Public Transport Access for Slums:
A Case of Transport Equity Assessment in Mumbai

Sarath KT, PhD Student IIT Bombay

Prof. Trupti Mishra Professot, IIT Bombay

Prof. Rangan Banerjee Director, IIT Delhi

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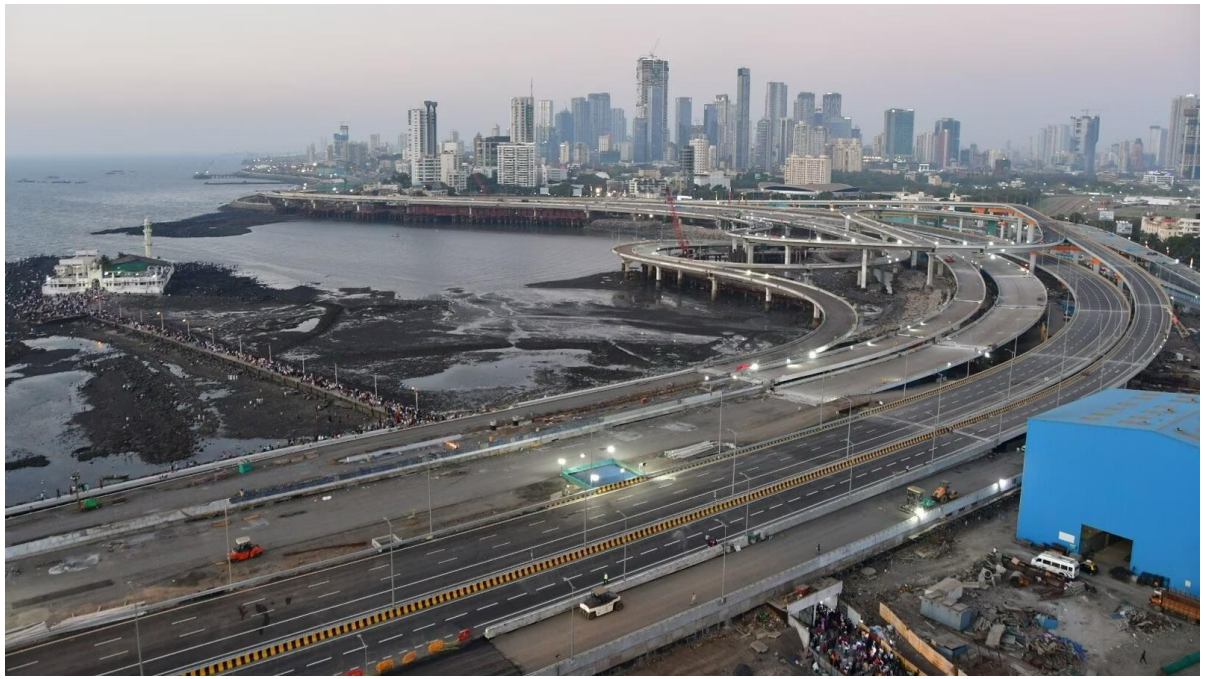


Structure of the Presentation

1. Introduction
2. Literature review
3. Methodology
4. Study Area
5. Results
6. Discussions & Conclusions

Introduction

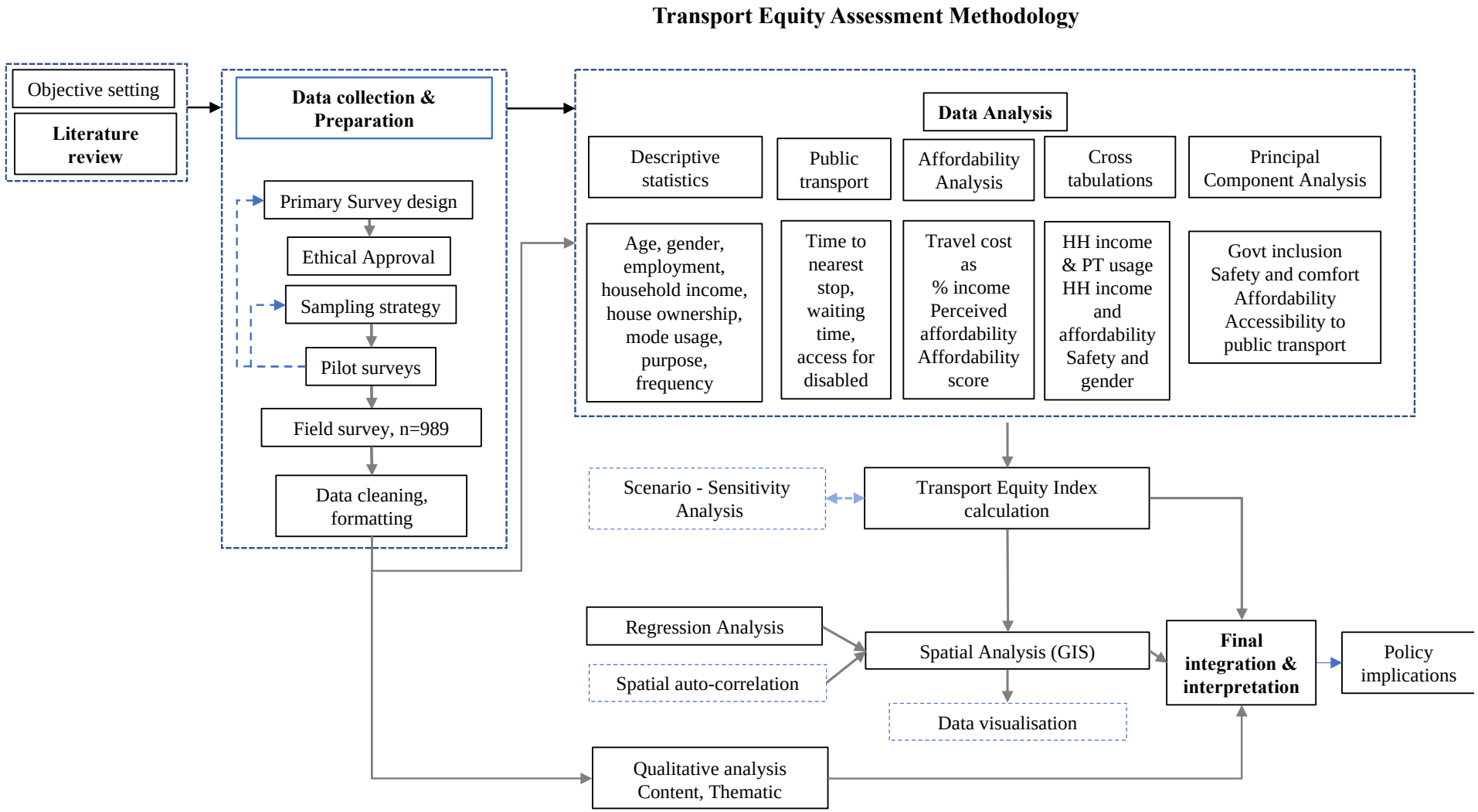
- “Who gets, how much?”
- Vulnerable Slum population are further excluded, leading to an unfair paradigm
- transport intertwined with broader socioeconomic outcomes

