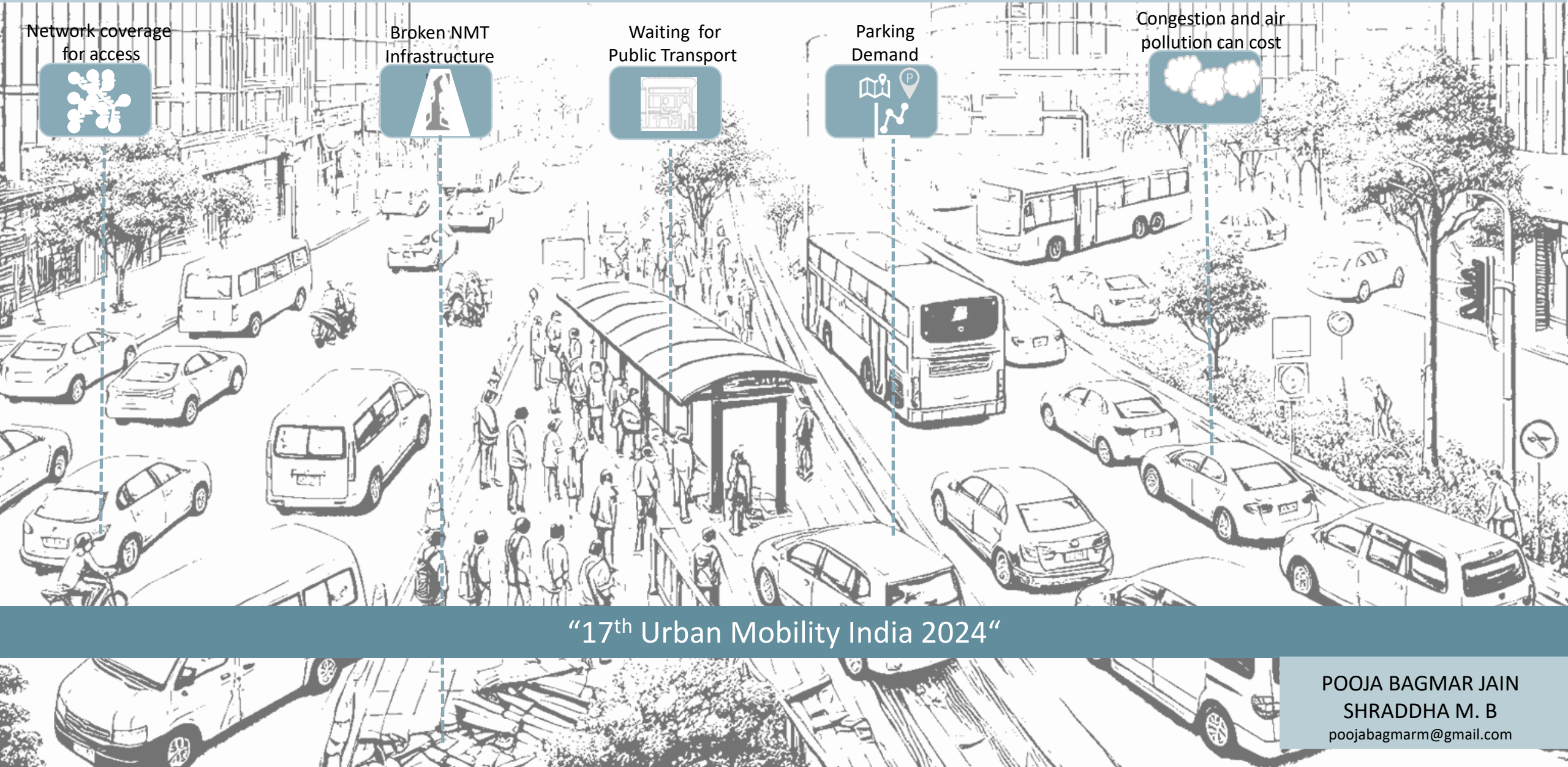
"An Investigation of Key Parameters for Sustainable and User-Friendly Public Transportation Systems"



"17th Urban Mobility India 2024"

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SHRADDHA M. B
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PRESENTATION STRUCTURE

Introduction & Background

1. Brief Purpose of the study Problem statement
2. Literature Review Gaps and context

STAGE 01

Context and Framework

1. Literature Review and Gaps
2. Developing the framework comprising Parameter
3. Introduction to study Area

STAGE 02

Methodology/ Design

1.Method opted for Data Collection Primary data from secondary data
2. Develop model from parameter Indicator for from Literature study

STAGE 03

Descriptive & Data Analysis

1.Analysis and synthesize of primary and secondary data
2.Method opted for Analysis and why

STAGE 04

Result and Conclusion

1. Result from model
2. Research findings
3. conclusion Report

STAGE 05

Recommendation way forward

1. Suggestion of policy from research findings
2. And Strategies

STAGE 06

PRESENT SCENARIO AND INTRODUCTION

Rising urban population and mobility needs

Urban population has increased by 70% in last 50 years.

Rapid motorization & personalized vehicle dominant travel to satisfy the increased demand:

Road congestion, travel delay, air pollution, accidents

Available public transport facilities:

Unreliable, slow, unsafe, uncomfortable, inadequate capacity, improper planning, managerial & financial issues

Myths

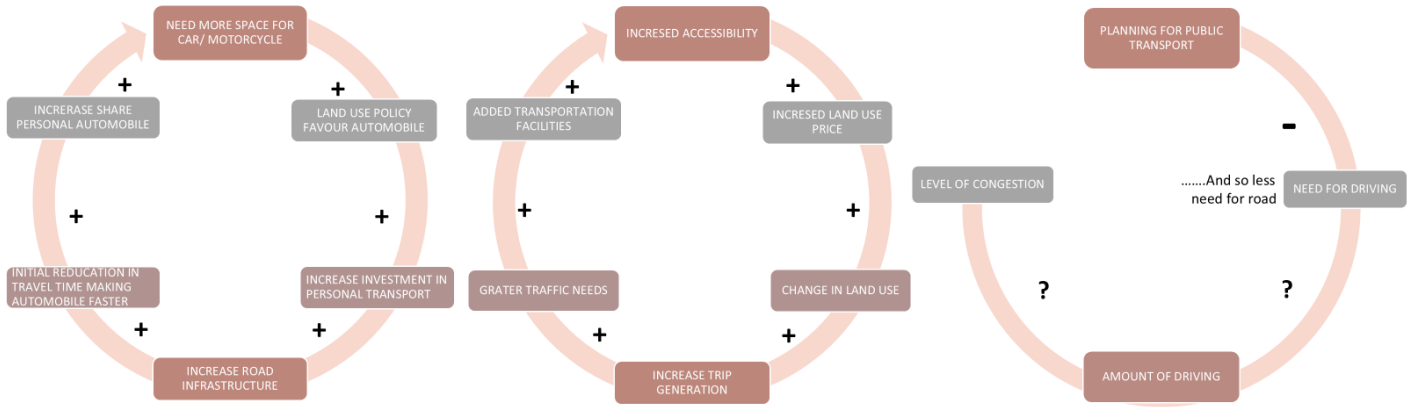
- Everyone travels by personal motor vehicles.
- Buses congest road space.
- Buses are inefficient modes of transport.
- City needs a metro.

Source : statista.com/statistics/271312/urbanization-in-India

Elements which can help to set a benchmark

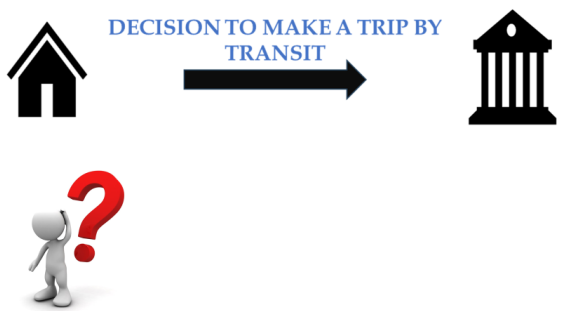
- Infrastructure which last longer, ensure sustainability
- Stations, where comfort meets efficiency
- Communication for a seamless experience
- Universal accessibility, transit integration

INTRODUCTION

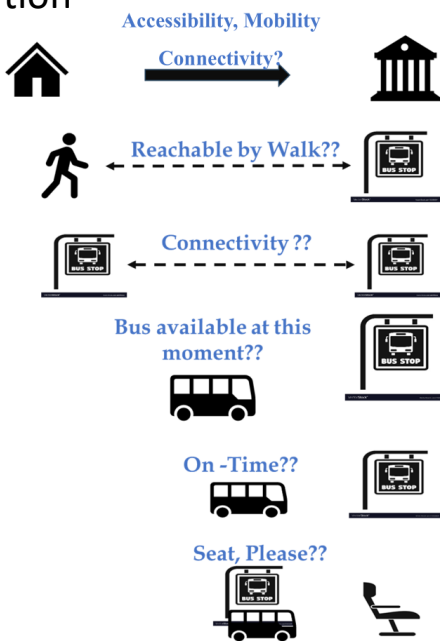


A VICIOUS CYCLE

Source : transportation engineering planning and design by Paul Wright, Norman Ashford 4th edition



Source : (Transit Capacity and Quality of Service Manual, 3'd Edition, 2013)



LITERATURE AND RESEARCH GAP

There is a common agreement (Briggs, Wilson 2014; Linda Worrall 2016; Katrin Lättman 2019; Chang, Shih 2012; Brons & Givoni 2008; Bhargav Adhvaryu, Abhay Chopde 2017; T. L. LEI and R. L. Church 2016) , that perceived factors are crucial in this regard and the solely consideration of calculated measures leads to distorted results. However, in order to include the perceived factors in the analysis of accessibility, mobility connectivity they must first be explored and fully understood . currently it is neither clear which factors are the most important ones when it comes to perceived factor nor how this differs for different people & at different places

Inadequate Translation of Travel Experiences into Measures

This gap suggests need for better alignment between qualitative insights gained from user experiences & quantitative metrics used in evaluation

The gap in the context of variable selection for a questionnaire-based study arises from the need to establish a robust and comprehensive set of variables that accurately capture the research objectives.

