Movement of People and Goods

Assessing Urban Transport in the City of Erode

Annexure

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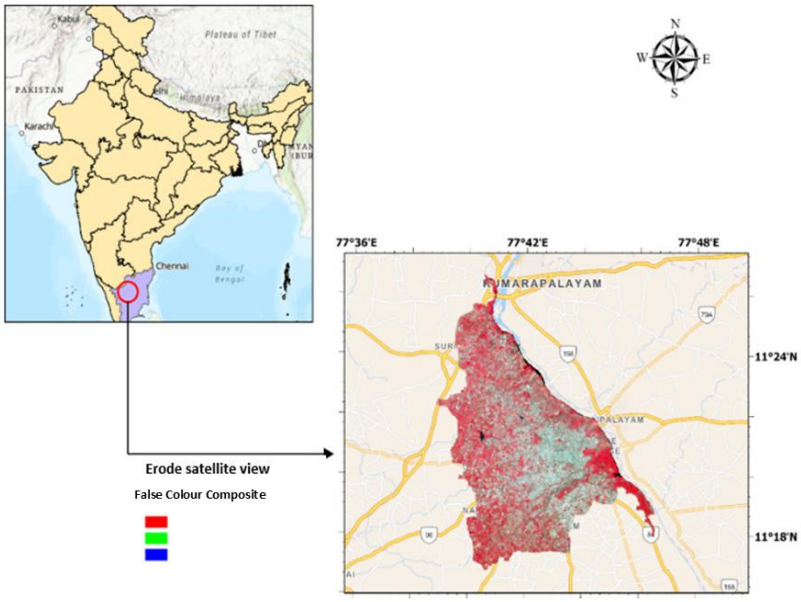
Annexure

Chapter 2: City context

Land use and land cover (LULC) trends

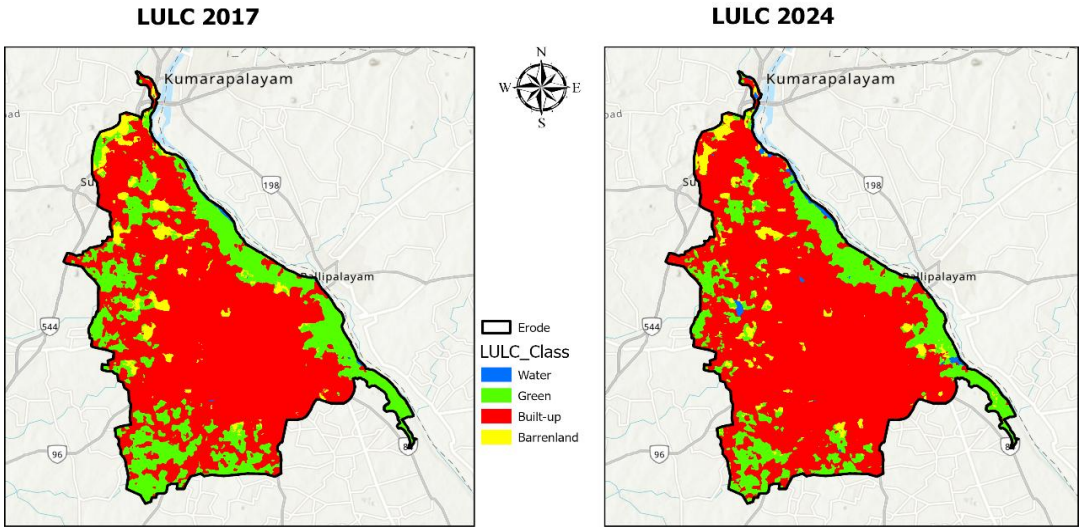
Figure A1. False Colour Composite view of Erode from the Landsat-8 OLI sensor, indicates most urbanisation concentrated in the central-eastern regions



Source: Authors' analysis of data from the Landsat-8 Operational Land Imager (OLI)

The False Colour Composite visualisation shows a satellite image of the land features (Figure A1). The red areas in the figure show vegetation cover, while the light blue represents urbanisation.

Figure A2. Land use and land cover (LULC) changes from 2017 to 2024 show the core city areas becoming denser rather than the periphery spreading outwards

