

# A Study on Traffic Forecast for Metro Railway Expansion in Chennai

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## Abstract

Infrastructure, specifically Transportation forms the backbone for the continuous development of any country and its economy. The cities around the world are facing critical problems due to improper planning and non implementation of modern transportation techniques. Metro being Low Carbon Transport, it is considered as an Eco Sustainable solution to reduce pollution in the city. This paper presents a detailed analysis of the requirement of implementation of metro rail system in an important corridor (Porur to Kamarajar Salai) in Chennai city (India). **Methods/Statistical Analysis:** In the present work Chennai city is divided into various zones for easy identification and demarcation. The population growth and the vehicle growth along the corridor for the base year 2015 are projected for the future. The survey of passengers in the corridor is done online using Google forms under various headings like trip purpose, trip time, trip cost, trip mode etc. **Findings:** The results provide the summary details of the existing scenario of the transportation density and its viability for future expansion in this sector. The passengers expect the metro rail travel cost to be around the expenses incurred per kilometre travel in their present mode of transport. Rs.30/- per metro trip is levied in the Corridor- I by Metro is almost closer to the expenses incurred by the commuters in Porur-KamarajarSalai Corridor, making the patronage favourable towards metro. The results of travel characteristics especially the trip purpose and trip distance give a cutting edge in the Sustainability of metro rail in the longer run. The short distance trip by daily trip users will bring more revenues for metro with regards to the infrastructure investment and running cost. The survey shows that the sure patronage of commuters is 84% i.e., are willing to switch over to Metro Rail for commuting, once the services are available. The travel comfort and reduction in travel time are the main considerations in preferring metro rail. It is seen from the analysis that this corridor requires immediate attention for the implementation of the metro rail system before it becomes too late. **Application/Improvement:** This method is a quick application for finding out the feasibility study on any corridor taking into consideration the details pertaining to the particular corridor and its surroundings. This study involves only the important characteristics that play a cardinal significance on the outcome. Hence it is closer to reality in identifying the information quickly.

**Keywords:** Chennai, CMRL, Low Carbon Transport, Metro Rail, Transport Congestion

## 1. Introduction

Chennai is one of the fastest industrially and commercially growing cities in Asia. Its significance as the state capital has seen rapid migration of people into the city. Naturally this trend has contributed to the increase in vehicle population. Due to the availability of attractive two wheelers at affordable price the road is flooded with more number of vehicles. Due to poor accessibility of railway system in many areas of the city bus transport continues to attract the passengers. Although the percentage of vehicle

share is dominated by public bus transport for so many decades, its growth has the main hindrance in narrow and often congested roads. In normal circumstance the city with a population of 7 millions should have 75% usage of public transport which is far from reality because the public bus transport available is very less. The passenger movement has crossed 20,000 persons per hour direction in many corridors. Road transport contributes to the CO<sub>2</sub> emission. Thus an alternative which will give public transport expansion with less or nil CO<sub>2</sub> emission is need of the hour. Metro rail is a low Carbon Transport

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alternative. The pollution levels at any place and time represent balance between the rates of emission from their sources and the rate at which they are removed from the atmosphere<sup>1</sup>. It is observed that night and early morning hours have less dispersal capacity of pollutants due to stable atmosphere accompanied by weak or no winds. Also observed is that the morning hours had a high pollution potential which decreases gradually with the time of day<sup>2</sup>. This pollution potential is directly proportional to the number of vehicles on the road, in the busy hours of schools and office. For the first time in India's history, the nation will have five large states (Tamil Nadu, Gujarat, Maharashtra, Karnataka and Punjab) that will have more of their population living in cities than in villages in 2030<sup>3</sup>. The provision of infrastructural facilities required to support such large concentration of population is lagging far behind the pace of urbanization<sup>4</sup>.