The existing literature on passengers' satisfaction with transit systems lies in the limited inclusion of socio-demographic characteristics in RASCH Modelling studies.

To assess passengers' perceptions and satisfaction with the transit service through subjective measures.
This research focus on to identify & analyze the key parameters that contribute to the sustainability & user-friendliness of public transportation systems.

01 To identify and study the key parameter for public transport

02 A model is developed to assess unobservable and immeasurable characteristics related to P.T services. Latent constructs are underlying variables that cannot be directly measured.

03 Policy suggestions & strategies based on empirical findings for operation agencies & policymakers to create user-friendly P.T services, with focus on addressing specific needs of diverse urban traveler segments.

INDICATORS FOR EVALUATION AND RESEARCH METHODOLOGY (Research design and data matrix)

What is an Accessibility Mobility and Connectivity ?

Accessibility 01

- **Hansen 1959**
  - Spatial distribution of activities
  - Adjusted for the ability and the desire of people
  - Overcome spatial separation
- **O'Sullivan, 2010**
  - Ease with which any land-use activity can be reached from a particular location, using a particular transport system.

Accessibility refers to how easily individuals can access reach to station and use P.T

Mobility 02

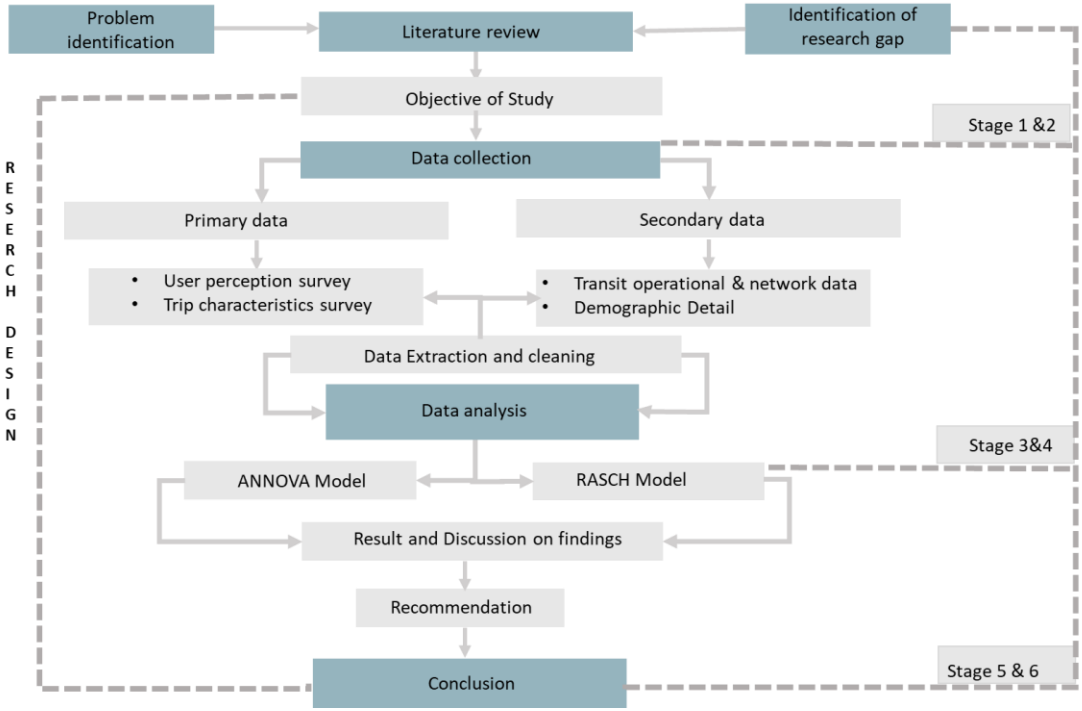
Mobility relates to the ease of movement and transportation options available.

- **Pitirim Sorokin 1927**
  - spatial change and crossing through space
- **Kaufmann 2011**
  - Mobility is the ability to freely move or be moved

Connectivity 03

- **Rodrigue 1991**
  - which is the ratio between the number of existing circuits and the maximum of circuits possible.
- **Mamun et al., 2013**
  - All indicator are origin & destination stop.

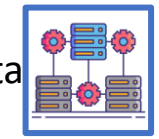
connectivity involves smooth & integrated connections between different modes of public transport.



SECONDARY DATA COLLECTION

Demographic Data

Transit operational Data



Transit Network Data

Geographical Data

Travel Characteristics Data

Data Type	Data	Source
Demographic	Population	AMC,VMC and census(2023)
	Employment	
Transit operational	Frequency	VSCDL , AMC,VMC & geo-tracker app
	Ridership	
	GPS data for Speed	
	Seating Capacity	
Transit Network	Route Length and location	VSCDL and google map data
	No of bus stops with latitude and longitude	
Geographical	Area ward wise	AMC,VMC and census(2021)
	ward wise city shape file(GIS data)	
	municipal administrative Boundaries	
Travel Characteristics	In vehicle travel time by Transit only	Google map data

PRIMARY DATA COLLECTION

The off-board interview method was used, stratified sampling technique was adopted to conduct individual user perception survey.

The variables used to measure the level of difficulty of users & variables are divided into several indicators.

To quantify the answers to the variables , five point Likert scale are used for weighted Satisfaction. Scale to describe satisfaction and weighting starting from: very dissatisfied = 1 to Very satisfied = 5

CITY OVERVIEW

01

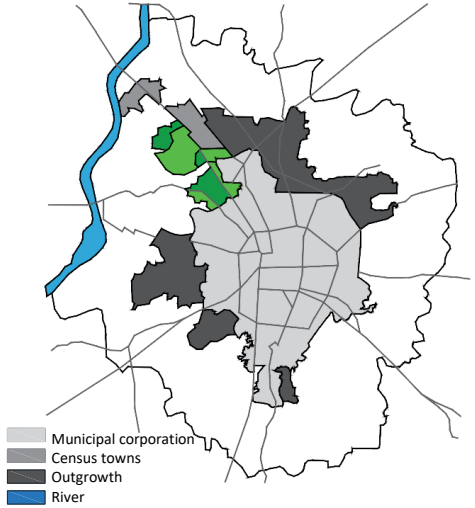
Composition of study area

220.33 Sq.km VMC of Area

80m VMC Space per person

256 Sq.km Built-up area

Source : Vadodara Municipal Corporation site



The density and economic center are concentrated within VMC

02

Population Demography

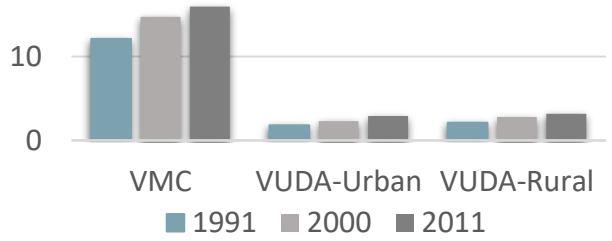
20,58,364 Population in 2011

23,27,345 Estimated in 2023.

127pph Current Population density within VMC limits

Source : Vadodara Municipal Corporation site

Population distribution from1991-2011



Growing population trend within VMC indicates possibility of further densification

03

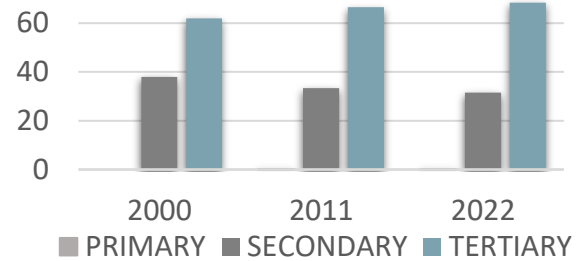
Economy and Employment

Secondary, Tertiary Sectors major contribution to economy.