- Slums vulnerable
- Less access
- More dependency on the public transport and non motorized transport

Literature review

- Accessibility - the extent to which land use and transport enable a person to reach activities using transport modes (Geurs and Van Wee, 2004).
- social dimension of transport
- Affordability
- The high cost of public transport often forces poorer sections to walk or cancel the trips (Centre for Science and Environment, 2019).
- prohibitively expensive for the lowest income groups(Guzman and Oviedo, 2018)
- priorities and capacities of cities in global south are different. (Zhang and Zhao, 2021)

Methodology and data



Data

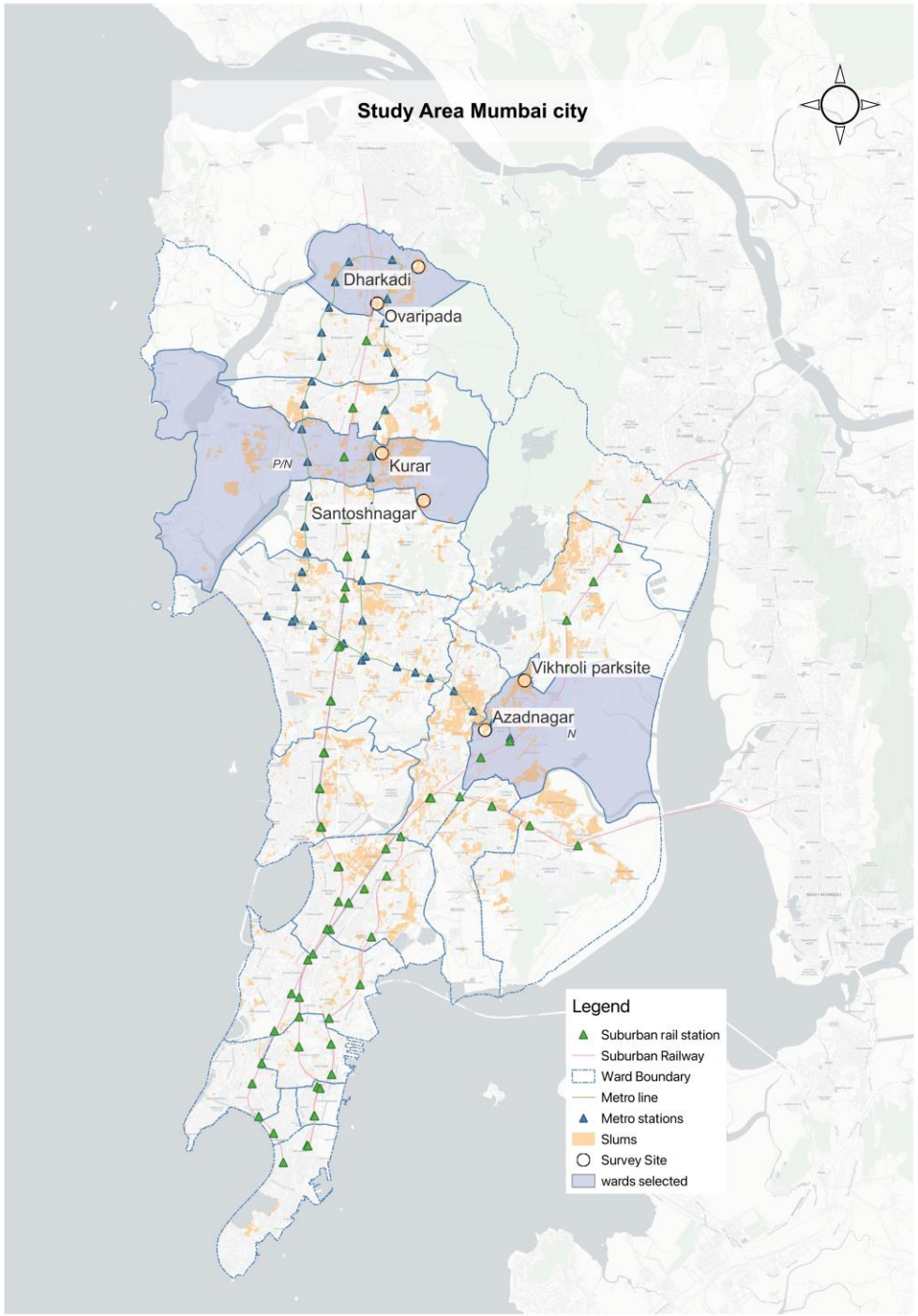
- N= 997
- Stratified random sampling
- all the streets were covered
- confidence level of 95% and a 5% margin of error
- spatial spread and representation check was done frequently

Study Area

- Mumbai
- Six slums in 3 wards
- Vikhroli, Ghatkopar, Malad, Goregaon, Dahisar, and Borivali

Questionnaire:

- sociodemographic characteristics,
- travel characteristics,
- perceived equity parameters,
  - access to public transport,
  - affordability,
  - inclusion from the government,
  - improvements in transport infrastructure