This paper presents a comprehensive study to forecast the passenger demand in the proposed corridor (Porur-KamarajarSalai) for metro railway in Chennai city. Chennai Metro Rail Limited (CMRL) project aims at providing the people of Chennai with Low Carbon, modern and economical mode of public transport, which is properly integrated with other forms of public and private transport including buses, sub-urban trains and MRTS<sup>5</sup>. The immediate and long term benefits of metro rail are unmatched with any other type of transportation system. It is pollution free, has lesser noise, comfortable, reliable and safe and occupies lesser ground space when compared to other systems. Metro rail consumes very low energy per passenger and reduces the journey time by 50%. These superior qualities of metro system has made many developing countries to go for it in the last decade or so, although it is existing in several developed countries for more than a century. The Indian government said it would reduce carbon emissions relative to its Gross Domestic Product (GDP) by 33% to 35% from 2005 levels by 2030<sup>6</sup>. Low Carbon Transport (LCT) is about reducing Greenhouse Gas (GHG) emissions<sup>7</sup> by the Transport Sector through the increased use of Public Transport. Metro Rail is categorized as LCT.

The need for high capacity metro rail system for Chennai City<sup>4</sup> based on Comprehensive Traffic and Transportation Study was done. Among the Indian cities Kolkata has the privilege of using the metro rail long back. Transportation system occupies a central position in the fabric of modern urbanized society. An appropriate mix

of alternative modes of transport resulting in the use of environmentally friendly fuels and land use patterns can be obtained by an ecologically sustainable urban transport system such as Metro Rail. Metro Rail as an urban transport system for Nagpur City is suggested<sup>8</sup>. Rail-based urban transport system will bring order in the city traffic. They will indeed bring about social and attitudinal changes, inculcating a sense of discipline and cleanliness among the citizens<sup>9</sup>.

Short-term passenger flow forecasting is an important information to support transportation system operation and management. A well performing divide-and-conquer method based on neural network and Origin-Destination (OD) matrix estimation<sup>10</sup> is developed to forecast the short-term passenger flow in high-speed railway system. Three-phase back-propagation neural network approach to forecast short-term railway passenger demand<sup>11</sup> can offer detailed demand prediction for railway operation planning, such as train scheduling and seat allocations. A non parametric Neural Network Technique to forecast transport demand<sup>12</sup> is experimented. The need for a heavy capacity mass transit system<sup>13</sup> is recommended when the Peak Hour Peak Direction Traffic (PHPDT) exceeds 40,000. The performance of the metro would also alter, at varying levels, the structure of the city by encouraging compact, high density city centres and by replacing residential uses with commercial and institutional uses<sup>13</sup>. Implementation of metro rail system reduces the carbon level and increases the overall growth. The 4-stage traffic model<sup>14</sup> comprising trip generation, trip distribution, modal split and trip assignment has been adopted to carry out transport demand forecast for Kochi metro rail. The metro railway work in Chennai city is already in progress on two corridors and the train is running in one part of corridor. By the end of 2016, the two corridors are expected to be fully operational.

## 2. Motivation for Study

### 2.1 Traffic and Transportation Scenario

A Comprehensive Traffic and Transportation Study have been undertaken by various government agencies along with the preparation of Master Plan (<http://www.cmdachennai.gov.in/masterplan.html>). As per the study the Chennai city is divided into various zones for easy identification and demarcation. The population growth and the vehicle growth along the zones around the selected

are increasing rapidly. The base year for this study is taken as 2015 for practical purposes and calculations.

## 2.2 Population and Vehicle Growth in the Corridor

The Figure 1 shows the trend line of the variations of the population growth in the traffic zones along the corridor (CTTS-2010). As seen from the graph it is understood that the population growth rate is steep and the projection in this sector in the year 2030 is around 37 lakhs and at that condition the present modes of transport will not meet the demand.

The Figure 2 shows the vehicle growth in Chennai city from the year 1992. Actually Chennai has the highest vehicle density of 2000 vehicles per kilometer in the country. The present vehicle strength in the city alone is 4,500,000 and among this, two wheelers account for 78% (<http://www.tn.gov.in/sta/g3.pdf>).