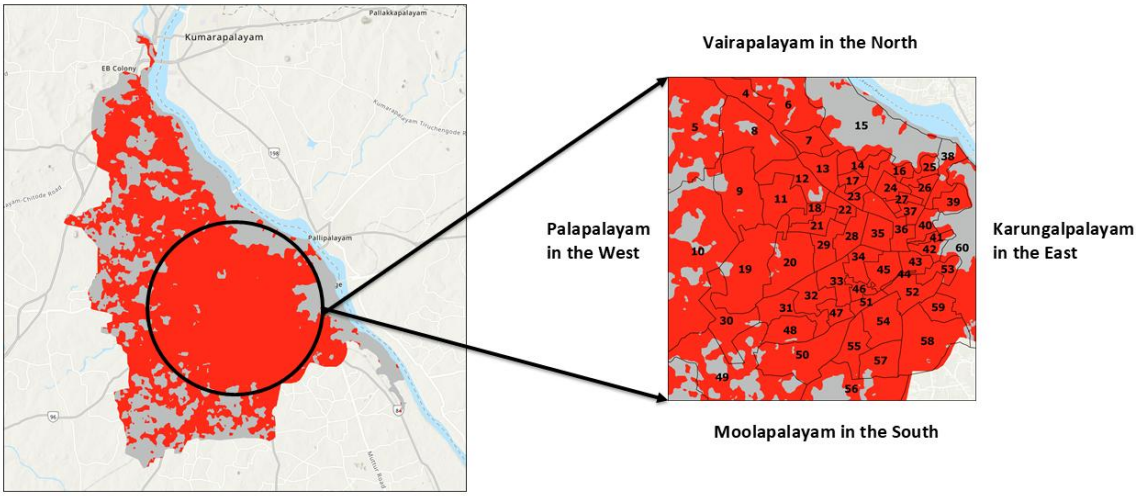


Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

Key locations

The Government College of Engineering area in the north-west of Erode, Chithode, and Villarasampatti have seen the greatest changes from barren to built-up land. The western and southern parts, such as Rettai Palli Valasu, Jeeva Nagar, and Maruthi Nagar, have witnessed the most change from green to built-up.

Figure A3. Areas experiencing most built-up transition are concentrated in the central-eastern city core



Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

Remote sensing indices

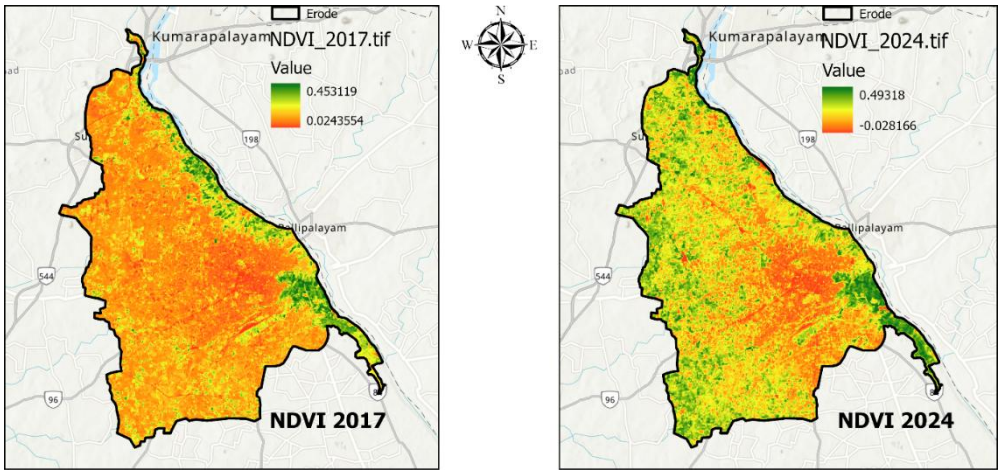
In addition to LULC maps, we used four spectral indices to assess changes in vegetation and urban growth in Erode – the normalised difference vegetation index (NDVI), green normalised difference vegetation index (GNDVI), normalised difference moisture index (NDMI), and normalised difference built-up index (NDBI). These indices were calculated from satellite image bands and help track on-ground changes more precisely.

Normalised difference vegetation index (NDVI): This is a widely used remote sensing index that measures the presence and health of green vegetation. It is estimated using red and near-infrared bands (NIR).

$$NDVI = \frac{NIR - red}{NIR + red}$$

High values mean healthy, dense vegetation, while low or negative values indicate barren land or stressed vegetation (Figure A4).

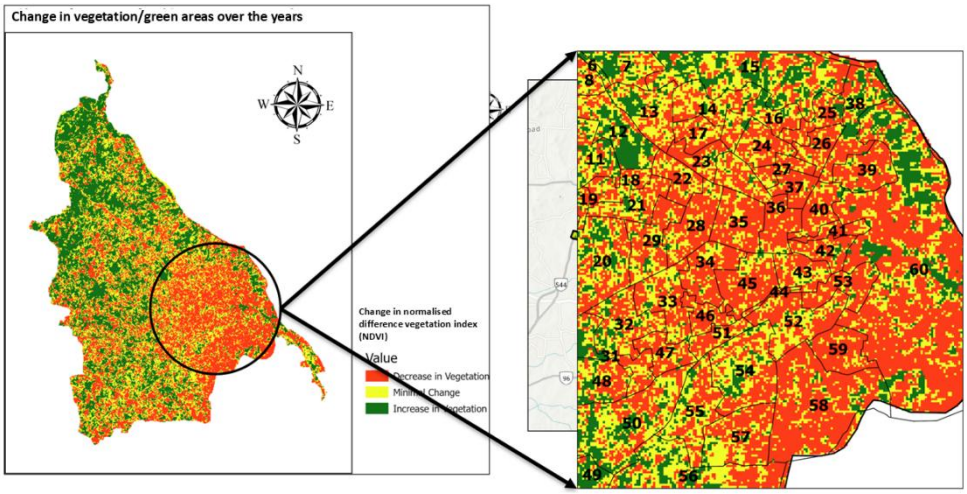
Figure A4. Normalised difference vegetation index (NDVI) change (2017–2024) notes higher greenness observed in 2024, which might be partly influenced by the sensor picking up moisture



Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

The 2024 NDVI map appears greener than the 2017 one, but this is partly because the sensor picked up moisture. When actual pixel values are compared, we can see that vegetation health has declined. The NDVI change map (Figure A5) displays this more clearly. Wards 36, 45, 58, and 59 show the greatest loss of vegetation. Areas such as Erode Public School (EPB) Nagar, Sampath Nagar, and Vairapalayam fall within this declining zone.

