

Commuter Preferences and Modal Shift Analysis: Metro Vs. Other Transport Mode in Chennai

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Abstract—Understanding commuters' preferences and perception in public transport is important to satisfy the commuters satisfaction. After the introduction of metro rail in Chennai, there is a significant change in the demand for public transportation system among commuters over the past decade. There are several factors that are considered important by commuters when choosing their mode of transportation. The study aims to analyse the factors influencing the commuter preference for Chennai Metro Rail vs Other Transport Mode. Additionally, the study identifies whether commuters have shifted from other transport mode to metro recently and the reasons that facilitated the shift. This would help to identify the interest commuters have for Metro and factors contributing to their modal choice. This study seeks to understand commuters' perception towards metro vs other transport mode. An online survey was conducted using a structured questionnaire on a five-point Likert scale among 116 respondents. The statistical tools used were percentage analysis, correlation, chi-square and regression analysis. Percentage analysis showed 35% shifted to metro due to reduced travel time (27%), safety, and reliability; 65% did not, citing metro unavailability (44%). Inferential analyses confirmed a significant association between age and primary transport mode ($\chi^2=56.0$, $p=0.014$), but no notable relationships between mode choice factors and shifting behaviour, with travel cost alone negatively influencing metro perception.

Index Terms—Commuters, Preferences, metro rail, public transport, mode choice, travel behaviour, Perception.

I. INTRODUCTION

The Indian Metros have remarkably contributed to the diversion of a significant portion of current passenger traffic from road to the Metros and consequently

reduced the number of buses, passenger cars and other vehicles carrying passengers on its roadways (Bhagyalakshmi & Vasudevan, 2020). The Chennai Metro Rail Limited (CMRL) was established in the year 2007, as a joint venture between the Government of India and the Government of Tamil Nadu. "Chennai Metro Rail's Phase I, operational since 2015, established the foundational Blue and Green lines connecting major corridors. The ongoing Phase II expansion includes the purple and orange lines, significantly expanding the network's coverage across Chennai's metropolitan area. The Chennai Metro Limited, is experiencing good reception from the commuters. Despite the fact that metro systems are expanding globally and offering an effective tool to fight congestion and pollution, there is a limited number of publications focussed on passengers' shift to metro (Otsu H 2008). This paper aims to identify the factors influencing the commuter's mode choice preference and also examine the mode shifting behaviour of the commuters and reasons facilitating such shift. The study further analyses the commuter's perception towards metro vs other transport mode.

Travel Behaviour:

Travel behaviour is defined the approach of people to travel by different means of transport and in a variety of motivations, as well as the relationship between the decisions taken, and socio-demographic factors and spatial. The choices made are based, among others, on current capabilities, limitations, and habits (Anjali Awasthi, 2019). There are various factors like Travel Cost, Travel Time, Frequency of travel, Primary Mode of transport and Purpose of Travel that determines the commuters' travel behaviour.

Commuters' preferences:

Understanding what commuters want in transportation is of utmost important. There are several factors that are considered while choosing primary mode of transport by people.

Travel time:

The total travel time is one of the most important factors that the traveller takes into account for choosing a mode of transport (Steer Davies Gleave, 2006). It is therefore a major factor to increase the demand, as travel time is reduced. (Ana Isabel Muro et al. 2017) The factor travel time indicate the total time spent on commuting by the chosen mode of transport.

Travel cost:

The travel cost factor represents the price paid for the route according to the form of transport chosen (Ana I Muro-Rodríguez et al. 2017). It includes fare, fuel, parking, and vehicle maintenance. Lower travel cost plays an important role in choosing the transport mode. Most survey report that travels cost is considered as the most important factor in choosing the mode of transport.

Comfort:

Comfort is an important motivator for mode choice, particularly for public transit use (Bhagat-Conway MW et al. 2022). The factor comfort includes physical comfort and psychological comfort. Physical comfort includes seating, temperature and vibrations in the domains of air travel and automobile design. (Jean-Marie Burkhardt et al. 2024). Social Interaction, space, aesthetics and sensory ambiances, safety feeling, control, multiple activity and Attention load are the dimensions of psychological comfort. (Jean-Marie Burkhardt et al. 2024).