750000 Total employment in 2019

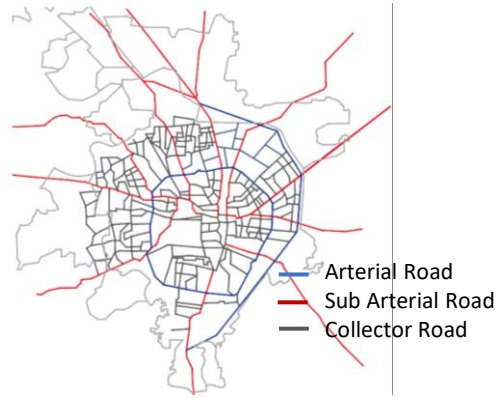
Source : Vadodara Municipal Corporation site

Sector wise economic distribution

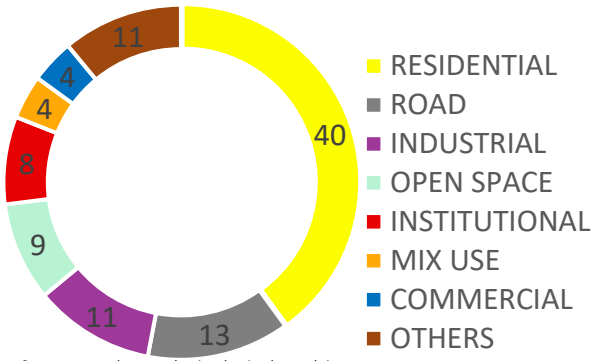


Sectoral shift is observed due to decline in industrial growth

Map of hierarchy of road

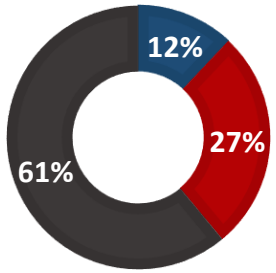


Land use character of Vadodara



Source : town and country planning planning dept website

Share of different hierarchy of road



Source : Vadodara Municipal Corporation site

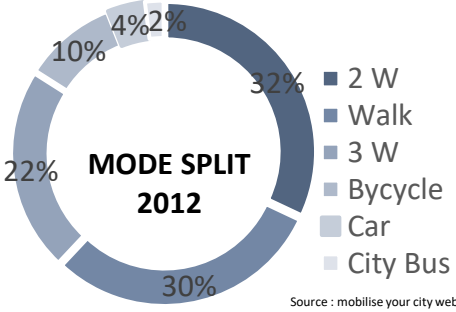
Ring radial Structure of road network

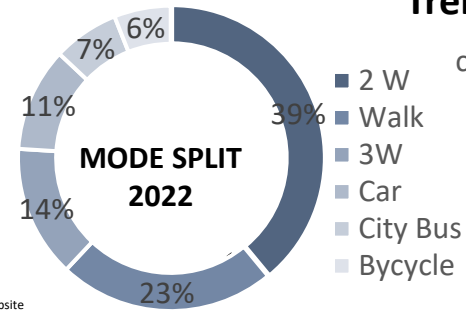
1000 km Total road network length

12% Share of higher order road

2.8 Road length km/sq.km

Share of different mode

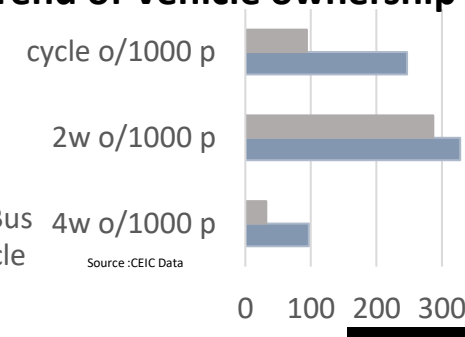




Source : mobilise your city website

Comparison of mode share from 2011 & 2022 **decrease in walk trip** & significant **increase in motorized (2w and 4w) trip**

Trend of Vehicle ownership



Source :CEIC Data

CITY OVERVIEW

01

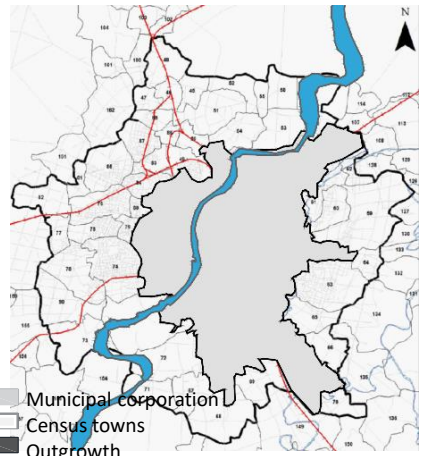
Composition of study area

466 Sq.km AMC Area

1.3 sq.mSpace per person

1060.9 Sq.km Built-up area

Source : Ahmedabad Municipal Corporation site



Since the density and economic center are concentrated within AMC

02

Population Demography

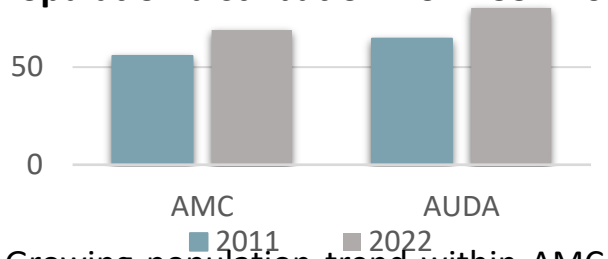
55.77 lakhs Population in 2011

69.1 lakhs Estimated in 2022

143pph Population density in AMC

Source : Ahmedabad Municipal Corporation site

Population distribution from1991-2011



Growing population trend within AMC indicates possibility of further densification

03

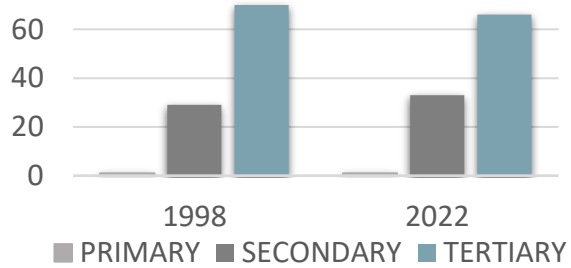
Economy and Employment

Secondary, Tertiary Sectors with major contribution to economy

23 la Total employment in 2022

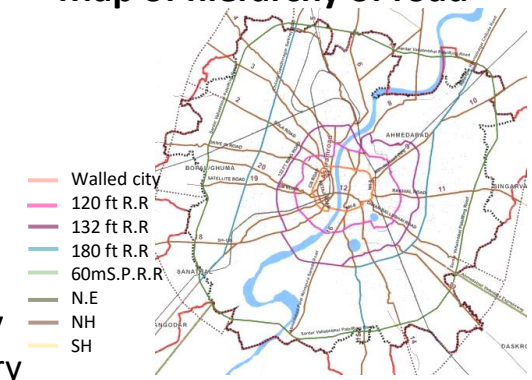
Source : Ahmedabad Municipal Corporation site

Sector wise economic distribution

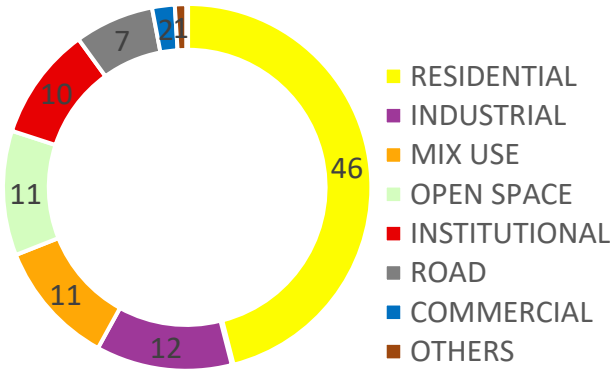


Major employment generating industries are textile, heavy machinery pharmaceutical & large share of tertiary

Map of hierarchy of road

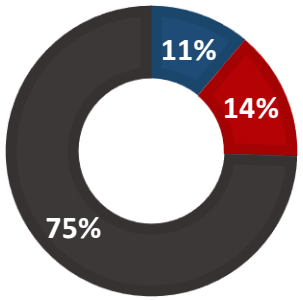


Land use of Ahmedabad



Source : town and country planning planning dept website

Share of different hierarchy of road



Ring radial

Structure of road network

2,569 km

Total road network length

14%

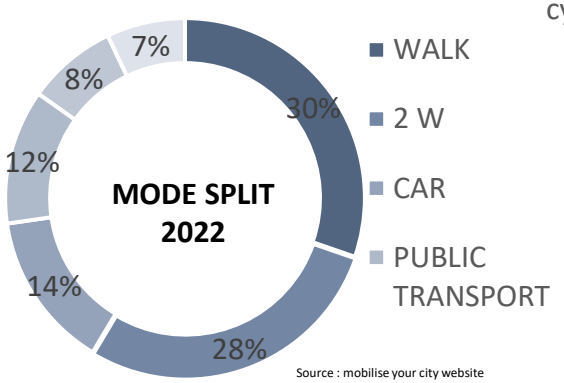
Share of higher order road

3.3

Road length km/sq.km

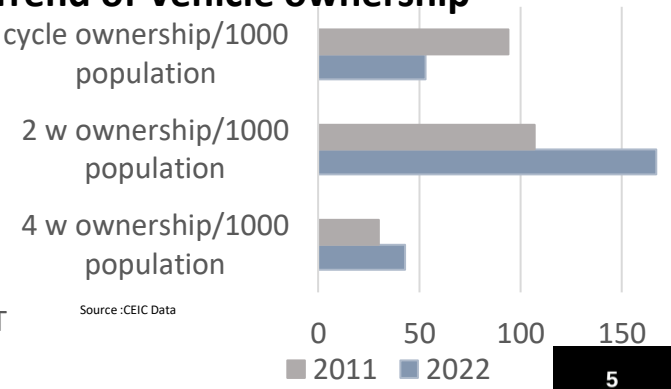
Source : Ahmedabad Municipal Corporation site

Share of different mode



Source : mobilise your city website

Trend of Vehicle ownership



Source :CEIC Data

Evaluation Framework

1 Accessibility

1. Network coverage and weather conditions
2. Walking quality

2 Connectivity

1. Transfer service quality
2. Transfer penalty

3 Mobility

1. Transportation mode service performance.
2. Transportation mode service quality

02
Cities

383
Survey respondent

03
Dimensions

06
Factors

35 & 47
Service Item

Framework Development with Parameter and Indictors (Service measurement items during public transportation travel)