Figure A5. Areas such as EPB Nagar, Sampath Nagar, and Vairapalayam show the greatest loss of vegetation from 2017 to 2024

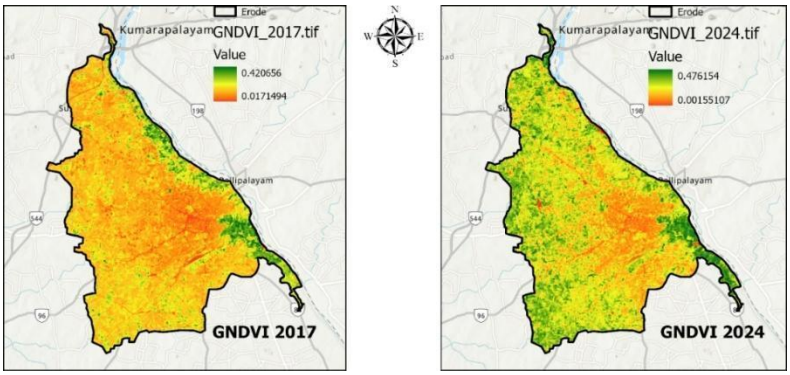


Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

Green normalised difference vegetation index (GNDVI): This works similarly to NDVI, but it uses the green light band instead of the red band. This improves the detection of chlorophyll levels in dense vegetation.

$$GNDVI = \frac{NIR - green}{NIR + green}$$

Figure A6. Erode may look greener in 2024 than in 2017, but this is deceptive



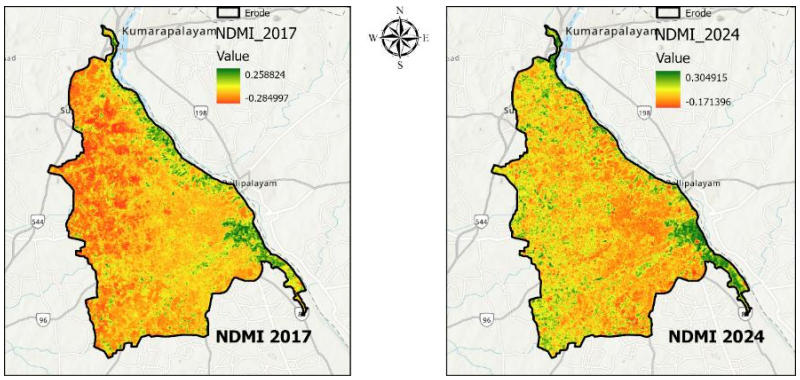
Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

The 2024 GNDVI map (Figure A6) appears greener, but the actual values are lower than those of 2017. This means that the vegetation quality has dropped, even if the map looks greener at first glance.

Normalised difference moisture index (NDMI): This is a remote sensing index used to detect vegetation moisture content and soil water stress. It measures moisture levels in vegetation and soil using NIR and short-wave infrared (SWIR) bands (Figure A7).

$$NDMI = \frac{NIR - SWIR}{NIR + SWIR}$$

Figure A7. Normalised difference moisture index (NDMI) shows little change from 2017 to 2024



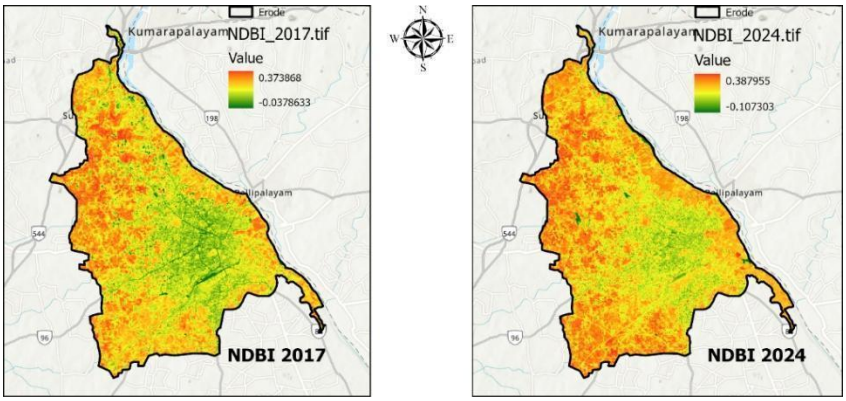
Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

In 2017, most of the city had low to moderate moisture levels. By 2024, a few patches showed slightly higher moisture levels, linked to the new water bodies seen in Figure 3. However, these improvements are minor and localised. Most of the city still shows moderate dryness, with no major improvement in moisture conditions overall.