Safety and security:

Transport safety refers to protection of people and property during transit. Security is implementing necessary measures to protect people and property from theft, damage and any other threats and ensuring a safe journey to the commuters.

Reliability:

According to USDOT A reliable transportation system dependably provides users with a consistent range of predictable travel times, ensuring its arrival and

departure on schedule with minimal breakdowns. According to Wu et al. (2018, Transportation Research Part C), reliability is evaluated through metrics like on-time performance, mean time between failures, and service availability. Reliable systems build passenger trust and reduce congestion.

Accessibility:

Accessibility, in the notion of facilitating individuals' ease in reaching their desired destinations. (Evangelos Vafeiadis 2024). Accessibility measures how easily people can reach key destinations (e.g., jobs, services) or transport nodes. Higher accessibility such as close proximity to transit stops or dense land-use around them increases transit usage.

Frequency:

Service frequency determines how often a public transport service runs within a given period of time. Services that run at short intervals reduce the waiting time of users and increase the accessibility of the service. (Parabol, 2023)

Modal Shift:

Modal shift is the transition from one transportation mode to another, such as from private cars to public transport. Several factors influence this change. This shift happens after evaluating its potential benefits, including reduced costs, transit times, frequency, safety, reliability etc. A modal shift occurs when one mode has a comparative advantage in a similar market over another. Comparative advantages can take various forms, such as costs, capacity, time, flexibility, or reliability. (Dr. Jean-Paul Rodrigue, 2024)

II. REVIEW OF LITERATURE

A study on "Commuters' Willingness to Shift to Metro: A Case Study of Salaya, Thailand", was conducted by "Anna Fraszczyk et.al.," (2019). The purpose of this study was to investigate the commuters' willingness to shift to metro and reasons facilitating such shift. This study targeted a group of potential metro users located close to a planned metro line and investigate people's willingness to shift to metro and studied certain factors that could facilitate such a change. The study revealed that 90% of the respondents are willing to shift to metro, while only 10% are not willing to shift.

“Passenger satisfaction towards metro infrastructures, facilities and services” by Yong Qi Sawa et al., (2019) studied the satisfaction passengers gain from Tyne and Wear Metro. Attributes such as security, safety, comfort, infrastructure quality, cleanliness, and ticketing convenience significantly affect satisfaction levels, while negative experiences related to crowding, station congestion, noise, and inadequate amenities contribute to dissatisfaction and reduced ridership. Data was collected through a questionnaire survey and Principal Component Analysis and Cross Tabulation Analysis were used to study the passenger’s satisfaction. Results reveal that three major satisfaction dimensions security/safety and comfort, infrastructure quality, and ticket purchase facilities and demonstrating that satisfaction levels vary across demographic groups such as age, gender, employment status, and frequency of metro use.

“Ranking factors affecting public transport mode choice of commuters in an urban city of a developing country using analytic hierarchy process: The case of Metro Cebu, Philippines” was conducted by “Francis L. Mayo et.al.” (2020). The purpose of the study was to identify and rank the factors that impact commuter's transport mode choice in selected urban cities in the Philippines. It taken into consideration various factors namely safety, accessibility, cost of travel, comfort and concern for environment. The results of the study showed that commuters gave importance to travel safety over all other factors regardless of age, gender and income.

A study on “Insights into Passenger Transport Choices: A Mumbai Case Study” was conducted by Mr. Raju Chauhan and Dr. Mangesh Panchal (2024) that aimed to understand the various preferences of commuters using different modes of transport within the Mumbai city. The study revealed that there exist differences in the preferences of the commuters due to factors such as socioeconomic status, occupation, travel distance, and access to infrastructure. For daily commuting, commuters showed a strong preference for public transportation while some demographics chose private modes like cars and motorcycles. The study further investigated into the areas that required improvements in the existing transport infrastructure.