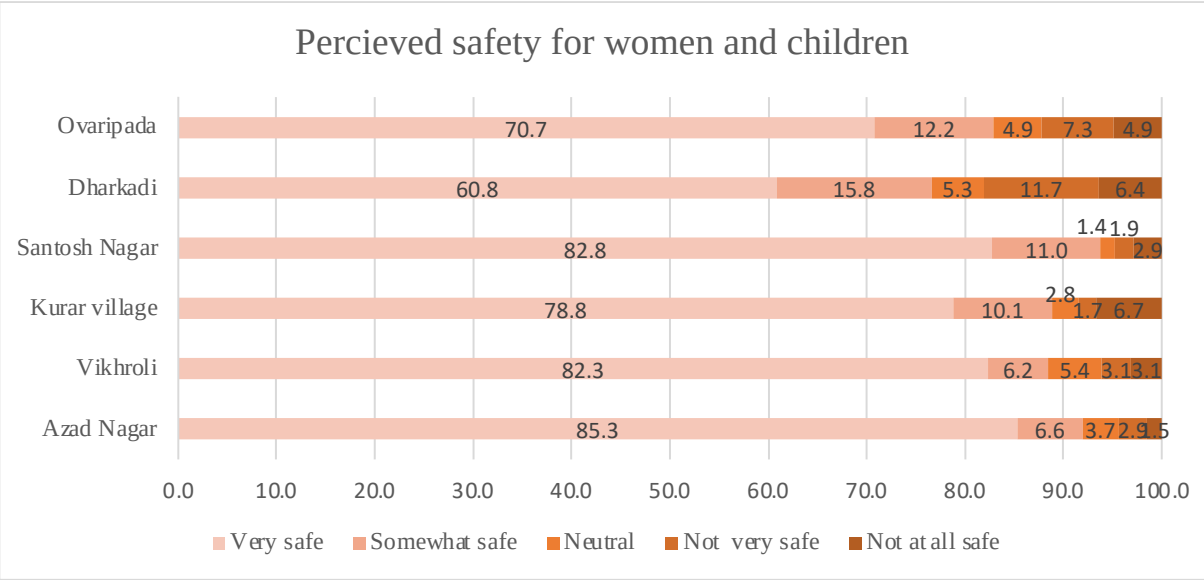


Results - Descriptive statistics

Income Rs.15-20k and Rs.20-30k disparity in income distribution in the wards
varying levels of economic development, employment opportunities, and demographic compositions across the wards

		N Ward		PN Ward		RN ward	
Variables	Categories	Azadnagar %	Vikhroli %	Kurar %	Santoshnagar %	Ovaripada %	Dharkadi %
Gender	Male	66.2	60.4	66.5	53.8	52.0	59.2
	Female	33.8	39.6	33.5	46.2	48.0	40.8
Age	18-25	22.1	23.2	28.2	20.5	21.8	25.4
	25-40	36.8	31.1	36.4	38.6	38.5	36.9
	41-60	28.7	31.1	28.2	29.8	29.6	28.5
	Above 60	12.5	14.6	7.2	11.1	10.1	9.2
Employment	Employed	23.5	23.1	22.9	32.1	28.7	34.8
	Self employed	23.5	16.2	22.9	22.0	21.6	12.8
	Labourer	10.3	12.3	2.8	6.7	4.7	7.9
	Unemployed	6.6	3.8	5.0	2.9	3.5	4.3
	student	9.6	14.6	14.0	16.7	11.1	9.8
	Retired	8.1	7.7	8.4	8.1	5.8	11.0
	Homemaker	18.4	22.3	24.0	11.5	24.6	19.5
HH income	Less than 5k (<$60)	2.9	0.0	2.2	2.9	1.2	0.6
	5-10k ($60- $120)	5.9	2.3	5.0	4.3	10.5	1.2
	10-15k ($120-178)	16.2	15.4	9.5	14.8	8.8	12.2
	15-20k ($178-$238)	12.5	42.3	38.5	28.7	14.0	25.0
	20-30k ($238-$357)	25.7	26.9	24.6	22.5	24.0	28.0
	30-50k ($357-$595)	26.5	10.0	14.5	17.7	25.7	25.0
	Above 50k (>$595)	10.3	3.1	5.6	9.1	15.8	7.9
House ownership	Own House	55.1	63.8	62.6	65.6	60.2	66.5
	Rented House	44.9	36.2	37.4	34.4	39.8	33.5