Normalised difference built-up index (NDBI): This identifies built-up or urban areas using satellite imagery. It uses the reflectance from the NIR and SWIR bands, which are sensitive to built-up surfaces.

$$NDBI = \frac{SWIR - NIR}{SWIR + NIR}$$

Figure A8. Normalised difference built-up index (NDBI) changes from 2017 to 2024 reveal intensified urban areas



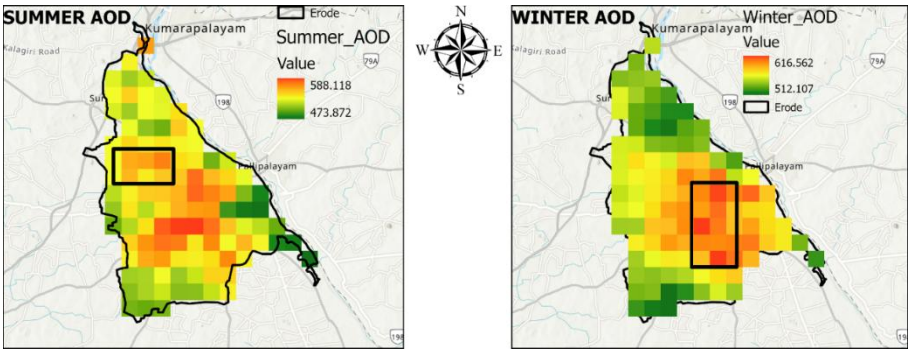
Source: Authors' analysis using ESRI Sentinel-2 land use and land cover (LULC) data

The NDBI maps show how built-up areas in Erode have changed between 2017 and 2024 (Figure A8). By 2024, high NDBI values had spread across a larger area, confirming that urban surfaces had expanded and intensified. The range of values has also widened, indicating a clear shift away from natural land covers towards built-up surfaces.

Air quality trends

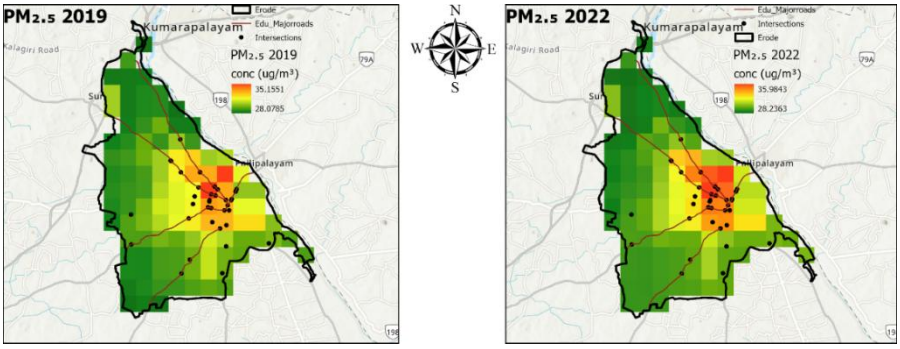
Aerosol optical depth (AOD): Aerosol levels in Erode follow a seasonal pattern (Figure A9). In the summer, the highest AOD values were found west of Kongampalayam, driven by emissions from textile and printing mills in the area. In winter, the hotspot moves eastward towards Vairapalayam, EPB Nagar, EV Narayanasamy (EVN) Road, and the Erode Railway Station area. The winter peak (616.56) is higher than the summer peak (588.12), likely because vehicular emissions are higher in cold conditions and pollutants disperse less freely.

Figure A9. Aerosol optical depth (AOD) trends: Summer has higher emissions from textile and printing mills in the west, while the winter hotspots are in the east



Source: Authors' analysis using MODIS (Moderate Resolution Imaging Spectroradiometer) – Combined Terra & Aqua (0.47µm), processed using Google Earth Engine

Figure A10. Annually averaged, global high air pollutants (GHAP) daily particulate matter ($PM_{2.5}$) in Erode for 2019 and 2022 suggest construction and vehicular sources are the main contributors

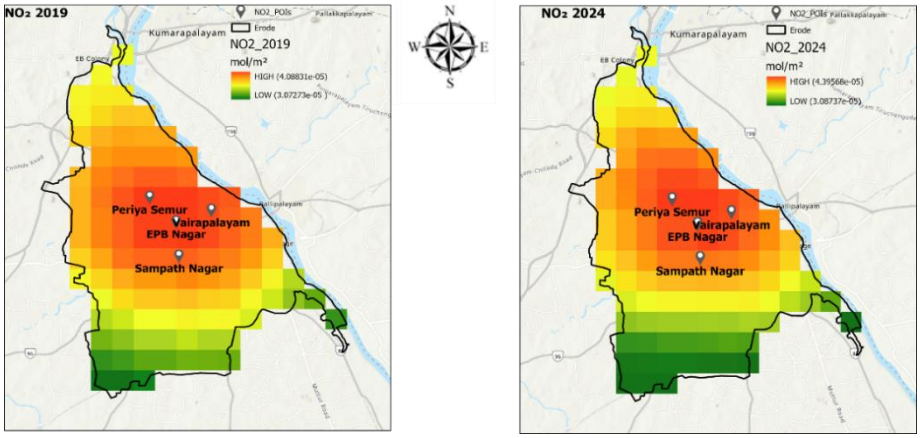


Source: Authors' analysis of GHAP-gridded $PM_{2.5}$ datasets, which provide globally gap-free, daily air pollution estimates at a 1 km spatial resolution.

Nitrogen dioxides (NO_2)

The NO_2 maps for 2019 and 2024 (Figure A11) show consistently high concentrations in central and northern Erode. The hotspot locations have not shifted much over the years, pointing to steady sources such as heavy traffic and dense urban activity. Periyasemur, Vairapalayam, EPB Nagar, and Sampath Nagar are the most affected areas.