III. CONCEPTUAL FRAMEWORK OF THE STUDY

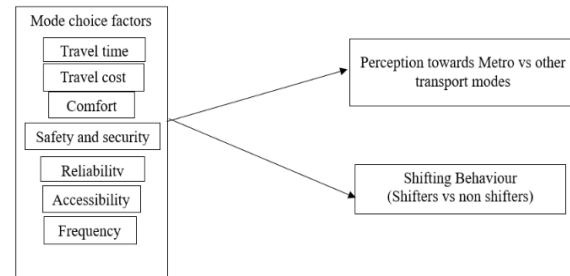


Fig No. 1 Conceptual Framework of the study

3.1 Statement of the Problem

There is a growing demand for metro rail transport in urban areas. Since Chennai Metro Rail is in the expansion stage it is important to understand commuters’ preference towards metro rail usage. There are various factors that plays important role in determining the transport mode choice and barriers that prevent commuter from opting metro as a primary mode of transport. This study aims to analyze those factors and barriers and understand how commuters choose transport mode amongst available alternative mode. This study further focuses on modal shift behavior of commuter towards metro and reasons for such shift. This research will help city planners and policy makers to make improvements in the metro rail system by better understanding the commuters’ preferences and barriers towards opting metro as a primary mode of transport.

3.2 Objectives

- To study the commuter demographic profile and travel behaviour in Chennai.
- To identify association between age group and primary mode of transport the choice of transport mode.
- To analyse the relationship between mode choice preference factors and shifting behaviour.
- To examine the impact of Mode choice Preference Factors on perception of metro vs. other modes.

3.3 Hypothesis of the study

Null Hypothesis 1: There is no association between age group and primary mode of transport.

Null Hypothesis 2: There is no significant relationship between mode choice preference factors (time, cost,

comfort, safety, reliability, accessibility, etc.) and shifting behaviour (shifters vs. non-shifters).

Null Hypothesis 3: There is no significant impact of Mode choice Preference Factors on perception of metro vs. other modes.

IV. RESEARCH METHODOLOGY

Primary data was collected using a structured and standardized questionnaire. The questionnaire was adapted from Anna Fraszczyk et. al (2016), whose model was originally developed based on university travel surveys conducted in Australia, the USA, and the UK. The sampling technique adopted was purposive sampling covering 116 respondents in Chennai city. The questionnaire focused on capturing information related to the respondent's demographic information, the primary mode of transport (bus, auto rickshaw, taxi, personal vehicle), frequency of use, reasons for choice, willingness to shift to metro and barriers that prevent metro usage. The statistical tools used were Chi-Square, Correlation and Regression analysis using Jamovi.

4.1 Limitations of the Study:

- The sample size is relatively small and predominantly composed of younger, female, and student respondents.
- The factors under travel behaviour and mode choice can be further extended.
- Commuter satisfaction towards various transport mode can also be studied.
- Comparative study between metro and any one of the public transports can be specifically studied.

V. ANALYSIS AND INTERPRETATION

The first part of the analysis deals with descriptive analysis of the study using percentage analysis.

Table 1.1 Demographic profile of the respondents

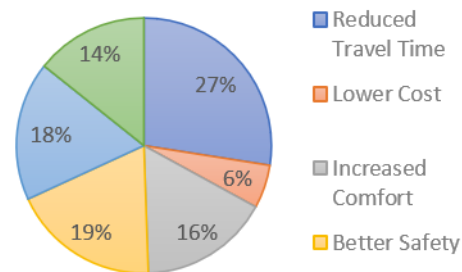
Gender	Count	Percentage
Male	14	12%
Female	102	88%
Total	116	100%
Age	Count	Percentage
Below18	30	26%
18–25 years	59	51%
26–35 years	21	18%