Dimensions and Factors	Sl.No AMD	Sl.N VOD	Service Item Description
1. Accessibility A) Network coverage and weather conditions	1		Finding my metro station is not easy [12]
	2	1	Finding my bus station is not easy [19]
	3		My metro station is too far away to walk [5]
	4	2	My bus stop is too far away to walk [17]
	5	3	I avoid walking when it is hot [17]
	6	4	I avoid walking when it is raining [30]
B) Walking quality	7	5	I feel uneasy due to the current traffic conditions [17]
	8	6	I feel stressed because of traffic conditions [17]
	9	7	I find crossing busy roads not easy [17]
	10	8	There is trash on streets near my bus/metro stop [17]
	11	9	There aren't enough shade trees along the way to the station [17]
	12	10	Don't like vehicles parked Irregularly on the footpaths. [32]
	13	11	Lack of walking environment around transit stop [32]
	14	12	Availability of footpath is poor
	15	13	footpath surface is poor
	16	14	Availability of parking near metro station is poor
	17		Availability of bicycle near metro station is poor
2. Mobility A) Transportation mode service performance	18		The metro is usually not on time [7]
	19	15	the bus is running late all the time [3]
	20		The metro service is infrequent [40]
	21	16	The bus service is infrequent [15]
	22		Metro crime and violence is high [15]
	23	17	Bus crime and violence is high [36]
	24		There is bad bus service on weekends and at night [36]
	25	18	There is bad metro service on weekends & at night [8]
B) Transportation mode service quality	26		Metro cars are crowded [8]
	27	19	Bus is crowded [24]
	28		Boarding and alighting the metro is not safe
	29	20	Boarding and alighting the bus is not safe [37]
	30		Overall cleanliness inside metro is poor [4]
	31	21	Overall cleanliness inside bus is poor [37]
	32	22	Unable to predict number of stops until my arrival [4]
3. Connectivity A) Transfer service quality	33	23	Transfer from the metro to a bus is not pedestrian friendly
	34	24	Passenger information for transfers isn't available [15]
	35	25	Schedule disclosure & route information are poor [32]
	36		Real time metro information is not provided at bus stop [4]
	37	26	Real time bus information isn't updated at bus/metro stop [24]
	38	27	Booths are not available when transferring [4]

Dimensions and Factors	Sl.No AMD	Sl.No VOD	Service Item Description
B) Transfer penalty	39	28	Transfer is risky on inappropriate stand [39]
	40	29	I dislike transfers with variable travel times [39]
	41	30	I dislike multiple transfers for trip planning [39]
	42	31	I find add charges expensive associated with the transfer [4]
	43	32	Connecting bus not adhering to the schedule [39]
	44	33	Connecting bus is less frequent [32]
	45	34	Bus wait time is not acceptable [39]
	46	35	Metro and bus transfers are not seamless [27]
	47		My smart card doesn't work on all P.T service

Questionnaire is meticulously designed based on past literatures resulting in items focusing on measuring accessibility, connectivity, and mobility, also incorporating items suggested by experts.

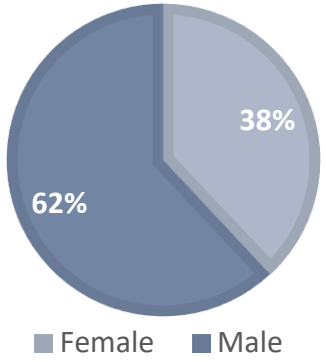
The Rasch model: It is used to measure abilities by comparing item difficulty and individual performance. Its key feature is the ability to provide results that are independent of the specific sample. It operates on a probabilistic scale, meaning it predicts the likelihood of a person answering a question correctly based on their ability. Rasch model allows for the measurement of latent traits such as commuter satisfaction, and service quality their performance on a set of items which are critical for designing effective and efficient P.T system

Consequently, integrating the Rasch model into public transportation planning can lead to improved service design, enhanced commuter experiences, and more informed policy decisions.

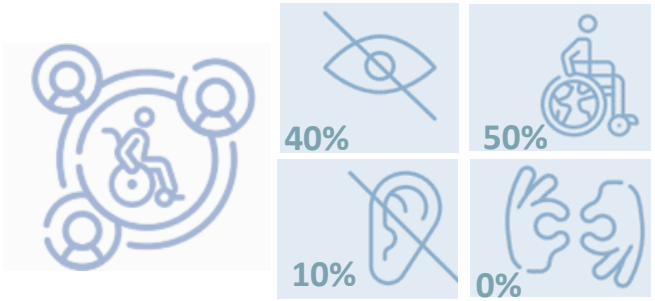
By transforming ordinal scale data into interval scale data, the model helps to eliminate biases inherent in ordinal scales, The model compares the perceptions of item parameters with parameters of person.. This transformation helps in accurately identifying specific difficulties in service scenarios.

PROFILE OF SURVEY RESPONDENTS VADODRA

Gender

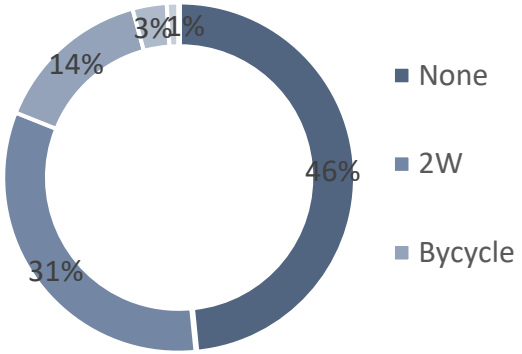


Persons with Disabilities

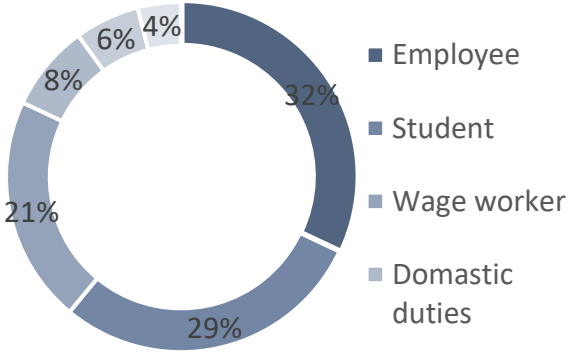


3% total survey respondents

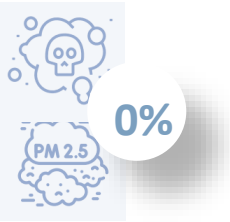
Vehicle Ownership



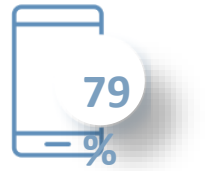
Occupation



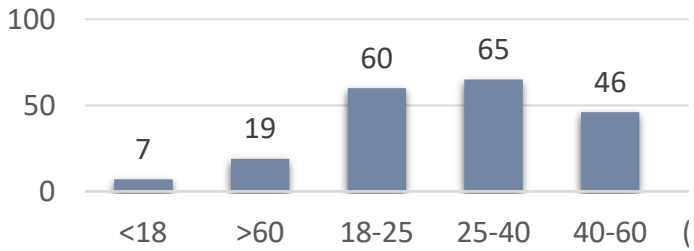
P.T for Environment



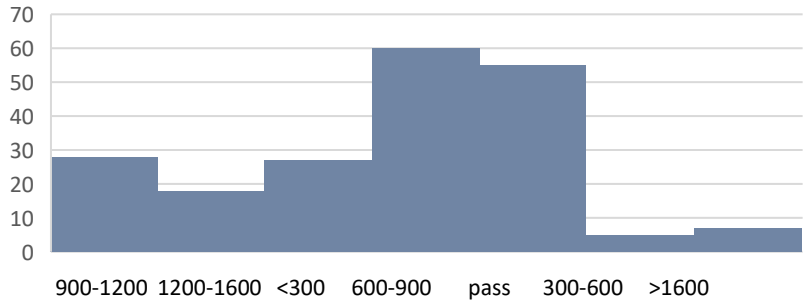
Smart phone



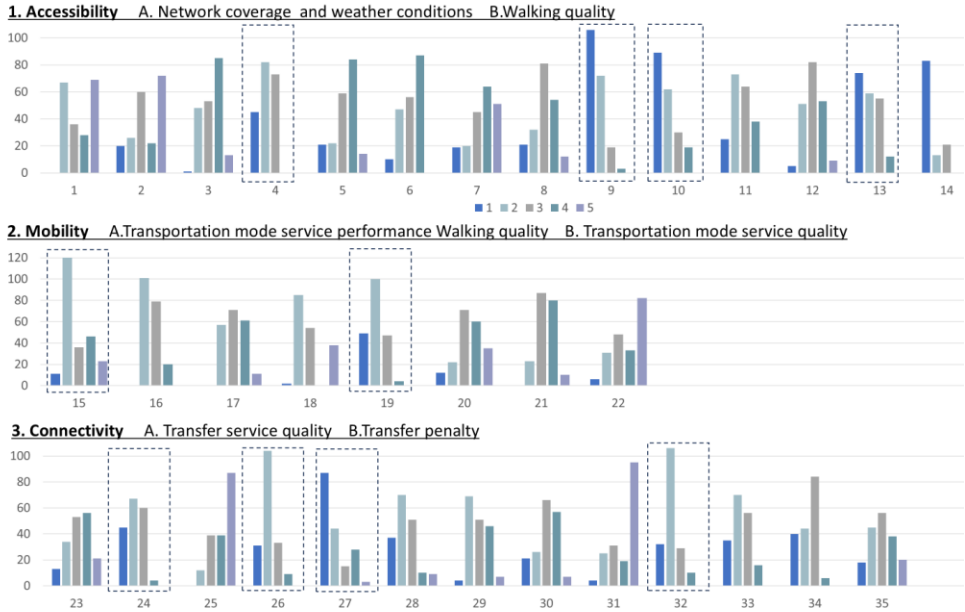
Age Group



Monthly expenditure on transport

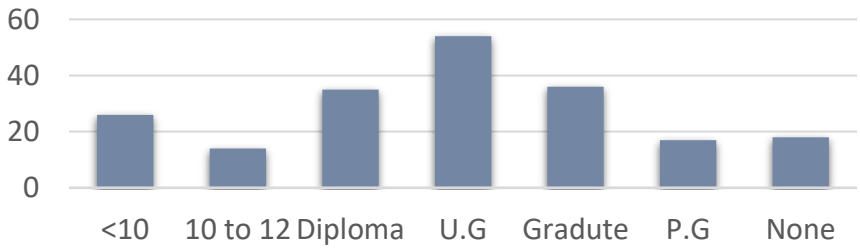


Likert scale response



A Likert scale is a commonly used rating scale that measures respondents' perceptions towards a particular statement. The variables used to measure the level of satisfaction of users of P.T services & variables are divided into several indicators.