Figure A11. Nitrogen dioxides (NO_2) trends 2019 vs 2024 show hotspots generated by heavy traffic and dense urban activity are largely unchanged

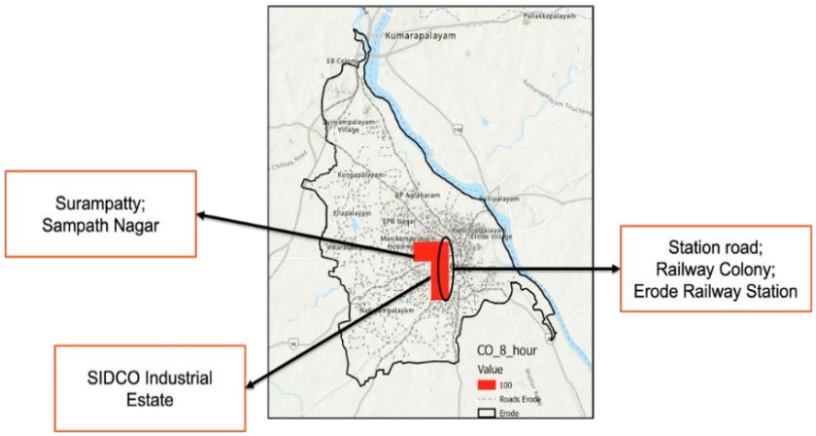


Source: Authors' analysis

Carbon monoxide hotspot (CO eight-hour exceedance)

The 2024 CO exceedance map shows the highest pollution levels in central Erode (Figure A12). Surampatti, Sampath Nagar, Small Industries Development Corporation (SIDCO) Industrial Estate, Station Road, Railway Colony, and the Erode Railway Station areas are the main hotspots. The combination of heavy traffic, industrial units, and a major rail junction in a compact area explains the elevated CO levels here.

Figure A12. Satellite-based imagery shows carbon monoxide (CO) hotspots are concentrated in central Erode



Source: Authors' analysis

Chapter 4: Baselining Travel Patterns

Table A1: Descriptive statistics of fuel station survey

Row Labels	No. of samples	Vehicle age	Trip Distance (km) – [a]	Trip Distance (km) –[b]	ADT Calculated (km) –[a*b]	ADT* (km)
2W	1832	6	12.5	3.6	45	32
3W	158	8	7.5	3.8	28.7	25
4W	1417	7	23.9	3.1	75.2	57
Bus	333	6	48.7	3.5	168.8	232
LCV	1276	8	21.5	3.1	65.5	49
Trucks	819	9	60.6	2.4	144.2	133

Source: Field survey conducted by CEEW. 2025
Notes: 2W: Two-wheeler, 3W: Three-wheeler; 4W: Four-wheeler; LCV: Light Commercial Vehicle; ADT: Average Daily Distance.
**Average daily distance is reported*

Table A2: Distribution of PT user respondents by key demographic characteristics (N = 1360)

Demographic Variable	Category	N (per cent)
Age (in years)	Below 15	56 (4.1)
	15-29	715 (52.6)
	30-59	431 (31.7)
	60 and above	158 (11.6)
Gender	Female	689 (50.7)
	Male	671 (49.3)
Education level	No formal schooling	239 (17.6)
	Up to Primary	34 (2.5)
	Middle	156 (11.5)
	Senior/Senior Secondary	324 (23.8)
	UG/Diploma/Polytechnic	546 (40.1)
	PG/PhD and above	61 (4.5)
Profession	Unemployed	122 (9.0)
	Casual labour	113 (8.3)
	Student	202 (14.9)
	Home maker	277 (20.4)
	Self employed	91 (6.7)
	Part-time employee	36 (2.6)
	Regular wage/ salaried employee	242 (17.8)
Monthly household income (in INR)	< 25000	895 (65.8)
	25000-50000	455 (33.5)
	50000-100000	10 (0.7)

Source: Field survey conducted by CEEW, 2025

Table A3: Reasons for choosing public transport in Erode

Reason for mode choice	Share of responses (per cent)		
	All	Female	Male
Avoids parking or driving hassles	10	10.6	9.4
Better connectivity to key locations	11.8	14.1	9.4
Easily available	21.4	22.4	20.4
Faster/saves travel time	12.8	12.1	13.6
Lower cost than other modes	13.6	12.4	14.8
More comfortable (especially for long trips)	3.8	3.7	3.9
More space for luggage	6.4	6.1	6.7
No other suitable alternative	3.1	3.0	3.2
No personal vehicle	4.7	4.7	4.8
Reliable schedule	3.1	3.1	3.0
Safer travel options	7.5	6.2	8.8
Weather protection	1.8	1.5	2.0

Source: Field survey conducted by CEEW, 2025

Table A4: Distribution of IPT user respondents by key demographic characteristics (N = 1,193)

Demographic Variable	Category	N (per cent)
Age (in years)	15-29	371 (31.1)
	30-59	611 (51.2)
	60 and above	211 (17.7)
Gender	Female	543 (45.5)
	Male	650 (54.5)
Education level	No formal schooling	128 (10.7)
	Up to Primary	205 (17.2)
	Middle	388 (32.5)
	Senior/Senior Secondary	156 (13.1)
	UG/Diploma/Polytechnic	285 (23.9)
	PG/Phd and above	31 (2.6)
Profession	Unemployed	103 (8.6)
	Casual labour	289 (24.2)
	Student	122 (10.2)
	Home maker	261 (21.9)
	Self employed	112 (9.4)
	Part-time employee	6 (0.5)
	Regular wage/ salaried employee	300 (25.2)
Monthly household income (in INR)	< 25000	844 (70.8)
	25000-50000	314 (26.3)
	50000-100000	23 (1.9)
	> 150000	12 (1)