36–45 years	3	3%
46–60 years	2	2%
Above 60 years	1	1%
Total	116	100%
Occupation	Count	Percentage
Student	75	65%
Employed	39	34%
Self-Employed	2	2%
Homemaker	0	0%
Total	116	100%
Monthly Income	Count	Percentage
Less than Rs. 50,000	65	56%
Rs. 50,001 – Rs. 1,00,000	26	22%
Rs. 100,001 – Rs. 1,50,000	10	9%
More than Rs. 1,50,001	15	13%
Total	116	100%

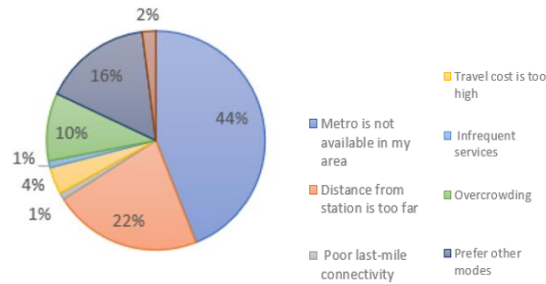
Source: Primary Data

The above table depicts the demographic profile of the respondents. The survey covered both male and female. The majority of the respondents were female (88%), maximum number of respondents belong to the age group of 18–25 years of age (51%) and are students (65%). And majority of the respondent's monthly income is Less than Rs. 50,000 (56%).

VI. PERCENTAGE ANALYSIS OF REASONS FOR SHIFTING TO METRO



The above chart presents the reasons for shifting to the metro. The study shows that 35% of the respondents shifted to metro from other modes of transport. The major reason for the shift among the respondents was 'Reduced Travel Time' (27%) followed by 'Better Safety' and 'Higher reliability'. Percentage Analysis of Reasons for Not Shifting to Metro



The above chart depicts the reasons for not shifted to metro. 65% of the respondents reported that they have not shifted to metro from other transport modes. The major reason for not shifting to metro is the non-availability of metro in their area (44%) followed by 'long distance from the nearest station (22%).

The next part of the analysis deals with the inferential analysis to examine the cause-and-effect relationship,

association and regression using various statistical tools like Chi-Square, Regression and Correlation Analysis.

Age Group and Primary Mode of Transport – Chi Square Test of Independence Analysis:

This part of the analysis attempts to study the association between age group and primary mode of transport which are depicted in the following table. While multiple demographics (gender, income, occupation) were profiled, age was prioritized for chi-square analysis with primary mode of transport due to its established role as a primary determinant of travel behaviour across lifecycle stages.

Null Hypothesis 1: There is no association between age group and primary mode of transport.

Table 1.2 Age Group and Primary Mode of Transport – Chi Square Test of Independence Analysis

Contingency Tables										
Primary Mode of Transport										
Age		1	2	3	4	5	6	7	8	Total
1	Observed	7	12	1	2	3	0	3	2	30
	% within row	23.3%	40.0%	3.3%	6.7%	10.0%	0.0%	10.0%	6.7%	100.0%
2	Observed	16	17	0	5	2	2	17	0	59
	% within row	27.1%	28.8%	0.0%	8.5%	3.4%	3.4%	28.8%	0.0%	100.0%
3	Observed	5	3	2	1	2	1	6	1	21
	% within row	23.8%	14.3%	9.5%	4.8%	9.5%	4.8%	28.6%	4.8%	100.0%
4	Observed	1	0	1	0	0	1	0	0	3
	% within row	33.3%	0.0%	33.3%	0.0%	0.0%	33.3%	0.0%	0.0%	100.0%
5	Observed	0	0	1	0	0	1	0	0	2
	% within row	0.0%	0.0%	50.0%	0.0%	0.0%	50.0%	0.0%	0.0%	100.0%
6	Observed	1	0	0	0	0	0	0	0	1
	% within row	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Total	Observed	30	32	5	8	7	5	26	3	116
	% within row	25.9%	27.6%	4.3%	6.9%	6.0%	4.3%	22.4%	2.6%	100.0%