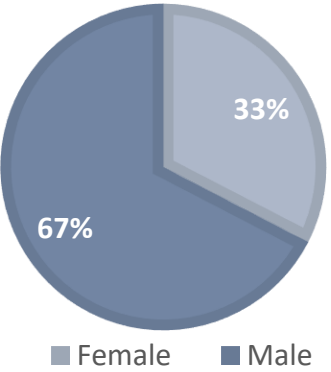
Educational Qualification



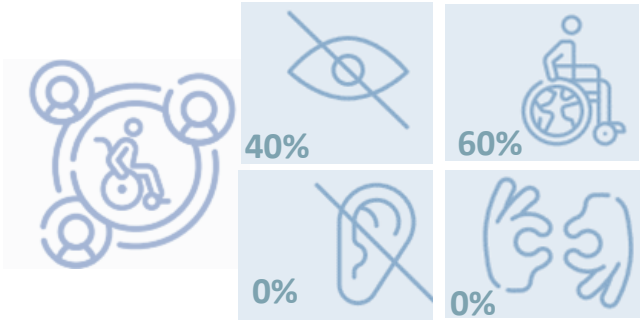
Monthly earning

PROFILE OF SURVEY RESPONDENTS AHMEDABAD

Gender

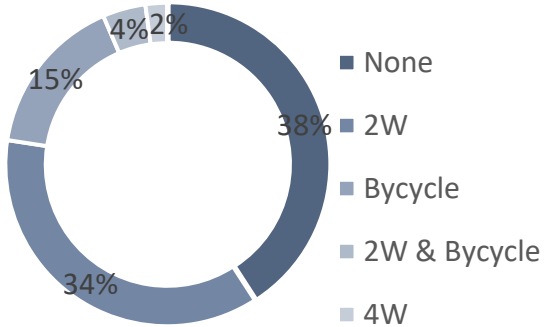


Persons with Disabilities

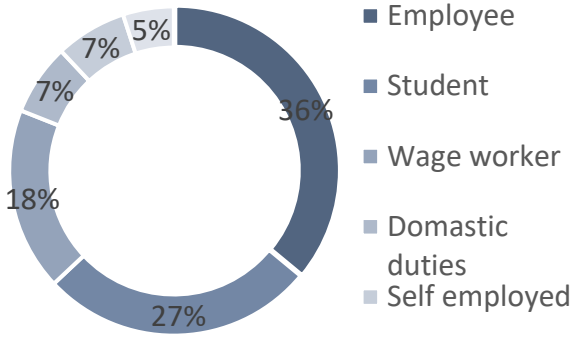


4% total survey respondents

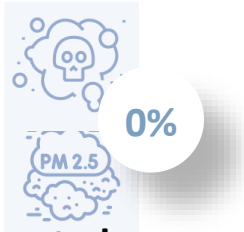
Vehicle Ownership



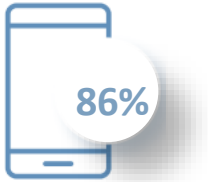
Occupation



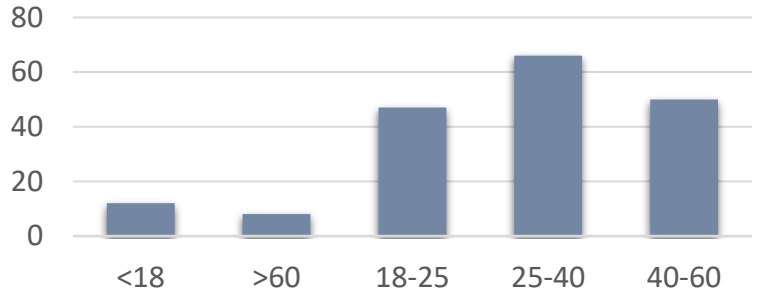
P.T for Environment



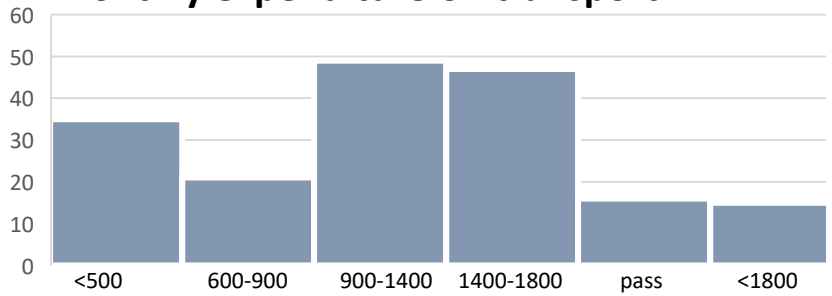
Smart phone



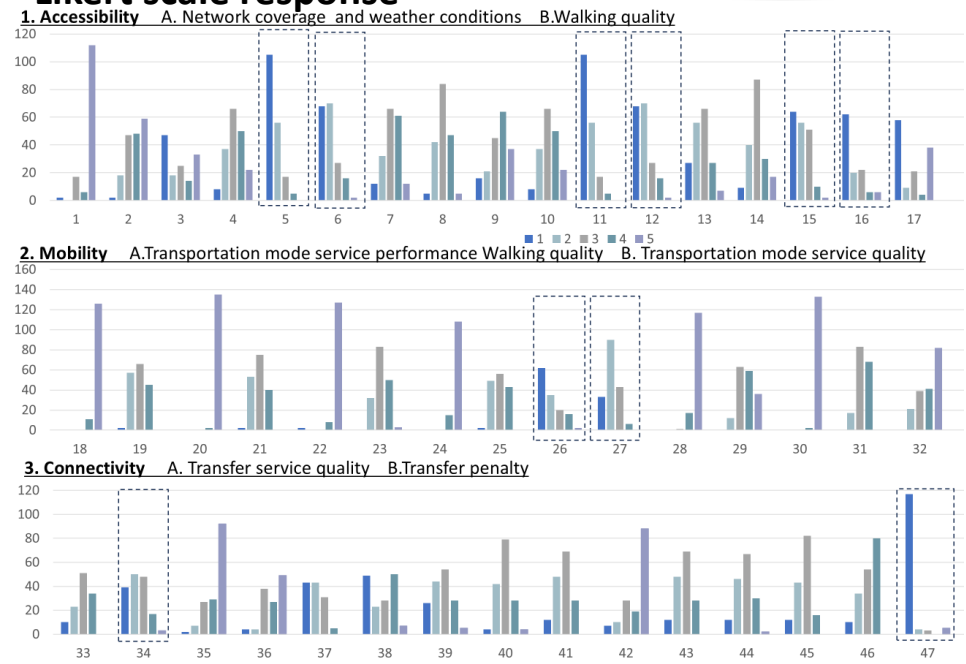
Age Group



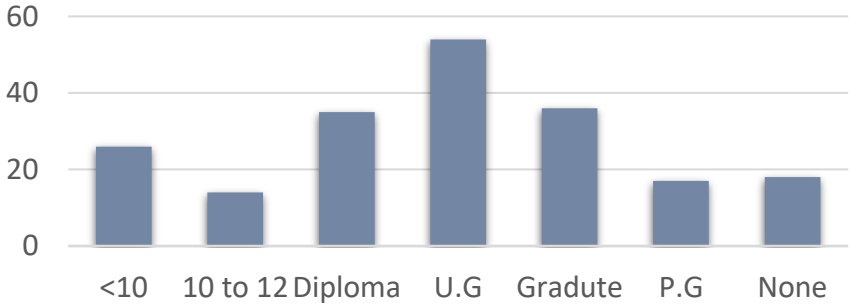
Monthly expenditure on transport



Likert scale response



Educational Qualification



Monthly earning

Standard five-point Likert rating scale was used for questionnaire, it requires minimum of 125 subjects (Hawkins et al., 2014), having 383 respondents, provides enough data for Rasch analysis.