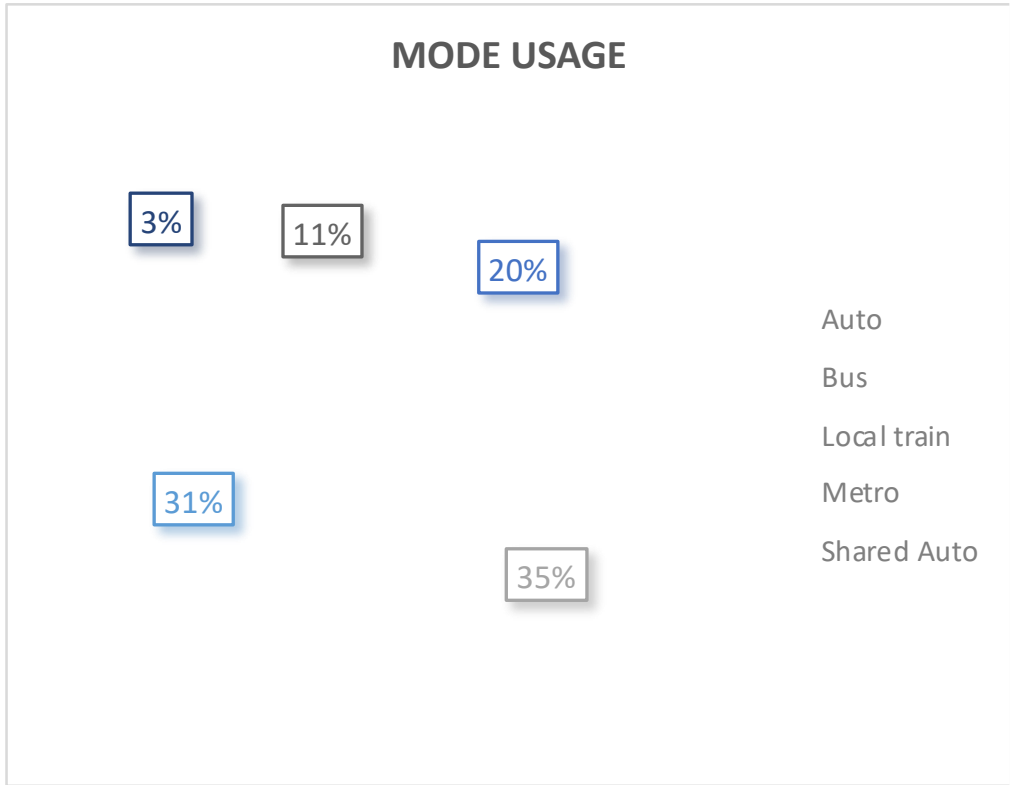
Results - Descriptive statistics



- The safety perception is overall positive.
- The variation observed in the slum, with Dharkadi and Ovaripada being more unsafe (All in R ward)

Results - Descriptive statistics

Mode usage



- 35% use bus transport (BEST bus service),
- 31% use local trains,
- 20% use Autos, and
- 11% use shared autos.
- The metro usage is negligible at 3%.

Mode usage, Purpose and frequency

- dependent on buses,
  - Santoshnagar 54% ,Dharkadi (35.4%) and Kurar (33.5%).
- Local train usage
  - highest in Azadnagar(46%) and lowest in Dharkadi,

- N ward - higher local train usage and shared auto usage.
- PN ward has the highest bus usage, especially in Santoshnagar.
- RN ward showed a diverse mode usage, including relatively higher metro usage.

		N Ward		PN Ward			RN Ward
Variables	Category/ slums	Azadnagar	Vikhroli	Kurar	Santoshnagar	Ovaripada	Dharkadi
Mode usage	Bus	30.5%	29.9%	33.5%	54.8%	24.3%	35.4%
	Local train	46.6%	25.6%	27.3%	31.6%	32.2%	23.9%
	Metro	0.8%	1.2%	3.8%	0.0%	4.5%	10.0%
	Shared Auto	3.8%	26.8%	19.1%	0.0%	6.8%	6.9%
Purpose	Work	58.8%	54.3%	56.5%	48.5%	57.5%	65.4%
	Market	14.0%	18.9%	16.7%	21.1%	11.7%	15.4%
	Education	10.3%	8.5%	16.7%	11.1%	15.6%	10.8%
	Hospital	4.4%	9.1%	1.4%	4.7%	4.5%	4.6%
	Recreation	12.5%	9.1%	8.6%	14.6%	10.6%	3.8%
Frequency of travel	Daily	35.3%	52.4%	51.7%	49.7%	42.5%	50.0%
	Several times a week	26.5%	15.2%	23.0%	11.1%	16.2%	16.9%
	Once a week	14.0%	12.2%	10.5%	19.3%	15.6%	13.8%
	Less than once a week	24.3%	20.1%	14.8%	19.9%	25.7%	19.2%

Public transport accessibility

Sr no	Mode	Average time to. Nearest stop (minutes)	Average waiting time (Minutes)
1	Auto	10.3	9
2	Bus	10.1	16
3	Local train	12.8	12
4	Metro	14.6	10
5	Shared Auto	8.8	9.5

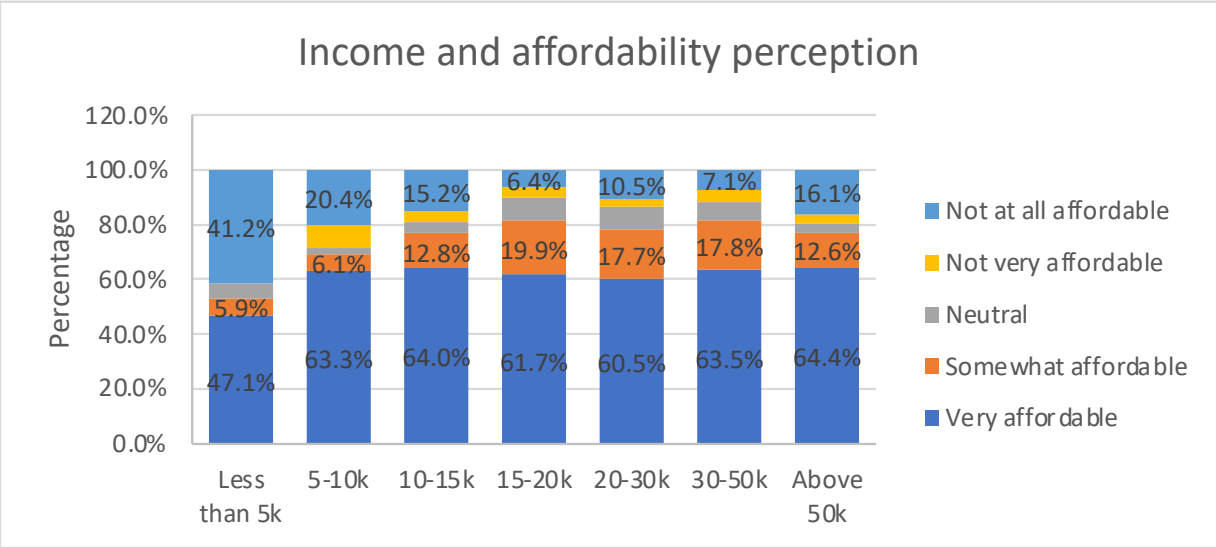
The average time to the nearest stop is the least for shared auto(8.8 minutes), followed by a bus (10.1 minutes). The waiting time is most for the bus (16 minutes) followed by the local train (12 minutes).
The slums are more serviced by shared auto and bus, with the bus taking the most time to reach the stop and wait (26 minutes).