Source: Field survey conducted by CEEW, 2025

Table A5: Reasons for choosing IPT services in Erode

Reason for mode choice	Share of responses (per cent)		
	All	**Female**	**Male**
Easily available	23.5	25	22.2
Cheaper	16.4	17.4	15.5
Improves accessibility to public transport	13.4	10.9	15.5
Saves travel time	10.9	10.7	11.1
Safer rides	7.8	8.7	7.1
Offers first-and-last mile service	6.3	5.6	6.9
More comfortable	5.8	5.9	5.7
Avoids hassle of riding own vehicle	3.3	2.9	3.6
No personal vehicle	2.6	2.9	2.3
Avoids waiting in traffic	2.4	2.3	2.5
Lack of other alternatives	2.2	2.1	2.3
Better in high congestion areas	2.1	2.1	2.1
Familiar with the driver	1.3	1.6	1.0
Better space for bags/luggage	0.8	0.7	0.9
Adaptable to weather changes	0.7	0.4	0.9
Because of older personal vehicles	0.3	0.6	0.2

Source: Field survey conducted by CEEW, 2025

Table A6: Distribution of IPT operators by key demographic characteristics (N = 587)

Demographic Variable	Category	N (per cent)
Age (in years)	15-29	27 (4.6)
	30-59	486 (82.8)
	60 and above	74 (12.6)
Gender	Female	3 (1)
	Male	584 (99)
Education level	No formal schooling	54 (9)
	Up to Primary	180 (31)
	Middle	304 (52)
	Senior/Senior Secondary	49 (8)
Driving experience (in years)	3-5	56 (9.5)
	5-10	269 (45.8)
	More than 10	262 (44.6)
Vehicle ownership	Owned	482 (82)
	Rented	102 (17)
	Leased	3 (1)

Source: Field survey conducted by CEEW, 2025

Table A7: Mean Operator Ratings of Key Electric IPT Service Perceptions (1-10 scale, 10 being the highest)

Parameters	All (N = 587)	Owned (N = 482)	Rented (N = 102)	Leased (N = 3)
	Mean (μ) ± Standard deviation (σ)			
Vehicle performance and features				
Acceleration	3.6 ± 2.4	3.6 ± 2.4	4.2 ± 2.4	4 ± 3.8
Steering	3.8 ± 2.1	3.7 ± 2	4.4 ± 2.4	3.7 ± 2.9
Noise	4.2 ± 2.4	4.2 ± 2.4	4.5 ± 2.2	4 ± 2.1
Vibration	4.2 ± 2.3	4.1 ± 2.3	4.9 ± 2.5	4.7 ± 2.1
Reliability	4 ± 2.4	3.9 ± 2.4	4.5 ± 2.5	4.7 ± 2.1
Range	4.2 ± 2.1	4.7 ± 2.2	4.2 ± 2.4	4 ± 2.2
Charging speed/time	4.8 ± 2.5	4.7 ± 2.5	5.3 ± 2.5	5.3 ± 0.6
Charger accessibility/availability	4.9 ± 2.6	4.8 ± 2.6	5 ± 2.5	6.7 ± 1.5
Operational characteristics				
Maintenance & repair	3.6 ± 2	3.5 ± 1.9	4.2 ± 1.9	4.3 ± 1.2
Route flexibility	3.7 ± 1.9	3.7 ± 1.9	4 ± 1.8	4.3 ± 3.2
Navigating traffic	3.8 ± 1.8	3.7 ± 1.8	4 ± 1.9	4 ± 2.6
Ease of driving	3.4 ± 1.9	3.5 ± 2	4 ± 1.9	4.3 ± 1.9
Physical well-being				
Physical health	3.4 ± 2	3.3 ± 1.9	3.8 ± 2.1	3.7 ± 2.9
Comfort during long hours of driving	3.7 ± 1.9	3.6 ± 1.8	4.2 ± 2.1	4.7 ± 0.6
Exposure to exhaust fumes and air pollution	3.6 ± 2	3.5 ± 1.9	4.8 ± 2	5.3 ± 1.1
Fatigue levels	3.6 ± 1.9	3.6 ± 1.9	3.7 ± 1.8	3.7 ± 2.1
Social and economic well-being				
Mental well-being	3.2 ± 2	3.8 ± 1.9	3.6 ± 2.2	3.7 ± 1.5
Job security	3.7 ± 1.9	3.7 ± 1.9	3.7 ± 2	3.7 ± 1.1
Income stability	3.9 ± 1.9	3.8 ± 1.9	3.9 ± 2.1	4.7 ± 2.2

Source: Authors' analysis

Table A8: Sample breakdown by select strata

Education level	N	per cent of total	N	per cent of total
	LCV and MHDV/T $N_{LCV+MHDV/T}$= 1540		Bullock Carts $N_{Bullock\_cart}$= 57	
Middle	771	50.1	35	61.4
Senior / Senior Secondary	321	20.8	7	12.2
Up to Primary	299	19.4	14	24.6
No formal schooling	149	9.7	1	1.75
Age				
30 - 59	1229	79.8	38	67
15 - 29	237	15.4	8	14
60 and above	74	4.8	11	19.3
City resident				
No	689	44.74	14	24.6
Yes	851	55.26	43	75.4
Driving experience (years)				
1–3 years	115	7.47	7	12.2
3–5 years	600	38.96	13	22.3
5–10 years	485	31.49	20	35
More than 10 years	340	22.08	17	29.9