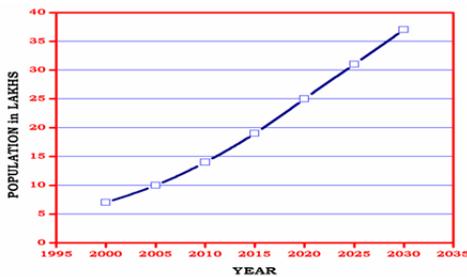


Figure 1. Population growth.

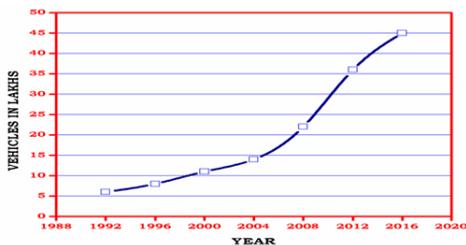


Figure 2. Vehicle growth in selected corridor Chennai city.

Again analysing the movement of vehicles in the selected corridor for the year 1992 and 2014, we find a steep reduction in the possible average speed of vehicle movement. The average speed of vehicles has come down from 27 km/hr to 17 km/hr in RK Mutt area, from 33 km/hr to 20 km/hr in T. Nagar area and from 32 km/hr to 20 km/hr in Arcot road area. This shows the traffic congestion in this area and unsuitable prevailing

conditions for development.

Based on the above government data and Chennai Metro implementation, the authors are self motivated to study the next congested traffic with high density passenger movement route, i.e., Porur-Marina Beach sector. This route is mainly selected because improvements of all other options of transport modes in this route are impossible due to narrow roads, establishment of many new commercial complexes, various types of vehicles plying, etc. The proposed corridor starts from Porur and passes through Arcot Road, Panagal Park, Thyagaraya Road, Eldams Road, Luz Church Road before ending at KamarajarSalai, covering a distance of 15 kms. Figure 3 shows the map for the existing Metro corridors in the Chennai city and the map for the proposed corridor taken in this study.

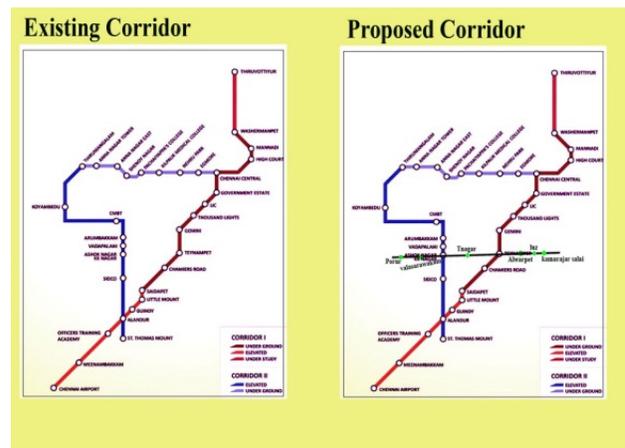


Figure 3. Existing corridors in Chennai and proposed corridor in this study.

## 2.3 Data Sampling

A survey was conducted online<sup>15</sup> using Google forms and data was collected. The survey aimed at bringing out the feasible patronage in the study corridor. The data was collected from about 700 people who are interested to use metro rail service. The data contained their age group, purpose of metro use, their economic sector, choice for metro, preferential expected metro fare, regular commuting time etc. The data was collected by popularizing the link through various social media and mail. A visit to the study corridor was carried out for this purpose. The participants of the survey were from different age group and economic background and as per Table 1 and Table 2 .

