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Evaluating the Paratransit System in Surat: Insights and Recommendations for Enhanced Service Quality

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Introduction

- India has experienced significant urbanization. The urban population increased from 20 percent in 1970 to 36 percent in 2023. This growth is accompanied by intra-state migration, further intensifying urban populations' mobility needs.
- The urban transport landscape in India is marked by heterogeneity, with a myriad of vehicles vying for space on city roads. The paratransit system stands out as a vital, affordable mobility option. This system is especially crucial in cities with inefficient public transport, where Intermediate Public Transportation (IPT) is a primary mobility option for economically disadvantaged populations.
- Public perception is a crucial factor in the success of paratransit systems with effective measures. Enhancing the service quality of IPTs is essential to improving public perception and increasing ridership. This involves addressing issues such as safety, reliability, comfort, and accessibility, particularly for vulnerable populations like the elderly and people with disabilities.
- The objective of this study is to assess qualitative parameters of the IPT system concerning users' perceptions.

Literature Review

- The literature on paratransit systems is diverse and can be broadly divided into two segments: the physical and operational characteristics of paratransit systems, and user perceptions and service quality assessments.

Physical and Operational Characteristics of Paratransit Systems

- In the Indian context, (Kumar et al., 2016) conducted an empirical study on informal public transport (IPT) modes in five Indian cities, emphasizing their role in bridging transport supply gaps. The study revealed that IPT systems play a crucial role in meeting the mobility needs of urban populations, particularly in cities where formal public transport is inadequate.
- Indicators such as traffic characteristics, network characteristics, socioeconomic profile, travel characteristics, and IPT infrastructure were used to study the IPT system in Walled City, Delhi, and identify the critical issues and gaps that act as hindrances to smooth mobility in the area.(Sharma et al., 2023).
- In Surat, for instance, the city's rapid growth and limited public transport infrastructure have led to a heavy reliance on paratransit services, particularly shared auto-rickshaws. These services provide crucial connectivity in areas not served by the city's limited bus network, demonstrating their importance in addressing urban mobility challenges.

Literature Review

User Perceptions and Service Quality of Paratransit Systems

- Tri Basuki Joewono & Hisashi Kubota, 2007 explored user satisfaction with paratransit services in Indonesia, identifying key factors influencing user perceptions, such as service quality, reliability, and safety.
- In India, user perceptions of paratransit systems have been influenced by factors such as affordability, accessibility, and convenience. Gadepalli, 2016 examined the role of intermediate public transport (IPT) in Visakhapatnam, highlighting the complementary roles of IPT and formal public transport in meeting urban mobility needs.
- In Surat, paratransit services are perceived as an essential mode of transport, especially for lower-income groups who rely on affordable and accessible options. However, challenges such as service reliability, safety, and regulatory compliance remain significant issues that need to be addressed to improve user satisfaction and overall service quality.