Source: Field survey conducted by CEEW, 2025
Note: MHDV/T- Medium and heavy-duty vehicle/trucks

Table A9: High-level sample descriptives (average)

	LCV	MHDV/T		Bullock
		MDT	HDT	Carts
Household size (persons)	4	4	4	4.6
Earning members in household	1.97	1.9	2.09	2.19
Vehicle age (years)	8.2	11.7	11	-
Odometer reading (km)	179,510	297,861	266,885	-

Source: Field survey conducted by CEEW, 2025

Table A10: Self-reported performative, operational, duty cycle and economic attributes (average)

	LCV	MHDV/T		Bullock
		MDT	HDT	Carts
Net daily earnings (₹)	1,370	1634	1814	700
Mileage (km per unit)	11.4	7	5.4	-
Average operational hours (hours/day)	9.2	9.02	9.19	7.1
Idle time (hours/day)	1.95	2.1	2.3	1.2
Average load/unload time (minutes)	37.9	61.7	58.5	16.2
Trip frequency (trips/day)	2.37	1.7	1.4	5.6
Average trip distance (km)	97.3	178.0	264.7	2.5
Total daily distance (km/day)	204	248	291	12.7

Rest stops (count/day)	0.92	1.6	2.13	0
Average rest stop time (minutes)	9.6	14.6	17.4	0
Toll crossings (count/day)	0.98	1.9	2.8	0
Commodity weight carried (tons)	0.89	4.5	12.41	-
City driving share (per cent)	58.5	28	21	-
Highway driving share (per cent)	41.5	72	79	-

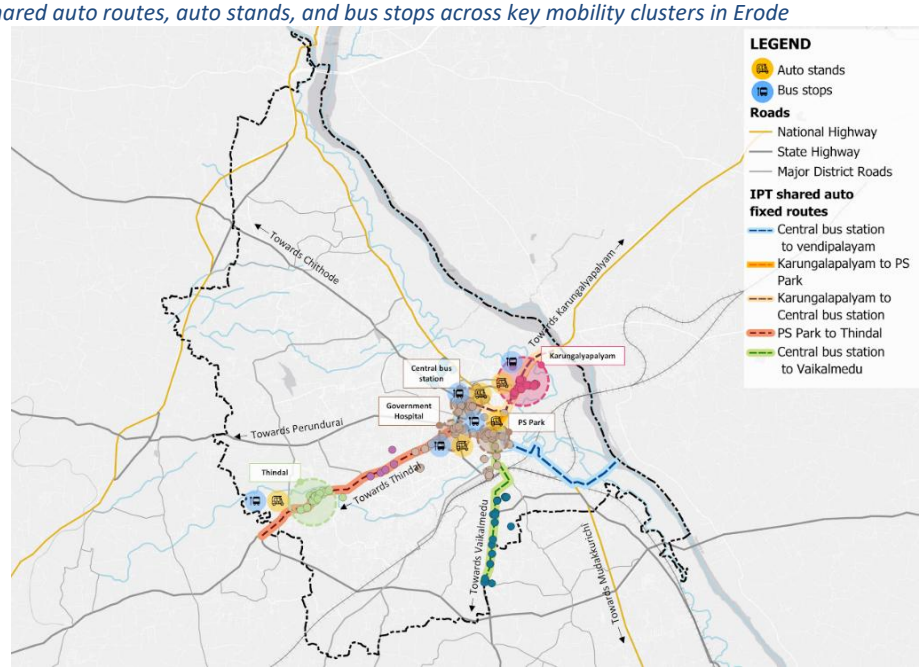
Source: Authors' analysis
Note: - denotes not applicable.

Table A11: Self-reported perception scores (average) across private, infrastructure and societal attributes

	LCV	MHDV/T		Bullock
		MDT	HDT	Carts
Income satisfaction	5.32	5.23	4.88	5.45
Income stability	5.49	5.3	5.12	5.22
Safety	5.51	4.99	5.09	5.4
Reliability	5.39	5.14	5.32	6.17
Efficiency	5.38	5.38	5.18	5.24
Comfort	5.38	5.56	5.14	5.96
Social recognition	5.27	5.41	5.03	4.73
Infrastructure adequacy	5.45	5.45	5.2	5.54
Accessibility	5.24	4.69	4.68	5.45
Regulatory support	5.54	5.04	5.02	5.89

Source: Authors' analysis
Note: Responses were collected on a sliding scale of 1-10, 10 being the highest