RESULT OF DATA ANALYSIS FOR VADODARA

ACCESSIBILITY Item statistics – RSM RASH MODEL

Item No.	Service Item	Item mean	Measure	Standard error	Infit	Outfit
9	There aren't enough shade trees along way to station	1.63	1.6199	0.1072	1.273	1.408
14	Availability of parking near main bus station is poor	1.63	1.6085	0.107	1.307	1.284
10	I don't like vehicles parked Irregularly on the footpaths	1.88	1.1654	0.0988	1.296	1.251
13	Footpath Surfaces is poor	2.09	0.8333	0.0935	1.352	1.402
4	I avoid walking when it is raining:	2.15	0.7387	0.0921	0.513	0.534
11	Lack of walking environment around transit stations	2.68	0.0414	0.0838	0.808	0.812
8	There is trash on the streets near my metro/ bus stop	3.05	-0.3787	0.0812	1.537	1.538
12	Availability of footpath is poor	3.11	-0.4444	0.081	0.867	0.875
6	I feel stressed because of traffic conditions	3.12	-0.4576	0.081	0.6	0.599
3	I avoid walking when it is hot	3.22	-0.5752	0.0808	0.692	0.699
5	I feel unsafe because of traffic conditions	3.39	-0.7582	0.081	0.691	0.692
2	My bus stop is too far away to walk	3.45	-0.8305	0.0812	2.001	2.017
1	Finding my bus stop is not easy	3.51	-0.9034	0.0816	1.243	1.267
7	I find crossing busy roads not easy	3.73	-1.155	0.0836	0.933	0.909

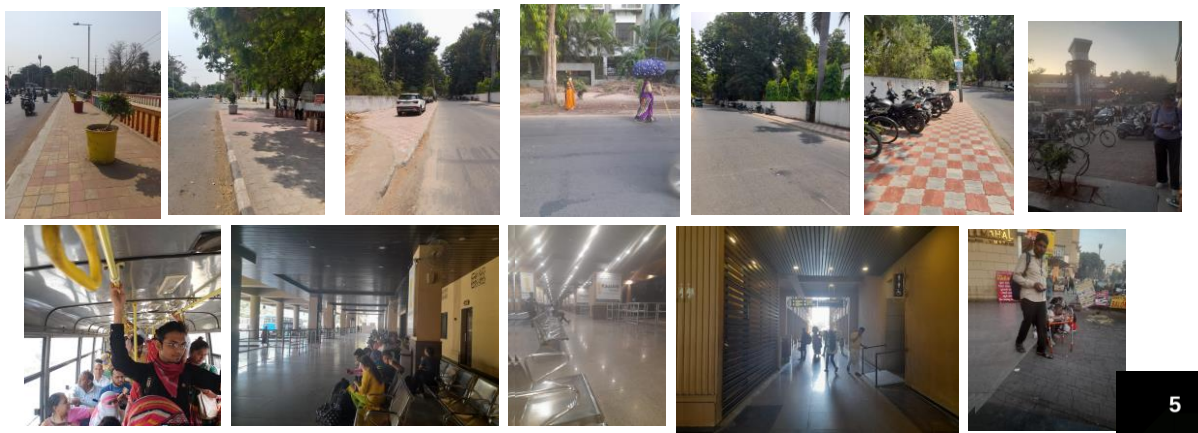
MOBILITY Item statistics – RSM RASH MODEL

Item No.	Service Item	Item mean	Measure	Standard Error	Infit	Outfit
19	Bus are crowded	2.06	0.8773	0.0941	1.02	1.078
15	The bus is running late all the time	2.25	0.6058	0.0902	0.64	0.637
16	The bus service is infrequent	2.49	0.2796	0.0862	0.677	0.684
18	There is bad bus service on weekends and at night.	2.59	0.1552	0.0849	0.636	0.616
17	Bus crime and violence is high	3.08	-0.4116	0.0811	0.399	0.399
21	Overall cleanliness inside bus is poor	3.28	-0.6405	0.0808	0.662	0.672
20	Boarding and alighting the bus is not safe	3.45	-0.8305	0.0812	0.75	0.734
22	Unable to estimate remaining bus stops until my arrival	3.85	-1.3048	0.0854	0.868	0.858

CONNECTIVITY Item statistics - RSM

Item No.	Service Item	Item mean	Measure	Standard error	Infit	Outfit
27	Booths are not available when transferring	1.84	1.2246	0.0998	1.68	1.571
32	Connecting bus not adhering to the schedule	1.98	0.9947	0.096	0.671	0.687
26	Real time bus information is not updated at bus/ metro stop	2.06	0.8685	0.094	0.723	0.752
24	Passenger information for transfers is not available	2.18	0.6965	0.0915	0.731	0.728
33	Connecting bus is less frequent	2.22	0.6385	0.0907	0.983	0.948
34	Bus wait time is not acceptable	2.31	0.5174	0.0891	0.824	0.828
28	Transfer is risky on inappropriate stand	2.39	0.4158	0.0878	1.063	1.051
29	I dislike transfers with variable travel times	2.85	-0.1517	0.0824	0.806	0.844
30	I dislike multiple transfers for trip planning	2.99	-0.3126	0.0815	0.768	0.788
35	Bus to bus transfers are not seamless	3.01	-0.3325	0.0814	0.941	0.952
23	Transfer from bus to a bus is not pedestrian friendly	3.13	-0.4707	0.0809	0.781	0.791
31	I find add charges expensive associated with the transfer	4.06	-1.5813	0.0902	2.366	2.584
25	Schedule disclosure and route information are poor	4.18	-1.742	0.0939	1.23	1.236

"Measure" value represents resistance of urban traveller to each item. Higher logit number indicates the highest difficulty level for the service item. Measure value larger than zero indicates that urban traveler is more likely to perceive difficulty when traveling.



RESULT OF DATA ANALYSIS FOR AHMEDABAD

ACCESSIBILITY Item statistics – RSM RASH MODEL

Item No.	Service Item	Item mean	Measure	Standard Error	Infit	Outfit
11	There aren't enough shade trees along the way to station	1.56	2.0375	0.1132	1.034	1.005
12	I don't like vehicles parked Irregularly on the footpaths.	1.89	1.5103	0.1	1.039	0.971
16	Availability of parking near metro station is poor	1.94	1.451	0.0988	1.365	1.283
15	Footpath Surfaces is poor	2.09	1.2529	0.0956	0.976	0.966
6	I avoid walking when it is raining	2.11	1.2256	0.0952	0.879	0.867
3	My metro station is too far away to walk	2.29	1.0058	0.0925	2.894	2.835
17	Availability of bicycles near metro station is poor	2.72	0.5062	0.0891	2.727	2.699
13	Lack of walking environment around transit stations	2.81	0.4113	0.0888	0.925	0.921
14	Availability of footpath is poor	3.01	0.1914	0.0885	0.804	0.802
4	My bus stop is too far away to walk	3.1	0.0895	0.0886	0.933	0.932
8	I feel stressed because of traffic conditions	3.12	0.066	0.0886	0.776	0.779
10	There is trash on the streets near my bus/metro stop	3.22	-0.0442	0.0888	1.009	1.008
5	I avoid walking when it is hot	3.44	-0.2834	0.0899	0.841	0.855
7	I feel unsafe because of traffic conditions	3.46	-0.3077	0.0901	0.847	0.877
9	I find crossing busy roads not easy	3.81	-0.7303	0.0944	0.79	0.787
1	Finding my metro station is not easy	3.9	-0.839	0.0961	3.051	2.798
2	Finding my bus station is not easy	4.01	-0.9911	0.099	1.076	1.054

MOBILITY

27	Bus are crowded	2.06	1.2896	0.0961	0.79	0.841
26	Metro cars are crowded	2.23	1.0748	0.0933	1.711	1.724
20	The bus service is infrequent	2.84	0.3798	0.0887	0.538	0.536
19	The bus is running late all the time	2.86	0.3483	0.0887	0.589	0.586
25	There is bad bus service on weekends & at night.	2.95	0.2541	0.0885	0.588	0.588
23	Bus crime and violence is high	3.1	0.0895	0.0886	0.496	0.494

MOBILITY Item statistics – RSM RASH MODEL

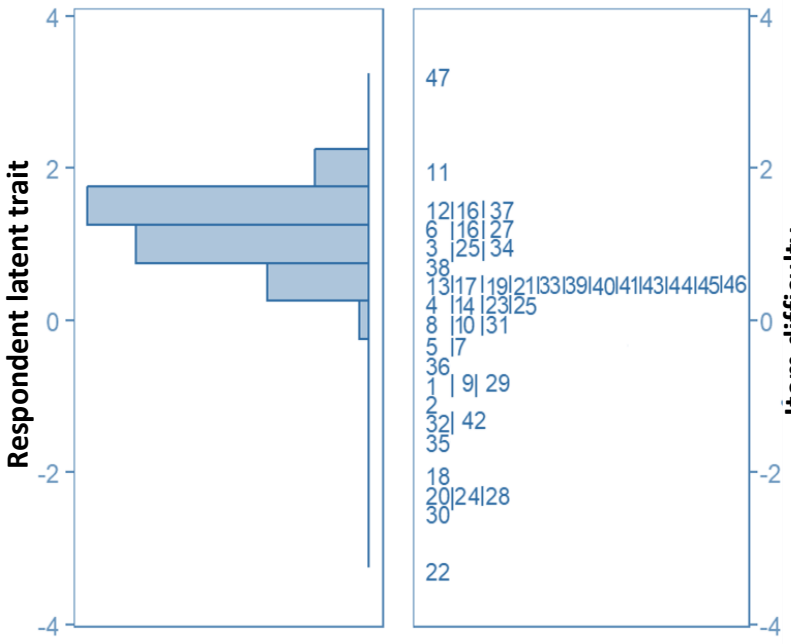
Item No.	Service Item	Item mean	Measure	Standard Error	Infit	Outfit
31	Overall cleanliness inside bus is poor	3.21	-0.0363	0.0888	0.311	0.31
29	Boarding and alighting the bus is not safe	3.78	-0.686	0.0938	0.656	0.65
32	Unable to estimate remaining stations until arrival	4.16	-1.196	0.1037	0.917	0.86
18	The metro is usually not on time	4.61	-2.0921	0.1404	0.598	0.658
24	There is bad metro service on weekends & at night.	4.64	-2.1736	0.1452	0.898	0.94
21	The metro service is infrequent	4.71	-2.3809	0.1589	0.633	0.614
28	Boarding and alighting the metro is not safe	4.71	-2.4064	0.1607	0.906	0.81
30	Overall cleanliness inside metro is poor	4.74	-2.5149	0.1688	0.662	0.639
22	Metro crime and violence is high	4.86	-3.161	0.2296	0.806	0.655