Attributes affecting service quality of paratransit

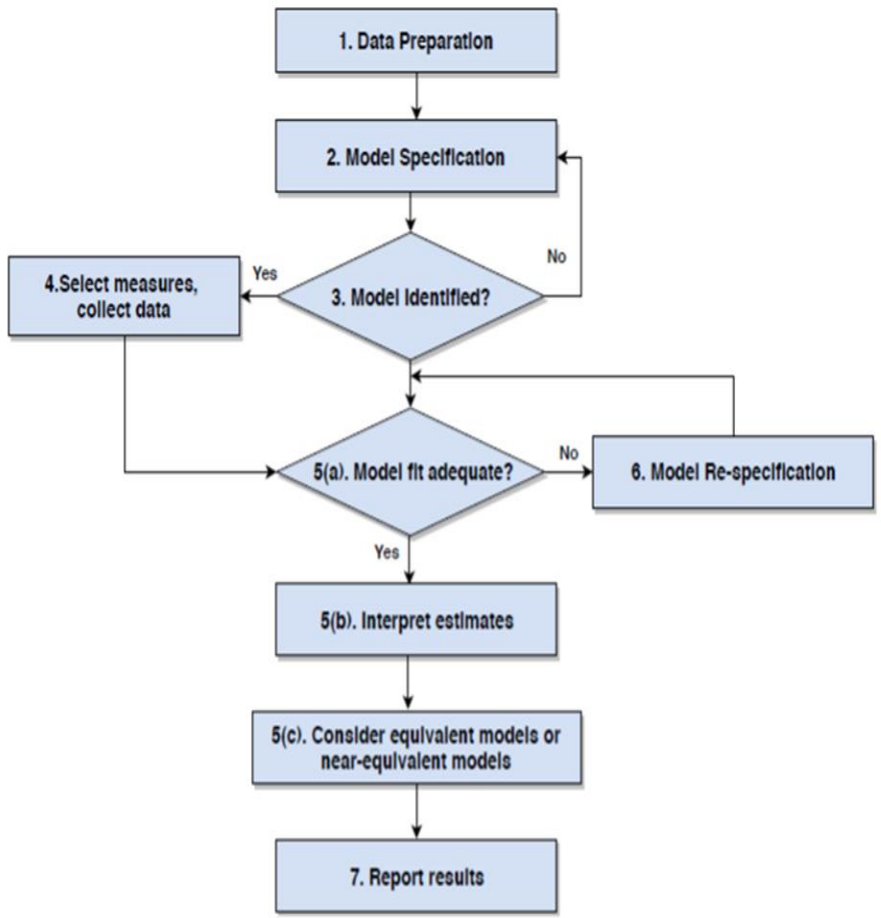
Attributes	(Joewono & Kubota, 2007)	(Rahman et al., 2016)	(Tri Basuki Joewono & Hisashi Kubota, 2007)	(Behrens et al., 2017)	(Phun, Masui, et al., 2018)	(Behrens et al., 2017)	(Sobhani et al., 2020)
Service Frequency	✓	✓		✓		✓	
Flexibility	✓	✓		✓			
Availability	✓	✓		✓	✓	✓	
Luggage handling	✓						✓
Ability to reach the exact destination	✓				✓		
Cleanliness in Vehicle	✓	✓					✓
Condition of Vehicle	✓	✓		✓		✓	✓
Crowing level	✓			✓			✓
Travel time	✓	✓	✓	✓		✓	
Waiting time	✓	✓		✓			✓
Noise level	✓	✓					✓
Accessibility	✓	✓		✓	✓	✓	
Distance from/to the stop	✓				✓	✓	✓
Seating comfort	✓	✓	✓	✓	✓	✓	✓
Overall satisfaction	✓		✓		✓		✓
Cost of travel	✓	✓		✓		✓	
Driver's attitude	✓				✓		✓
Overall safety	✓			✓	✓	✓	
Waiting time	✓			✓		✓	
Riding safety	✓	✓			✓		✓
Monthly Income	✓		✓		✓	✓	✓
Expenses on IPT	✓		✓		✓		✓
Users Age	✓		✓	✓	✓	✓	✓
Users Qualifications	✓		✓	✓	✓	✓	✓
Trip purpose	✓		✓		✓	✓	✓
Vehicle ownership	✓		✓	✓	✓	✓	✓
Job category	✓		✓	✓	✓		
Stress	✓			✓			✓

Set of observed variables (indicators)

Latent Variables	Label	Observed Variables (Attributes)
Convenience (CONV)	CONV1	Service frequency
	CONV2	Flexibility to route change
	CONV3	Availability of IPT services at night/early morning time
	CONV4	Ability to reach the exact point of destination
	CONV5	Easiness in luggage handling
Vehicular characteristics and others (VCR)	VCR1	Cleanliness in vehicle
	VCR2	Condition of vehicle
	VCR3	Crowding level and seat availability
	VCR4	Noise level while commuting
Perceived service quality (PSQ)	PSQ1	Accessibility
	PSQ2	Seating comfort
	PSQ3	Overall satisfaction
	PSQ4	Cost of IPT travel as compared to other modes of transport
	PSQ5	Riding Safety
	PSQ6	Driver's attitude
	PSQ7	Reliability
Socio-economic factors (SEF)	SEF1	Monthly income
	SEF2	User's age
	SEF3	Average monthly expenses on IPT commuting
	SEF4	Qualification of user
	SEF5	Vehicle ownership
	SEF6	Trip purpose

Structural Equation Modeling (SEM)

- Structural equation modeling (SEM) is a statistical technique that allows researchers to test complex relationships between variables in a model.
- The flowchart depicts the Structural Equation Modeling (SEM) process, starting with data preparation, which involves collecting and organizing pertinent data. Next, during the model specification step, researchers create the theoretical model that defines linkages between the variables of interest.
- Then, model identification determines if the stated model can be estimated using the data that has been provided. Once discovered, researchers pick measurements and collect data to test the model.
- Finally, the model assessment step assesses the model fit; if it is acceptable, the results are interpreted; otherwise, the model may be re-specified before the findings are presented.
- SEM can help researchers overcome this challenge by allowing them to test complex models that include multiple variables and interactions.