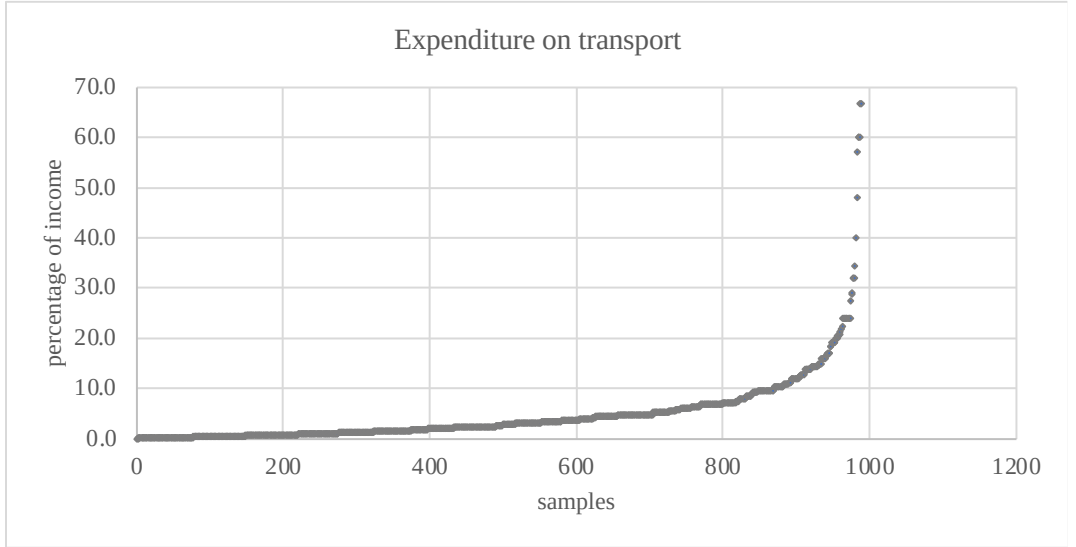
Footpath quality

Sr No	Location	Good	Not good	Absent
1	Azad Nagar	38.2%	18.4%	43.4%
2	Vikhroli	1.8%	1.8%	96.3%
3	Kurar village	18.2%	34.9%	46.9%
4	Santosh Nagar	23.4%	1.8%	74.9%
5	Ovaripada	17.3%	10.1%	72.6%
6	Dharkadi	19.2%	4.6%	76.2%
7	Overall	19.1%	12.9%	67.9%

Vikhroli had no accessible footpath for the samples surveyed (96.3%), followed by Dharkadi(76.2) and Santoshnagar (74.9%).

Affordability and Income





- As income increases, a higher proportion of people find travel affordable.
- In the 5-10k and 15-20k groups, there is a sharp increase in the number of people finding travel very affordable. 20-30k and 30-50k groups find travel very affordable
- While income plays a role in affordability, it is not the sole determining factor.

- over 90% of the samples spend less than 10% of their income on transportation.

Income and travel frequency

- correlation between income and travel frequency, particularly for daily travel. There are variations and peaks indicating other influences could be at play, especially with the highest income groups.

Principal Component Analysis

Variable	Govt inclusion	Safety	Affordability	Accessibility	Unexplained
Frequency of travel				**0.502**	0.5551
Travel cost			**0.6849**		0.3339
Time to nearest stop				**0.5658**	0.624
Level of comfort		**0.6875**			0.2834
Safety perception		**0.5678**			0.467
Affordability perception			**0.6865**		0.3324
Streetlight condition				-0.4728	0.6661
Access for disabled				0.3489	0.6761
Importance from government	**0.5832**				0.2088
Recent improvement in infra	**0.5781**				0.219
Complaint redressal speed	**0.5207**				0.3243

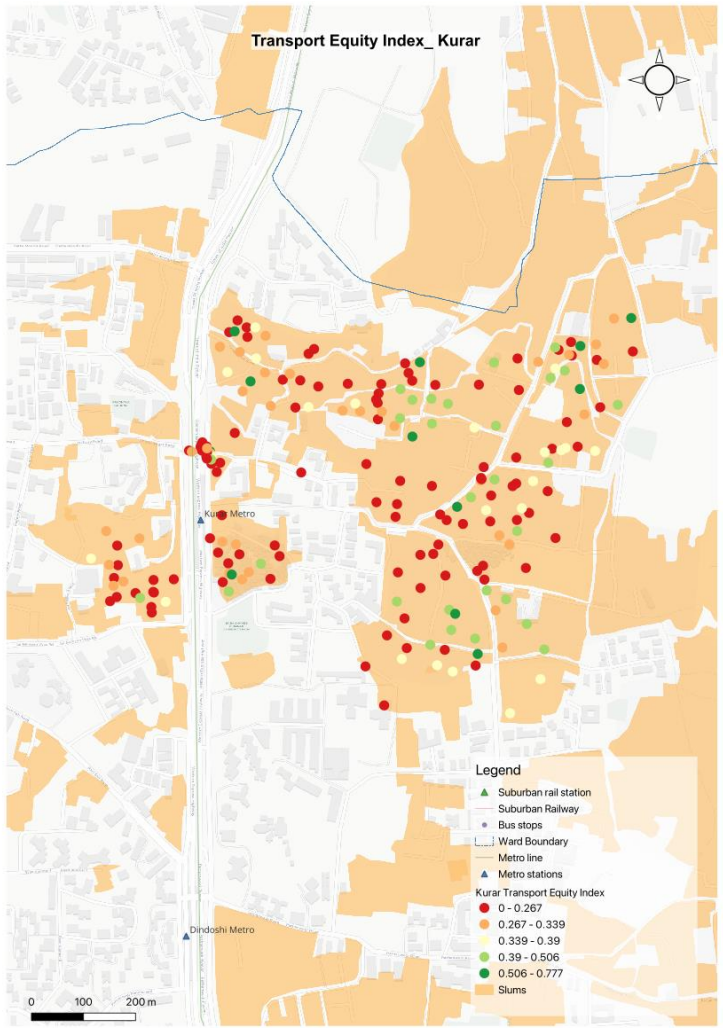
- P1 = Government inclusion perception (perceived attention from government, infrastructure improvements)
- P2 = Safety of the area and comfort of travel (Women's Safety of streets and travel comfort perception)
- P3 = Affordability of travel (travel cost, affordability perception)
- P4= Accessibility to public transport/ IPT