**Table 1.** Distribution by income

Sl. No.	Participant's Income Per Month in Rs.	Percentage of participants
1	<10K	18.6
2	10K to 20K	33.7
3	20K to 30K	21.1
4	30K to 40K	15.1
5	40K to 50K	5
6	>50K	8

**Table 2.** Distribution by age

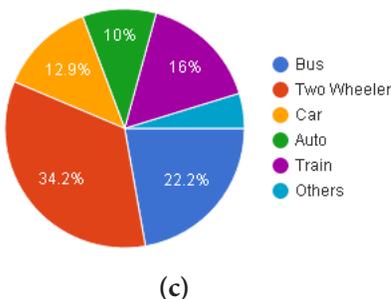
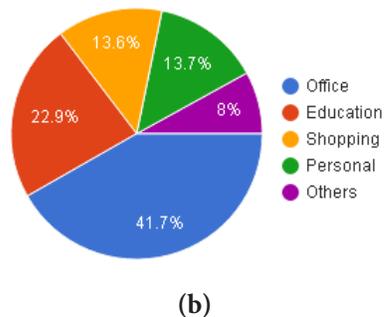
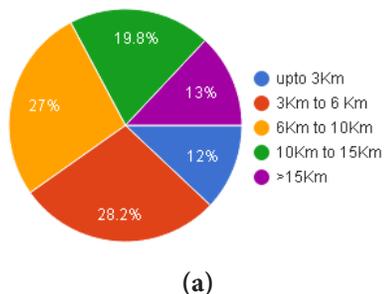
Sl. No.	Age Group in Years	Percentage
1	10-25	33.2
2	26-40	33.7
3	41-50	15
4	51-60	10
5	>60	5

### 3. Analysis and Discussion

#### 3.1 Analysis of Travel Characteristics

Various factors like trip purpose, trip mode, trip time, trip rate etc., are obtained from the survey for analysis. The details collected indicate the individual characteristic analysis to evaluate traffic pattern. The travel undertaken by an individual depends on his purpose which may be regular or irregular and likewise the individual reasons are calculated.

Three characteristics were considered for the trip i.e., purpose of trip, travel distance and present mode of travel. The distribution of trip purpose is illustrated in Figure 4(b). The office trips and trips to educational institutions are regular and can be considered for all the week days whereas other trips are considered occasional. The regular trips account for almost 60% and this is a positive signal for the patronization for metro rail.



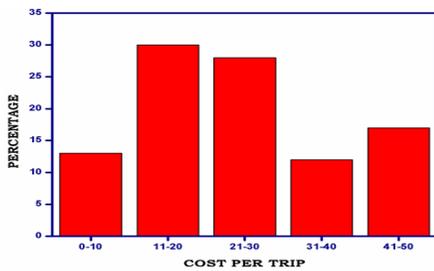
**Figure 4.** Distribution by (a) Trip Length (b) Trip Purpose (c) Trip Mode .

Data collected under trip length is useful in deciding the ticket pattern and for economical mode of pricing the tickets. The distribution and the details are given in the form of pie chart in Figure 4(a). The mid range in the trip length of 6 km to 10 km is used by maximum number of passengers in survey and this type of occurrence will naturally bring in more revenues since more number of short trips will bring in more profit. Passengers travelling for more than 15 kms constitute to only 13%. This group from more than 6Km is expected to use metro rail mainly due to the convenience in travelling.

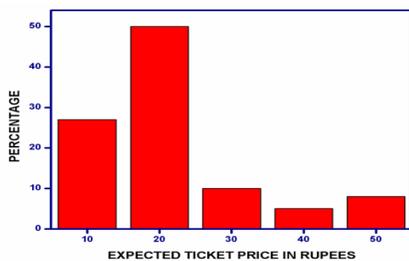
The mode of trip is about the participants present mode of travel and is classified as in Figure 4(c). The figure shows that more number of people are using two wheelers which is around 34%. Next highest value comes for the people who use bus transport. The number of people going in two wheelers is bound to reduce when proper approach and parking facility is made available in metro stations. The switch over is to happen for sure since metro rail gives a convenient, swift mode of transportation. When this segment switches over to Metro Rail, certainly the CO<sub>2</sub> emission on the roads will reduce and improve the air quality. In all there is a greater likelihood of 75% of the population switching over to metro rail, including those using the local train for daily commuting.