Flowchart of the basic steps of SEM

Study Area : Surat, Gujarat, India

- The city is a major commercial and economic center, with a bustling port and a rapidly growing real estate market.
- In Surat, despite extensive PT coverage, IPT remains essential for first-mile/last-mile connectivity, especially in areas underserved by PT. IPT offers flexible, demand-responsive services for short trips and off-peak hours, complementing the mass transit network.
- It fills gaps where PT cannot serve directly, ensuring seamless multimodal travel. Additionally, IPT contributes to local employment and supports informal economic activity. Thus, IPT's role is vital in enhancing overall transport accessibility and inclusivity.
- The study involved a comprehensive and multi-faceted approach to gather extensive information on the Intermediate Public Transport (IPT) system in Surat.

Data Collection

- The study employed a stratified random sampling approach to gather data on users' perceptions of Intermediate Public Transport (IPT) services in Surat. Between March 25 and April 20, 2019, the survey involved 550 respondents across various key nodes and public places in the city
- A preliminary questionnaire was designed based on a thorough literature review, identifying 38 factors influencing IPT users' perceptions.
- After conducting a pilot study, the questionnaire was refined to 32 questions across three sections. The first section inquired about socio-economic characteristics, while the second focused on travel characteristics, including trip purpose, travel details, waiting time, average walking distance to nodes, and willingness to shift to bus services. The third section aimed to capture service quality attributes using a five-point Likert scale, ranging from 1 (very poor) to 5 (very good), assessing factors such as service frequency, vehicle condition, crowding level, seat availability, flexibility to route change, ease in luggage handling, driver's behavior, and overall satisfaction.

Exploratory factor analysis

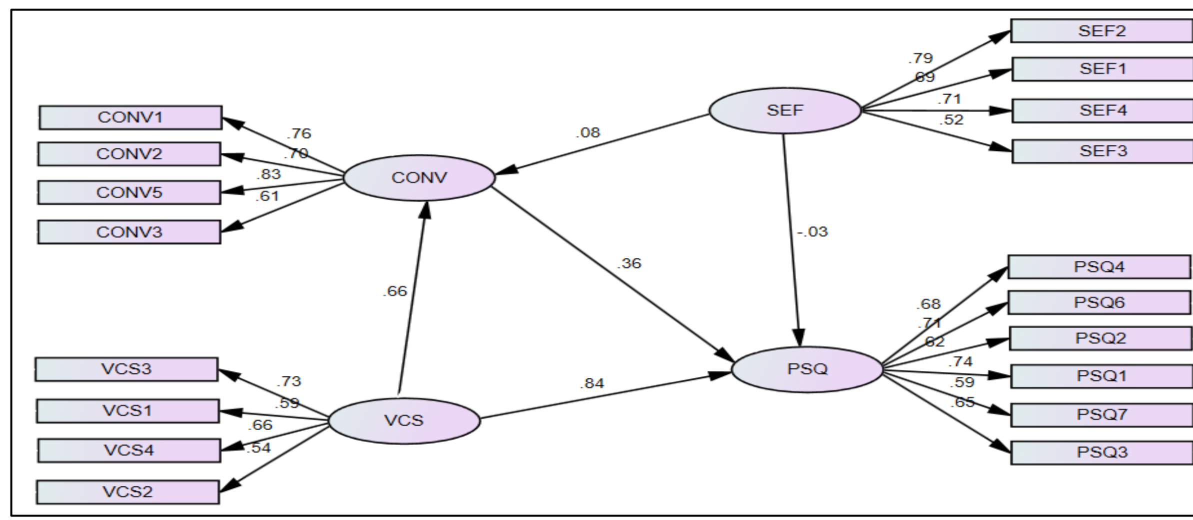
- EFA aims to determine the number of latent factors that explain the variability and correlation among the attributes. The EFA was performed using SPSS software, with PCA for factor extraction and varimax rotation. Items with factor loadings of 0.5 or higher were considered significant. The remaining factors were classified as "Perceived service quality (PSQ)", "Vehicular characteristics and others (VCS)", "Convenience (CONV)" and "Socioeconomic factors (SEF)".
- The EFA loadings for the first factor, "Perceived service quality (PSQ)", consisted of five attributes with values ranging from 0.59 to 0.82, second factor "Vehicular characteristics and others (VCS)", consisted of four attributes with values ranging from 0.54 to 0.73, third-factor Convenience (CONV), consisted of four attributes with values ranging from 0.61 to 0.73. while "Socioeconomic factors (SEF)", the fourth factor, consisted of four attributes with EFA loadings between 0.52 to 0.7. When Cronbach's alpha is greater than 0.70, it suggests that the items in the test or questionnaire are highly consistent and likely measure the same construct.