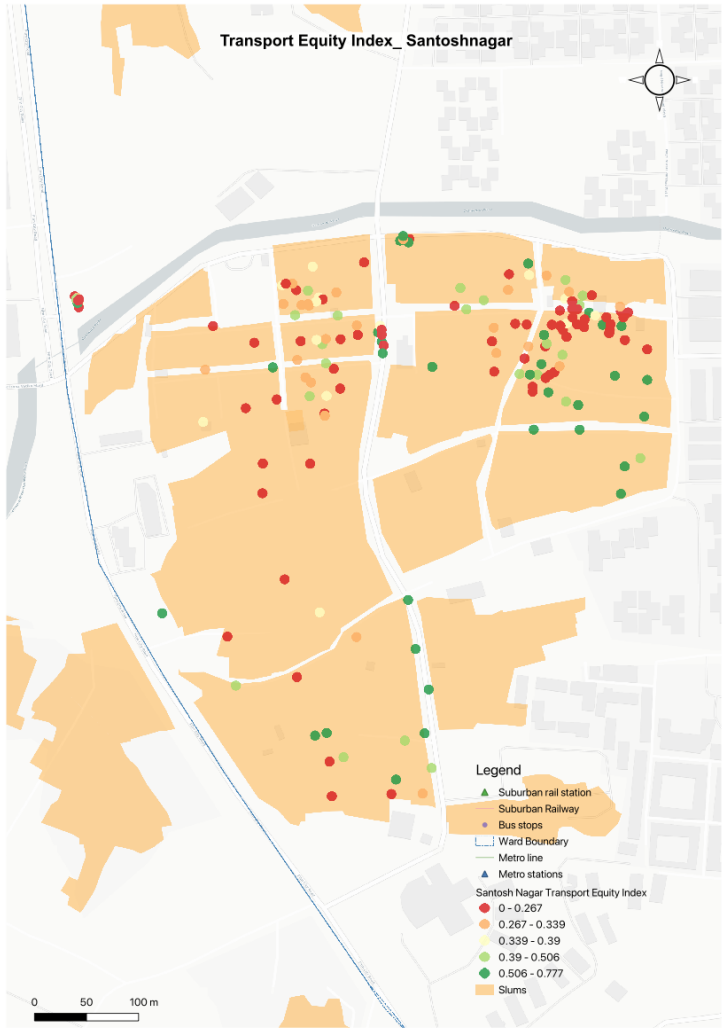
Transport Equity Index (TEqI) = w_1*P1 + w_2*P2 + w_3*P3 + w_4*P4

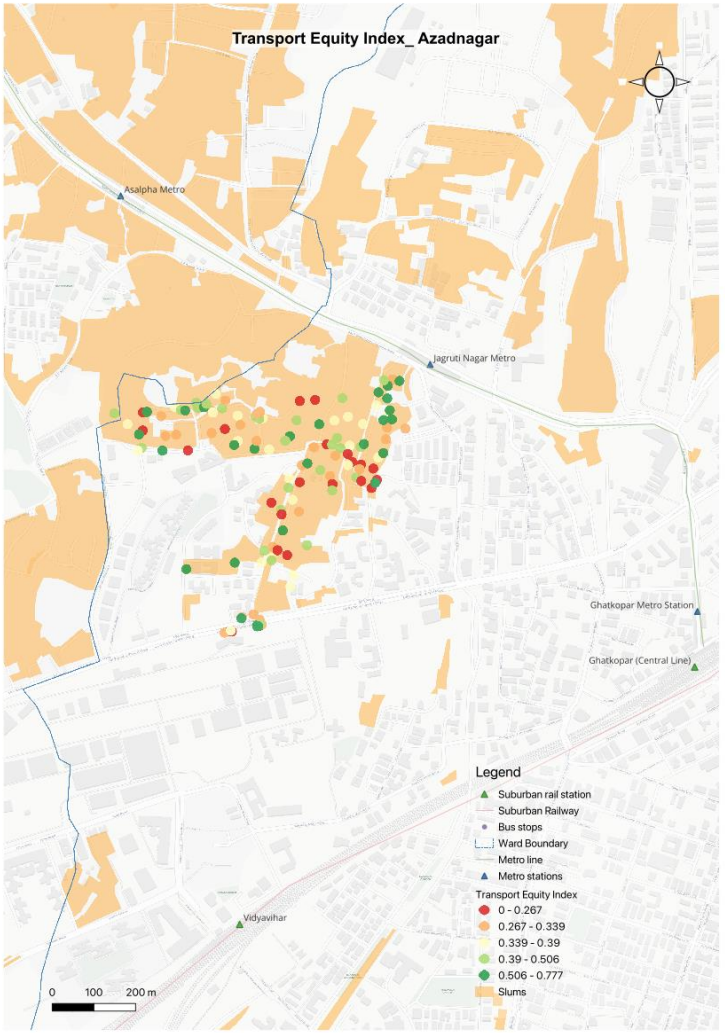
Sr no		Mean	Std. dev.	Min	Max	Samples
1	Overall	0.343	0.165	0.000	1.000	989
2	Azadnagar	0.387	0.134	0.150	0.777	136
3	Vikhroli	0.391	0.165	0.055	0.899	164
4	Kurar	0.296	0.148	0.045	0.982	209
5	Santoshnagar	0.341	0.177	0.028	0.969	136
6	Ovaripada	0.322	0.159	0.000	0.775	179
7	Dharkadi	0.305	0.160	0.041	0.707	130

Overall Transport Equity index for the slums in Mumbai city is 0.343,
1 being the most equitable and 0 being the least equitable condition.