CONNECTIVITY

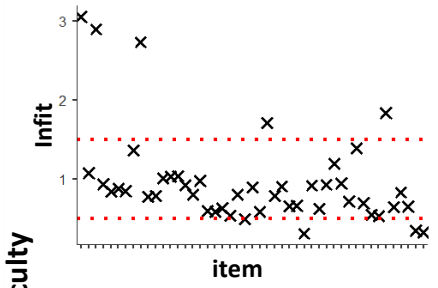
47	My smart card doesn't work on all P.T service	1.07	3.2192	0.1529	0.326	0.27
37	Bus information at metro stations is not in real-time	1.96	1.4122	0.0981	0.721	0.695
34	Passenger information for transfers is not available	2.37	0.9043	0.0915	0.927	0.922
38	Booths are not available when transferring	2.63	0.6099	0.0895	1.391	1.386
46	Metro and bus transfers are not seamless	2.65	0.5859	0.0894	0.351	0.343
45	Bus wait time is not acceptable	2.68	0.5539	0.0893	0.653	0.647
39	Transfer is risky on inappropriate stand	2.72	0.5062	0.0891	0.695	0.698
33	Transfer from metro to a bus is not pedestrian friendly	2.72	0.5062	0.0891	0.624	0.625
43	Connecting bus not adhering to the schedule	2.72	0.5062	0.0891	0.649	0.646
44	Connecting bus is less frequent	2.76	0.4666	0.089	0.831	0.826
40	I dislike transfers with variable travel times	2.8	0.4192	0.0888	0.551	0.553
41	I dislike multiple transfers for trip planning	2.84	0.3798	0.0887	0.532	0.529
36	Real time metro information is not updated at bus stop	3.7	-0.5905	0.0926	0.943	0.948
42	I find add charges expensive associated with transfer	4.18	-1.2285	0.1046	1.837	2.021
35	Schedule disclosure and route information are poor	4.39	-1.5916	0.1164	1.195	1.134

RESULT OF DATA ANALYSIS FOR AHMEDABAD AND VADODARA

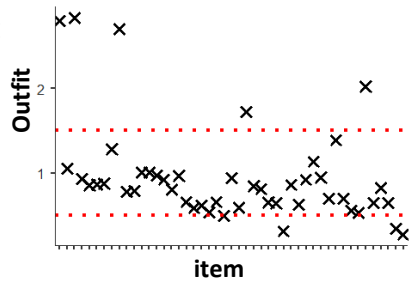
Wright Map (Person-item map) of Ahmedabad



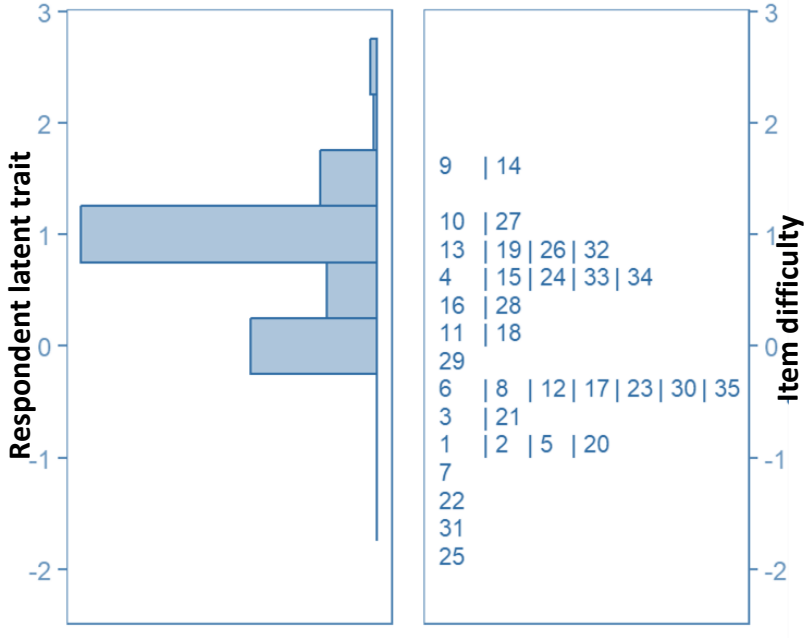
Infit Graph



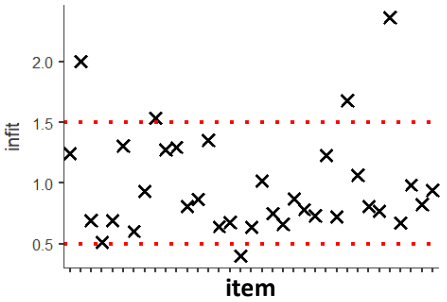
Outfit Graph



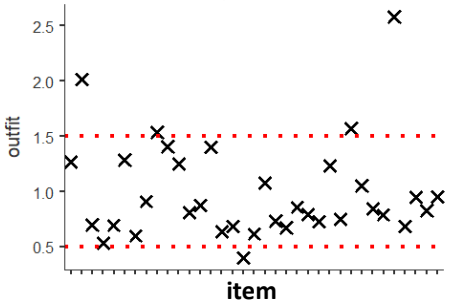
Wright Map (Person-item map) of Vadodara



Infit Graph



Outfit Graph



Acceptable fit statistics values is between "0.5-1.5" for infit & outfit (Tavakol & Dennick, 2013).

MODEL FIT

Results indicate strong reliability scores, indicating stability of collective information(Aiken, 1996).

Person separation reliability using eRm R package

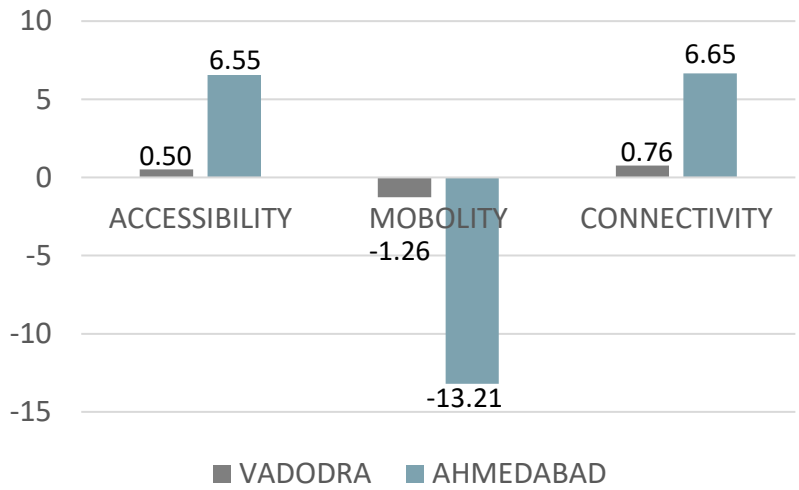
	SSD	MSE	Reliability
Ahmedabad	0.186	0.0299	0.839
vadodra	0.231	0.0381	0.836

Note. SSD=Squared Standard Deviation; MSE=Mean Squared Error.

Model information - RSM

	AIC	BIC	CAIC	Log-likelihood	Parameters	Persons
Ahmedabad	15593	15879	15976	-7700	97	140
Vadodara	14936	15165	15238	-7395	73	171

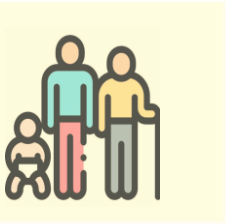
Abilities (in logit)



RESULT OF DATA ANALYSIS FOR AHMEDABAD & VADODARA

ANOVA (Analysis of Variance) is a powerful statistical technique used to compare the means groups & determine if there are any **significant differences** among them.

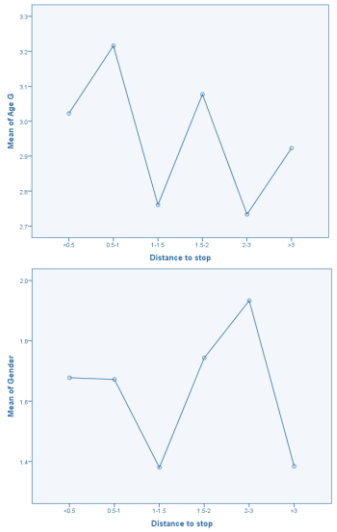
Average user's ability to overcome perceived difficulties in each subgroup.

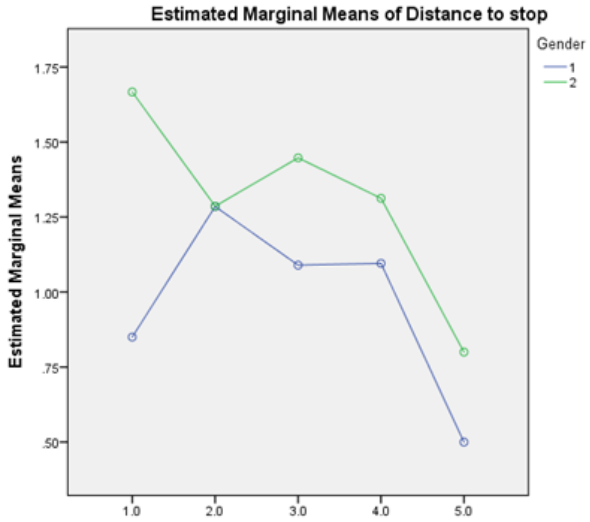


Age Groups

Age G

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.444	5	2.689	2.692	.021
Within Groups	376.545	377	.999		
Total	389.990	382			





ACCESS DIST

GENDER

Gender

1- Female 2- Male

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10.162	5	2.032	9.919	.000
Within Groups	77.253	377	.205		
Total	87.415	382			

Hypothesis Testing: H0: There is no significant difference between the groups
Ha: There is significant difference between the groups

A low p-value (usually below threshold of 0.05) 0.021 & .000 for age & gender respectively suggests that there are significant differences between two of the socio-demographic groups in relation to the variable being analysed.