Attributes	Communalities	Loadings	Variance (%)	Cronbach's Alpha
Factor 1: Perceived service quality (PSQ)				
Cost of travel (PSQ 4)	.657	0.68	23.47	0.802
Seating comfort (PSQ 2)	.632	0.82		
Waiting time (PSQ 6)	.493	0.71		
Safety (PSQ 7)	.660	0.59		
Accessibility (PSQ 1)	.670	0.74		
Overall satisfaction (PSQ 3)	.598	0.65		
Factor 2: Vehicular characteristics and others (VCS)				
Condition of IPT vehicle (VCS 3)	.523	0.73	14.05	0.797
Crowding level and seat availability (VCS 2)	.513	0.54		
Noise level (VCS 4)	.652	0.66		
Cleanliness in the vehicle (VCS 1)	.624	0.59		
Factor 3: Convenience (CONV)				
Flexibility to route change (CONV 2)	.778	0.79	11.41	0.810
Frequency (CONV 1)	.660	0.76		
Availability during late night and early morning (CONV 3)	.715	0.61		
Ability to reach exact point (CONV 5)	.582	0.83		
Factor 4: Socioeconomic factors (SEF)				
Users Qualification (SEF 4)	.619	0.71	7.37	0.766
Monthly expenses on IPT commuting (SEF 1)	.610	0.69		
Monthly income (SEF 2)	.566	0.79		
User's age (SEF 3)	.517	0.52		

Structure Equation Model

- The ML method was used to estimate the SEM with 550 observations, and the AMOS 23.0 package was used to calibrate the SEM model.
- The first column lists the variables of the model, including the latent model. The other columns show different statistics related to the relationships, such as the Standardized Regression Weights (Std.R.W.), Standard Error (S.E.), the Critical Ratio (C.R.), and Probability value (P).
- The CFI score for this model is 0.789, indicating a decent match. This model has an RMSEA of 0.041, indicating a decent match. The above-fit indices indicate the structural model has a fairly good fit.

Latent variable	Observed variable		Std.R.W.
Perceived service quality (PSQ)	x1	Cost of travel (PSQ 4)	0.68
	x2	Seating comfort (PSQ 2)	0.82
	x3	Waiting time (PSQ 6)	0.71
	x4	Safety (PSQ 7)	0.59
	x5	Accessibility (PSQ 1)	0.74
	x6	Overall satisfaction (PSQ 3)	0.65
Vehicular characteristics and others (VCS)	x7	Condition of IPT vehicle (VCS 3)	0.73
	x8	Crowding level and seat availability (VCS 2)	0.54
	x9	Noise level (VCS 4)	0.66
	x10	Cleanliness in the vehicle (VCS 1)	0.59
Convenience (CONV)	x11	Flexibility to route change (CONV 2)	0.79
	x12	Frequency (CONV 1)	0.76
	x13	Availability during late night and early morning (CONV 3)	0.61
	x14	Ability to reach an exact point (CONV 5)	0.83
Socioeconomic factors (SEF)	x15	Users Qualification (SEF 4)	0.71
	x16	Monthly expenses on IPT commuting (SEF 1)	0.69
	x17	Monthly income (SEF 2)	0.79
	x18	User's age (SEF 3)	0.52



Conclusions

- The ability to reach the exact point (CONV5) has the highest value of standardized path coefficients and so it is the most significant factor affecting the convenience level as per users' perception in the study area.
- The condition of vehicle (VCS3) has the maximum value of standardized path coefficients and so it is the most significant factor defining the vehicular characteristics and others.
- Moreover, perceived service quality is defined by six important indicators, accessibility to get paratransit services (PSQ1) has the highest potential to contribute service quality for present services in the city.
- Socioeconomic factors play an important role in understanding the travel behaviour of a user. In this study, four crucial indicators are considered amongst which monthly income of user (SEF2) is highly affecting the socioeconomic status of users.
- From the results, it is seen that among the latent variables, VCS has the greatest influence (0.84) on PSQ which is followed by CONV (0.36). Amongst the attributes 'Accessibility' (PSQ1) has the maximum potential on service quality which is closely followed by 'Waiting time' (PSQ6). Likewise, 'Ability to reach the exact point' (CONV5) has the maximum influence (0.83) on CONV, 'Condition of vehicle' (VCS3) has highest potential (0.73) to explain VCS, 'Monthly income' (SEF2) contribute uppermost (0.79) in defining SEF. All the above maximum connections are highly influencing the PSQ of paratransit system.

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