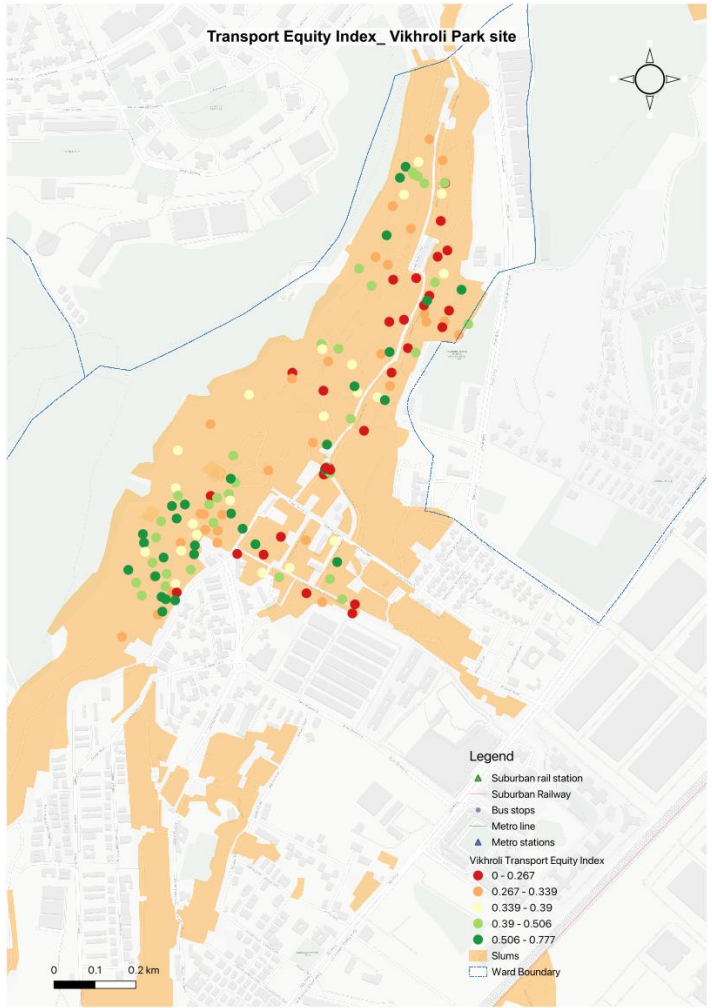
Transport Equity Index Spatial Distribution