RESEARCH FINDINGS

- Considering three-dimensions, among the commuters connectivity is major issue compare to accessibility and mobility. Under accessibility dimension "The number of shaded trees on route to station is insufficient" underperformed the most. The item "availability of parking" near metro and main bus station is poor was second toughest "vehicles parking randomly on the sidewalk" also created difficultly for passenger, inversely, passenger perceived that Finding my bus station is not easy did not cause any difficulty.

- For mobility dimension "Bus are crowded" is most difficult item for passenger. "The bus is usually not on time and "The bus service is infrequent" are also problem. "Unable to estimate remaining stations until my arrival" is not difficult item for rider. Based on study bus service is lacking does not meet mobility need of passenger.

- Connectivity dimension connecting "bus not adhering to the schedule", "booths are not available when transferring", unified smart card not available Bus information at metro stations is not in real-time are most difficult, schedule disclosure and route information are poor is not a problem for passenger.

- According to the results of Rasch model, riders in Ahmedabad were able to overcome perceived problems more easily than those in Vadodara, nonetheless, riders in both cities gave connectivity lower rating than accessibility and mobility, younger travellers and those who relied mostly on public transit had shown a greater capacity to overcome challenges.

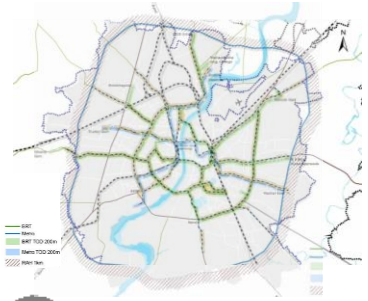
Policy Implications

- The research results suggest range of various potential outcomes for policy development. Firstly, regarding accessibility very few commuters can handle challenges linked to poor walking conditions, user found walking in non-shaded and interrupted footpath (vehicle parked) in hot weather was challenging. Authority should provide Complete Streets Approach (NUTP,2014) with prioritizing pedestrian Zones & Connected Walkways, Build Sheltered walkways with shaded trees and artificial shading structures (solar) connecting transit hubs, this encourages walking to bus stops and metro stations creating pleasant environment for commuters.

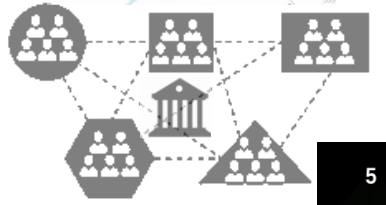
- Secondly, passengers are often frustrated by bus delays and overcrowding. To address this, transit authorities should provide Mobility-as-a-Service digital platform that integrates all modes of public transport into single app (J., & Buehler, R. 2010) offering real-time updates and seamless ticketing. Implementing high-frequency transit services with dynamic scheduling, adjusting frequency based on demand using real-time data analytics to reduce wait times and overcrowding. This can improve customer satisfaction and enhance reputation of transit service.

- Thirdly, Transfer between modes are challenging for user. To overcome, Integrated multi-modal hubs should be developed where all services are in one location and passengers can easily switch between modes (bus, metro). These hubs would have clear signage, short walking distances between modes, and real-time information displays showing the next available service for each mode. This majorly helps elderly and disabled. Coordination between bus and metro schedules would reduce wait times and enhance the overall experience. Unified smart card system where all P.T providers collaborate to develop a single smart card that is accepted across all modes.

- Fourth, The data suggest Ahmedabad should focus on minimizing travel distance and improve access to livelihoods this can be achieved by TOD (Cervero et al., 2002) along the route and both side of metro station, making Ahmedabad public transport-oriented city that is denser, diverse, user friendly and support economic growth while offering good quality of life, making this a long term strategy. On the other hand, Vadodara should focus on expanding its transport network and performance with dedicated bus lanes and prioritize buses at traffic signals, ensuring buses operate on time and reducing delays caused by phantom traffic congestion.

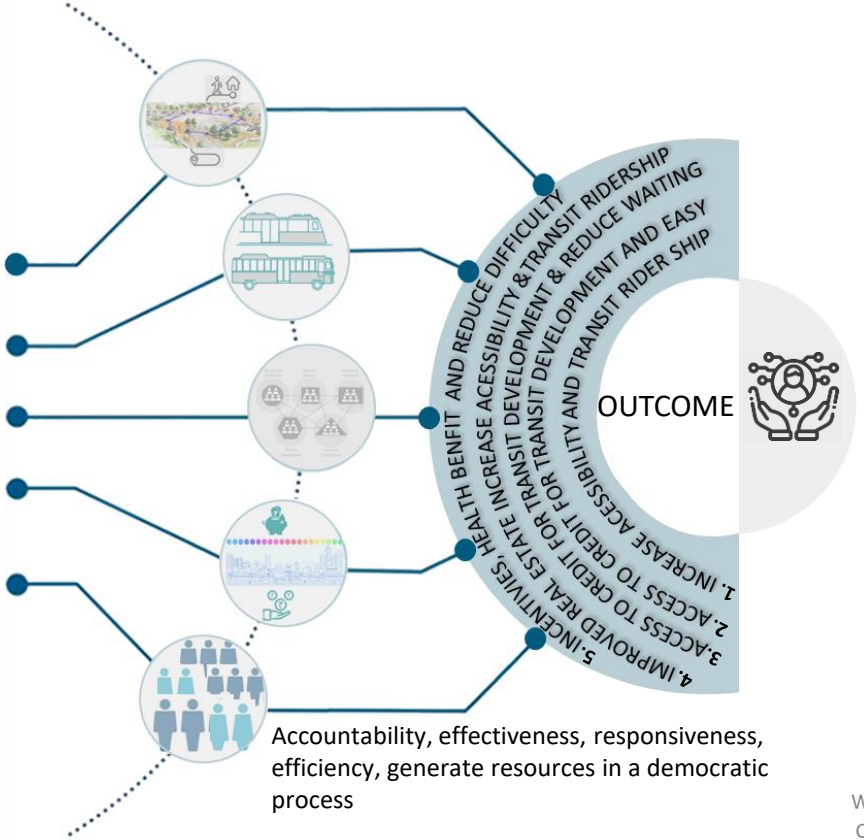


- Lastly, Collaboration of metro and bus could offer more incentive for commuter to use both modes efficiently (Litman, T., 2021). For successful implementation multiple agencies must work together to enhance pedestrian access, bus reliability, and reduce transfer difficulties. Establishing institutional mechanisms with representation from all transit agencies and urban planning bodies giving authority with fiscal and regulatory power to achieve objectives of integrated urban transport planning and development



RECOMMENDATION STRATEGIES AND CONCLUSION

Strategies



Accountability, effectiveness, responsiveness, efficiency, generate resources in a democratic process

Conclusion

The study examined Ahmedabad and Vadodara, two cities of India, in order to offer policy recommendations and strategies for planners based on defined user perception. This research model can be applied in various cities by considering demographic data and local transit system.

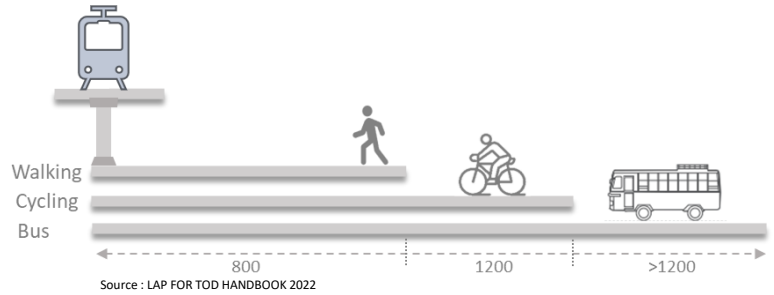
According to research findings, connectivity and then accessibility is rated as the most challenging aspect and perceptions of accessibility is highly influenced by traveler's age and gender. Hence focusing on specific demographic needs will encourage people to rely more on public transport.

While travelers' perception is as critical as enhancing physical infrastructure, this shift calls for a collaboration across urban planning, technology and social equity, where public transport is not merely a service but vital part of urban life that adapts to changing user needs.

No	MACRO		POPULATION& TRANSIT	MICRO	
	DIMENSION	MEASURE		DIMENSION	MEASURE
1.	ACCESS TO TRANSIT	Transit accessibility	6 million	INFRASTRUCTURE AND ACCESS & MANAGE PARKING	Street for walking and cycling
		Ped-shed			Transit node design
		Impedance ped-shed			Vehicular circulation design
2.	DIVERSITY & DENSITY	Mixed-use		MIXED USE AND ACTIVITY	Consistent mixing
		Entropy			Street for mixed activity
		local destination	2 million		
3.	DESIGN	street network density		STREETSCAPE	imageability
		connected node ratio			Human scale
		permeable network ration			Transparence and complexity

Source : LAP FOR TOD handbook -2022

1. ACCESS to transit



Source : LAP FOR TOD HANDBOOK 2022

2.DIVERSITY & DENSITY

mixed use and activity

Diversity is a function of land use, building use, built form and users.

High density
Low crowding of vehicles
High crowding of people

3.PARKING MANAGMENT

The **limited** and **no parking** leads to **commuters parking their vehicles on the streets**, which causes inconvenience to other **road users** and **pedestrians.**