Source: Computed Data

χ^2 Tests			
	Value	df	p
χ^2	56.0	35	0.014
Fisher's exact test			0.009
N	116		

Source: Computed Data

Nominal	
	Value
Phi-coefficient	NaN
Cramer's V	0.311

Post Hoc Test (Standardized Residuals)								
TB2								
Age	Metro	Bus	Suburban Train	Auto	Taxi	Personal Car	Two-wheeler	Bicycle
Below 18	-0.367	1.767	-0.306	-0.0577	1.059	-1.350	-1.894	1.635
18-25	0.314	0.301	-2.326	0.6824	-1.217	-0.497	1.682	-1.785
26-35	-0.237	-1.507	1.300	-0.4266	0.742	0.113	0.748	0.694
36-45	0.299	-1.083	2.508	-0.4776	-0.445	2.508	-0.943	-0.286

46-60	-0.843	-0.880	3.209	-0.3883	-0.362	3.209	-0.767	-0.232
Above 60	1.700	-0.620	-0.213	-0.2733	-0.255	-0.213	-0.540	-0.164

Source: Computed Data

A Pearson's chi-square test of independence was conducted to examine the relationship between age group and Primary mode of transport. The test was statistically significant, χ^2 (35, N = 116) = 56.0, $p = .014$, indicating that transport mode preferences varied by age. The strength of this association, measured by Cramer's V, was 0.311, which reflects a moderate effect size. The standardized residuals showed that this association was driven primarily by specific age-transport combinations. In particular, Age group 46-60 was strongly over-represented in Suburban Train, while Age group 36-45 was over-represented in transport modes Suburban train and Personal car. Conversely, Age group 18-25 was under-represented in Suburban Train. These deviations highlight that transport preferences were not evenly distributed, with older age groups showing more distinct patterns of choice.

VII. MODE CHOICE PREFERENCE FACTORS AND SHIFTING STATUS – CORRELATION

This part of the analysis attempts to study the relationship between mode choice preference factors and shifting behaviour which are depicted in the following table

Null Hypothesis 2: There is no significant association between mode choice preference factors (time, cost, comfort, safety, reliability, accessibility, etc.) and shifting behaviour (shifters vs. non-shifters).

Table No.3 Mode Choice Preference Factors and Shifting Status – Correlation

Factor	r	p
Travel Time	0.019	0.838
Travel Cost	-0.092	0.324

Comfort	-0.019	0.840
Safety and Security	-0.073	0.438
Reliability/Punctuality	-0.000	0.999
Accessibility to Stations	-0.051	0.590
Frequency of Service	-0.064	0.492

Source: Computed Data

The correlation analysis between mode choice preference factors and commuters' shifting behaviour (shifters vs. non-shifters) shows very weak and non-significant relationships. Travel time ($r = 0.019$, $p = 0.838$), travel cost ($r = -0.092$, $p = 0.324$), comfort ($r = -0.019$, $p = 0.840$), safety and security ($r = -0.073$, $p = 0.438$), reliability/punctuality ($r = -0.000$, $p = 0.999$), accessibility to stations ($r = -0.051$, $p = 0.590$), and frequency of service ($r = -0.064$, $p = 0.492$) all exhibit negligible correlations with whether commuters shift or do not shift modes. These results indicate that individually, these factors do not significantly influence commuters' decision to switch to another mode of transport.

VIII. MODE CHOICE PREFERENCE FACTORS AND PERCEPTION OF METRO VS OTHER MODES – REGRESSION

Null Hypothesis 4: There is no significant effect of Mode choice factors on perception of metro vs. other modes. (regression).