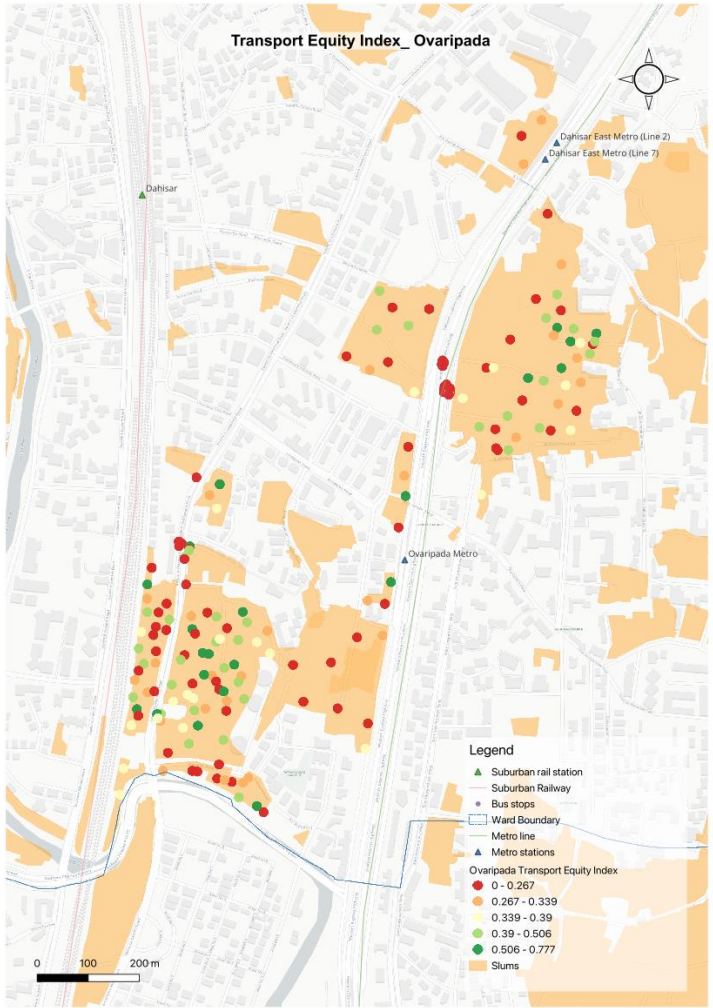


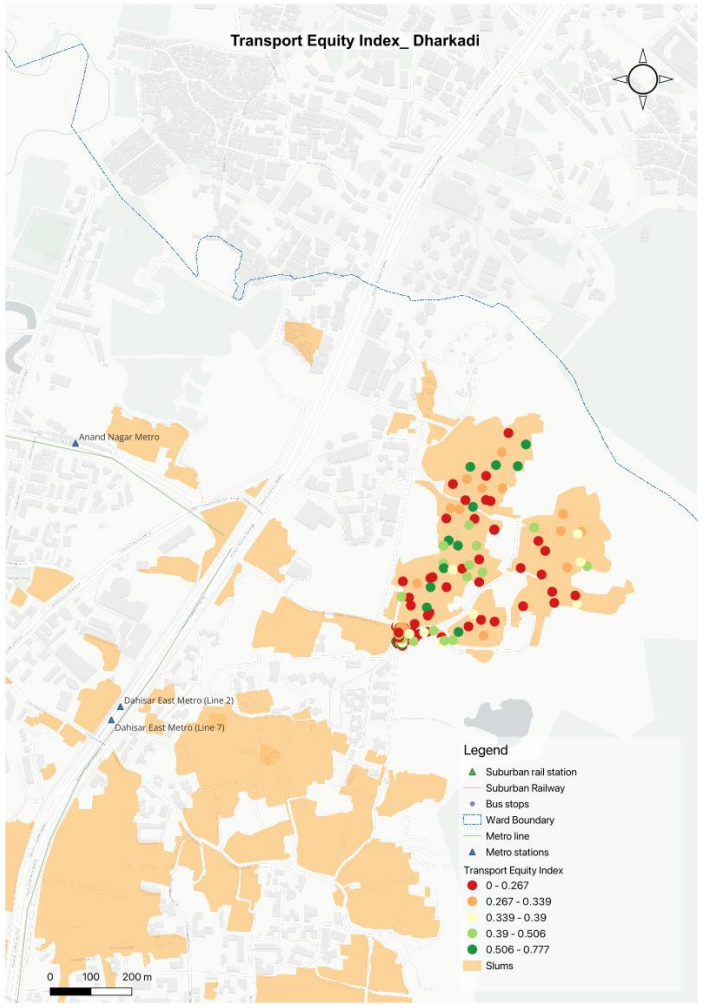




Transport Equity Index Spatial Distribution

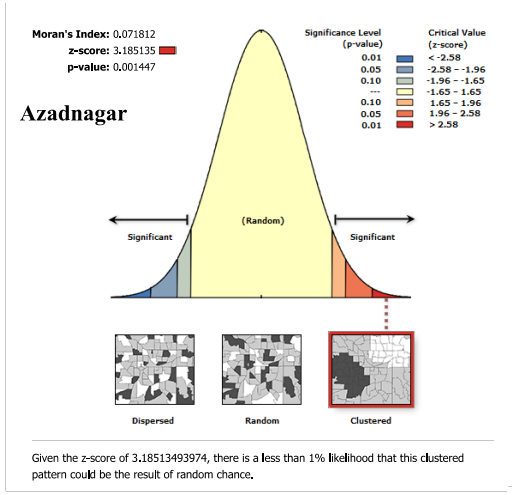


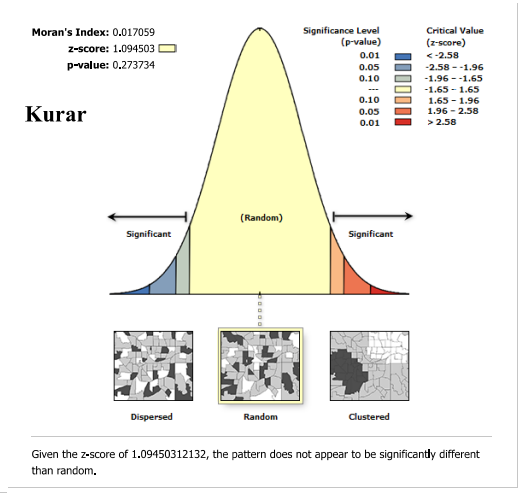


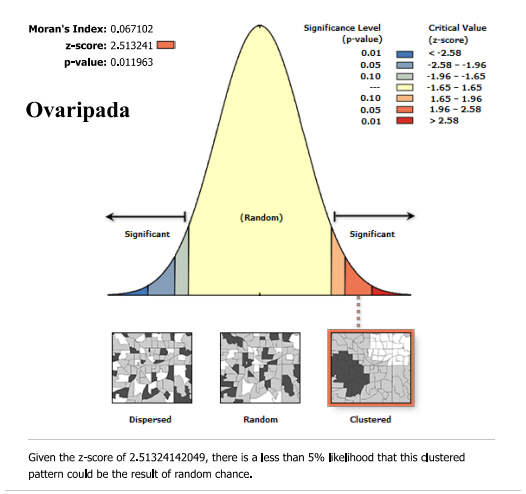


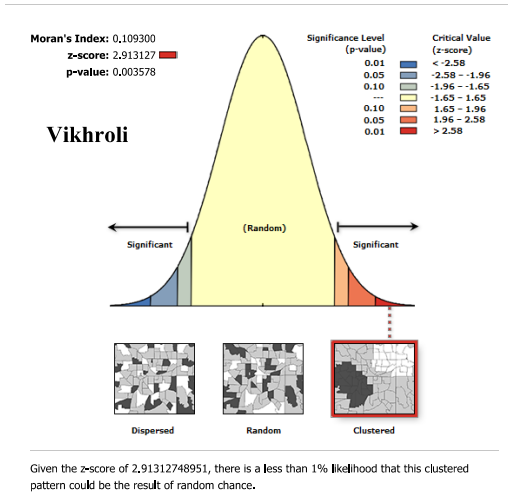
Clustering of data points

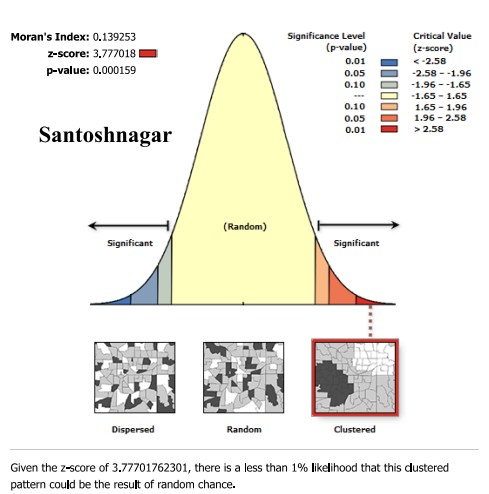
- Moran’s I spatial autocorrelation
- Clustering is visible in 5 out of 6 slums

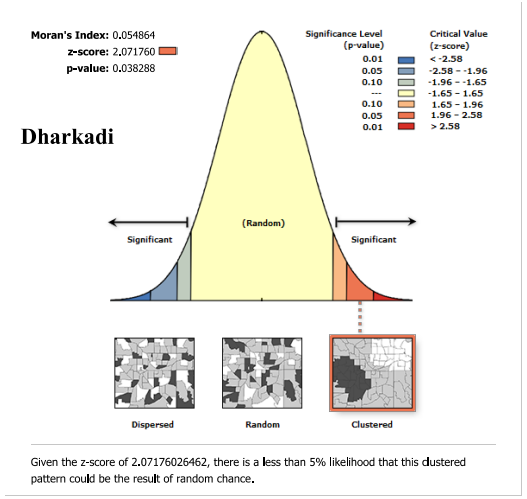












Discussions & Conclusions

1. The normative idea of equity is ever-evolving, and a convergence of ideas through research on transport justice can help form an institutionalised definition of transport equity.
2. variables of transport equity include **accessibility, affordability, safety and comfort, and inclusion from the government**
3. high level of inequity in the slum population in the city 0.34
4. the residents living in slums within walking distance from public transport stops have an enhanced level of accessibility compared to slums further away

Thank You