### 3.2 Demand Forecast

The Demand Forecast is done based on the passengers current spending for the regular trip and their expectation while switching over to Metro. The distribution of the present cost per trip is given in the Figure 5(a). At present majority of the passengers pay more than 20 rupees per trip. The next Figure, 5(b) gives the passenger readiness to spend for the metro rail and almost 72% of the expected passengers for metro rail are ready to more than 25 Rupees. This is a very good sign for the economical run of the metro system. The survey shows that 23% of the passengers are ready to pay more than the present expenditure for travelling the distance. The Figure 6 shows that 62% of the people are looking forward to use metro and another 22% are finding metro rail as a better mode of transport. This makes the 'sure' patronage to 84% of commuters. The travel comfort and reduction in travel time are the main considerations in preferring metro rail.

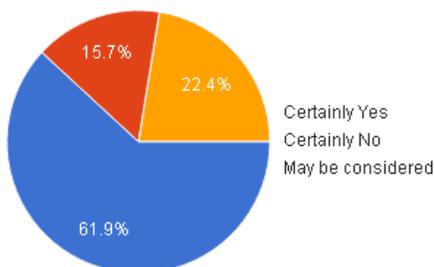


(a)

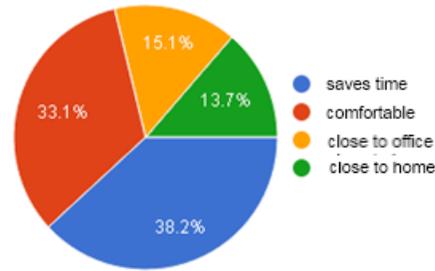


(b)

Figure 5. (a) Distribution by trip cost. (b) Distribution of expected ticket price.



(a)



(b)

Figure 6. Distribution of. (a) Preference for metro. (b) Reason.

The population growth and the vehicle growth are increasing in the same trend and the trend is likely to continue in the same way for the horizon year which is taken as 2030. The heavy investment for a project like this is expected to bring in profit in the long run. The forecast of passenger income and requirement for the horizon year 2030 is expected to grow at the same rate. The fuel prices are to rise and hence the trip cost will also rise. The passengers will be ready to spend for the metro depending on his or her spending on present mode of transport and the time reduction. The analysis from the graphs indicates a clear preference of passengers opting for metro rail mainly due to the difficulty in travelling by bus and lesser frequency of buses in various routes.

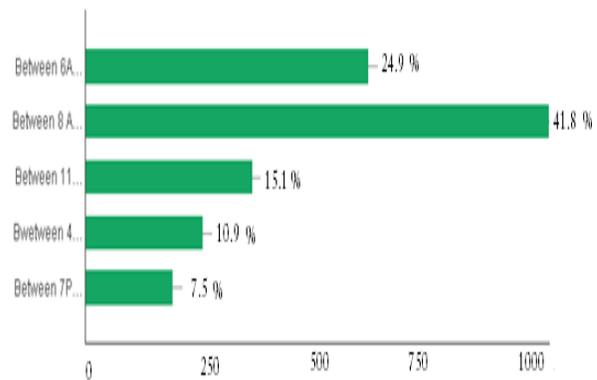


Figure 7. Trip period vs passengers.

The results presented in Figure 7 show that the commuters are ready to spend a little more money for the comfort they expect to get in metro rail. The demand for Metro rail in the peak hour that is from 8.00 A.M to 10.00 A.M. the demand is very high and the metro rail will surely help the passengers at this time.

## 4. Conclusion

An independent study and survey for passenger demand in one of the most congestive areas i.e., Porur to KamarajarSalai, is done over a period of time and at frequent interval using Google forms and the results presented graphically. The analysis shows a clear passenger demand in this sector and in many cases the commuters are not worried about the ticket price of metro rail. The chances of expansion in this corridor for the present modes of transport are almost exhausted and hence the willingness of the commuters is easily visible in looking for an alternate transport especially metro rail. This independent study report seeks the attention of Chennai Metro for a speedy implementation in the corridor from Porur to KamarajarSalai.

## 5. Acknowledgement

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