Table No.3 Mode Choice Preference Factors and Perception of Metro vs Other Modes – Regression

Model Fit Measures			
Model	R	R ²	Adjusted R ²
1	0.260	0.0675	0.00704

Source: Computed Data

Table No.4 Mode Choice Factors and Perception of Metro Vs Other Modes – Regression

S. No	Mode choice factors	Perception of Metro vs. Other Modes				
		Unstandardized coefficients		Standardized coefficients	t value	P value
		Beta Value	Std. Error	Beta		
	(Constant)	4.0408	0.2791		14.47991	<.001
1.	X1	-0.0460	0.0854	-0.0718	-0.53820	0.592
2.	X2	-0.2277	0.1007	-0.3507	-2.26159	0.026
3.	X3	-0.0233	0.1023	-0.0378	-0.22811	0.820

4.	X4	0.0242	0.1187	0.0380	0.20408	0.839
5.	X5	0.1619	0.1221	0.2325	1.32657	0.187
6.	X6	0.1157	0.1154	0.1829	1.00335	0.318
7.	X7	-0.0002	0.1222	-0.0003	-0.00158	0.999

Source: Computed Data

A multiple regression was conducted to examine whether mode choice factors predicted overall perception of metro. The predicted values of mode choice preference factors 'Travel Time'(X1), 'Travel Cost'(X2), 'Comfort'(X3), 'Safety and Security' (X4), 'Reliability/Punctuality' (X5), 'Accessibility to Stations'(X6), 'Frequency of Service' (X7). The multiple R value of 0.260 measures the degree of relationship between the Mode Choice Preference Factor and Perception of Metro vs. Other Modes.

R square value is 0.0675 which indicates that 6.75 % of the variation in the Perception of Metro vs. Other Modes of the respondents is explained by the estimated mode choice preference factors comprising of seven independent variables. The multiple regression equation is Perception of metro = $4.0408(\text{Constant}) - 0.0460X1 - 0.2277X2 - 0.0233X3 + 0.024X4 + 0.1619X5 + 0.1157X6 - 0.0002X7$

It can be inferred that the mode choice preference factors namely, 'Travel Cost' significantly predicted perception ($\beta = -0.23$, $t = -2.26$, $p = .026$), indicating that higher emphasis on Travel Cost was associated with lower perception of metro. Other predictors did not significantly affect overall perception (all $p > .05$). Thus, except for Travel Cost, mode choice factors were not found to be meaningful determinants of overall perception.

IX. FINDINGS

- It is found that 35% of the respondents shifted to metro from other modes of transport and reduced travel time factor being the major reason for such shift.
- 65% of the respondents reported that they have not shifted to metro from other transport modes and non-availability of metro in their area is the major reason for not shifting to metro.
- It is found that there exists a statistically significant relationship between age group and primary mode of transport. This means that the choice of primary mode of transport varies across different age group.

- It is found that all seven factors of Mode choice preference have emerged as non-significant relationship with commuters' shifting behaviour (shifters vs. non-shifters). Out of the seven factors, the factor namely Travel time showed a positive relationship with commuters' shifting behaviour whereas all others being negative. It means that commuters don't shift just because of one factor.
- It is found that the mode choice preference factor namely Travel cost only significantly predicted perception and indicate that higher emphasis on Travel Cost was associated with lower perception of metro. All other factors (Travel Time, Comfort, Safety & Security, Reliability, Accessibility, Frequency) were not significant predictor of overall perception.

X. CONCLUSION

The study found that even though the Chennai Metro Rail has made a big change in how people get around the city, not many commuters are switching from other forms of transport to the metro. The main reasons people do make the switch include shorter travel times, better safety, and more reliability. However, a major hurdle is that many neighbourhoods don't have metro services, and the distance to access those services can be a problem too. The analysis showed a clear link between age and the mode of transport people prefer, revealing that different age groups have varied preferences. Interestingly, factors like travel time, cost, comfort, safety, and accessibility don't independently convince commuters to change how they travel. Among these, the cost of travel has the most influence on how people view the metro, suggesting that fare sensitivity plays a big role in overall attitudes toward it. These findings point to the need for focused policy measures, broader metro reach, and better access to really encourage more people to switch their travel mode. Going forward, planning needs to tackle geographic gaps and address commuter concerns to make them happier and ultimately boost metro usage in Chennai.

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