preference (SP) survey. In their study, SP survey is first designed to incorporate the influence of future income, as well as other level-of-service attributes, whereas a revealed preference (RP) survey is also prepared. Then an RP/SP combined mode choice model is estimated in which the parameters of travel time and cost are defined as a function of future income. This SP survey is the first one conducted in Myanmar and respondents showed a great interest in the survey. As a result, more than 400samples were successfully collected with a high response rate of 80%. Reliability analysis of SP data found that there is only one profile with high income showing significant variations in SP responses. This means that respondents’ high interests in the survey may not cause serious policy manipulating biases as expected, suggesting that respondents carefully answered the SP questions based on the trade-off relationships existing in the assumed level-of-service variables.
III. DESCRIPTION OF THE STUDY AREA

Mumbai is the capital city of the state of Maharashtra in India, and it's the most populous city in India. It is the 4th most populous city in the world and one of the populous urban regions in the world. The recent census was conducted in India during 2011, which put Mumbai's Urban Agglomeration at 20,748,395, while the city itself was recorded at 12,478,447. The next national census is scheduled for 2021. Brihanmumbai Municipal Corporation covers 603.4 sq. km. area and possesses a good road network. Various transport policies like constructing flyover bridges at major junctions, city bus service etc. have been adopted by the Brihanmumbai Municipal Corporation so far and many more such policies will be implemented in time to come. As of 2015, the BEST runs a total of 3,600 buses, ferrying 4.8 million passengers over 365 routes, and has a workforce strength of 38,000, which includes 22,000 bus drivers and conductors. Mumbai Suburban Railway consists of exclusive inner railway lines augmented by commuter rail on main lines serving outlying suburbs to serve the Mumbai Metropolitan Region. It is spread over 465 kilometres (289 mi), the suburban railway operates 2,342 train services and carries more than 7.5 million commuters daily. Line 1 of the Mumbai Metro, also referred to as the Versova-Andheri-Ghatkopar (VAG) corridor, is part of the metro system for the city of Mumbai, India. The line is 11.40 km and it is fully elevated and consists of 12 stations from Versova to Ghatkopar. Line 2 of the Mumbai Metro is an under construction metro line in the city of Mumbai connecting Dahisar in the northwest with Mandale in Mankhurd in the east. Construction on the first section called Metro 2A (between Dahisar and D.N. Road). This section shall be 18.589 km (11.551 mi) long and comprise 17 of the 39 stations that form part of this route. Metro Line 2B from D N Nagar to Mandale is 23.643 km. long elevated corridor with 22 stations.

IV. METHODOLOGY

The methodology adopted is as follows.

a) Objective and scope of work.
b) Selection of the study area.
c) Collection of inventory data and design of questionnaires.
d) Field survey is carried out. Home interview survey technique is used for the data collection.
e) Data collection and compilation.
f) Data analysis.
g) Conclusion.

V. DESIGN OF THE QUESTIONNAIRE

The questions pertained to the socioeconomic condition and travel characteristics of the trip maker. The socioeconomic characteristics were assessed by considering factors such as age, gender, nature of the job, monthly income, and vehicle ownership. Travel characteristics included distance from home to office, mode of conveyance, waiting time, in-vehicle travel time, cost of travel, etc. Commuter's satisfactory levels with respect to present mode, their willingness to switch over to another mode, through the questionnaire survey. The efficiency level of existing service was ranked based on factors such as comfort, time of travel, cost of travel, safety, ease of boarding, frequency/availability, reliability, traveling difficult weather. A survey was conducted and 870 samples were obtained. Based on the response, preferences, and the suggestions of the commuters, the variables were shortlisted and the questionnaire was further refined.

VI. DATA ANALYSIS

The analysis is done considering two characteristics; trip length and additional travel expenditure. They are analyzed on the basis of percentage of trips corresponding to trip length and additional cost.

1. Trip Length Analysis

The trip lengths of all the samples are divided into the range of 0 to 10 where minimum travel length of the entire sample is obtained as 0.3 km and the maximum trip length is obtained as 70 km. The analysis is done for various modes like two wheelers, three wheelers, four wheelers, bus, and train. The percentage of trips for each mode is calculated for different ranges of trip length.

![Fig. 1. Trip length analysis](image-url)
Figure 1 shows the analysis of the data collected from the survey which shows that with the increase of trip length the percentage of people traveling through that mode decreases for almost all the mode except train. For train, the percentage of trips increases with increasing length for certain distance and then again decreases with increasing length.

2. Additional travel expenditure analysis

Additional travel cost is analyzed for determining the preference of type of mode and number of trips if the cost of the trip increases by a certain percentage. The escalation in the cost is considered from 20% to double the present cost. The analysis is done on the basis that if the cost of the travel increases whether the travelers will prefer to travel through the same mode, shifts to another mode or reduce the number of trips for different percentage of cost increase. This analysis is done for two important categories i.e. trips taken for work purpose and trips taken for education purpose. Each mode is analyzed separately for both the categories. The different modes which are considered are two-wheelers, four wheelers, three wheelers, bus, and train.

A. Analysis of trips for the educational purpose

Trips for the educational purpose are analyzed separately for the increase in the cost of 1.2X to 2X, where X is the original cost.

![Fig. 2. Variation in travel expenditure for the educational purpose for two wheeler](image)

The analysis indicates that with the increase in the cost of trips the people preferring the same mode of transport decreases whereas with the increase in cost people shifting to another mode of transport starts increasing. The people preferring to reduce the number of trips with the increase in cost do not show the linear behavior. There is an increase in the percentage of people who choose to reduce their number of trips till about 40% to 60% increase in cost and after that the percentage of trips starts reducing with further increase in cost.

![Fig. 3. Variation in travel expenditure for the educational purpose for four wheeler](image)

![Fig. 4. Variation in travel expenditure for the educational purpose for three wheeler](image)
From the graph of Fig. 2, 3, 4, 5, 6 it is observed that for all the above-mentioned mode of transport the graph shows almost the same kind of behavior. That is with the increase in the cost the percentage of people remaining in the same mode decreases and people shifting to another mode increases. Whereas the percentage of people reducing their trips increasing by about 40% increase in cost and then starts decreasing with the increase in cost.

B. Analysis of trips for work purpose

Trips for work purpose are analyzed separately for the increase in the cost of 1.2X to 2X, where X is the original cost. From the survey, it was observed that the number of trips for work purpose where more than compared to the number of trips for educational purpose. Even though with the difference in the number of travelers the graph shows somewhat the same behavior like that for educational purpose for all the mode of transport and travel behavior with an increase in cost.

The analysis indicates that with an increase in the cost of trips the people preferring the same mode of transport decreases whereas with the increase in cost people shifting to another mode of transport starts increasing. The people preferring to reduce the number of trips with the increase in cost do not show the linear behavior. There is an increase in the percentage of people who choose to reduce their number of trips till about 40% increase in cost and after that the percentage of trips starts reducing with further increase in cost.
Fig. 8. Variation in travel expenditure for work purpose for four wheeler

Fig. 9. Variation in travel expenditure for work purpose for three wheeler

Fig. 10. Variation in travel expenditure for work purpose for bus

Fig. 11. Variation in travel expenditure for work purpose for the train

From the graph of Fig. 7, 8, 9, 10, 11 it is observed that for all the above-mentioned mode of transport the graph shows almost the same kind of behavior. That is with the increase in the cost the percentage of people remaining in the same mode of transport decreases and people shifting to another mode of transport increases. Whereas the percentage of people reducing their trips increasing by about 40% increase in cost and then starts decreasing with the increase in cost.

VII. CONCLUSION

The study was conducted on Mode Choice Behaviour of Commuters in Mumbai City. The study was done for all kind of trips. The questionnaire covered the areas of socioeconomic and trip information of commuters. The variables considered for analyzing the mode choice behavior of commuters are i) trip length and ii) variation in travel expenditure.

The trip lengthwise comparison revealed that with an increase of trip length the percentage of people traveling through that mode decreases for almost all the mode except train. For train, the percentage of trips increases with increasing length for certain
distance and then again decreases with increasing length. It has also been noted that the minimum travel length of the entire sample is 0.3 km and maximum travel length is 70 km.

Additional travel expenditure wise comparison revealed that with an increase in the cost of trips the people preferring the same mode of transport decreases whereas with the increase in cost people shifting to another mode of transport starts increasing. On the other hand, there is an increase in the percentage of people who choose to reduce their number of trips till about 40% to 60% increase in cost and after that the percentage of trips starts reducing with further increase in cost. This indicates that with the increase in the cost of travel people prefer to reduce their number of trips and with a further increase in cost people prefer to shift their mode of transport from the existing mode. This analysis was restricted to educational and work trips only. It was also observed that the number of trips for work purpose where more than compared to the number of trips for educational purpose. Even though with the difference in the number of travelers the graph showed the same behavior like that for educational purpose for all the mode of transport.

VIII. REFERENCES