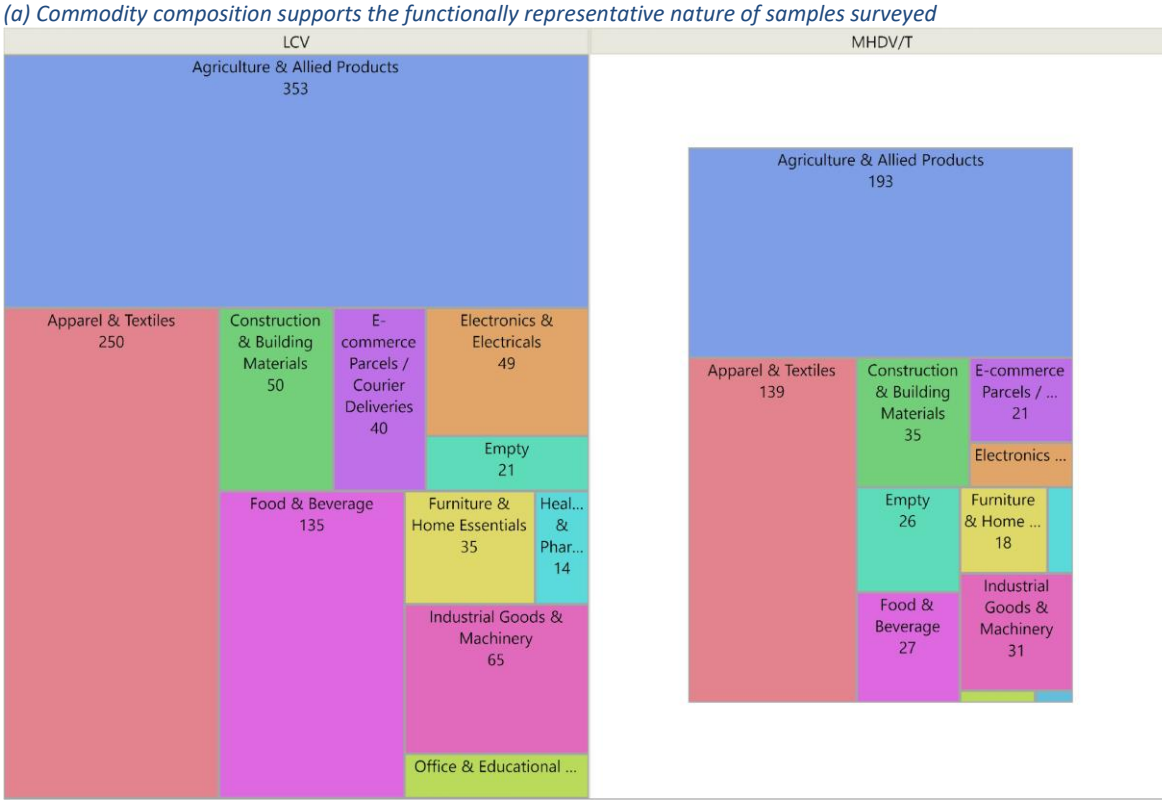
Figure A13: Shared auto routes, auto stands, and bus stops across key mobility clusters in Erode



Source: Authors' analysis
Note: The shared auto routes presented here were identified through discussions with the shared auto association head. Only the key clusters are shown, selected based on user survey origin points concentrated within a 500m radius around each cluster.

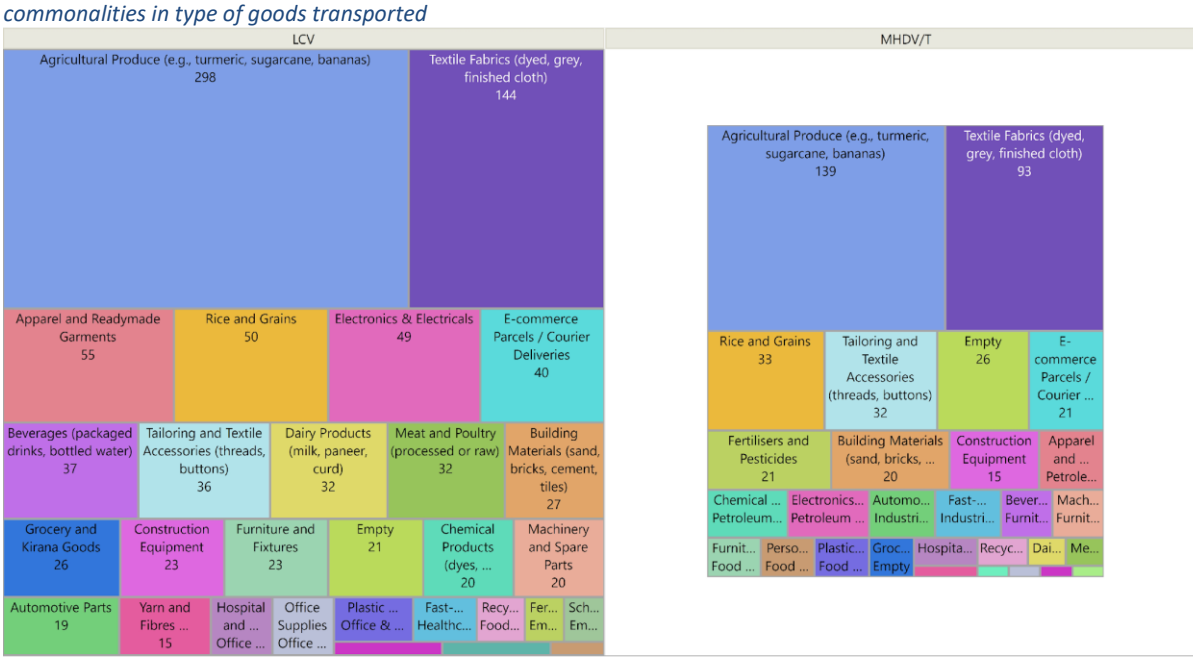
Figure A14

(a) Commodity composition supports the functionally representative nature of samples surveyed



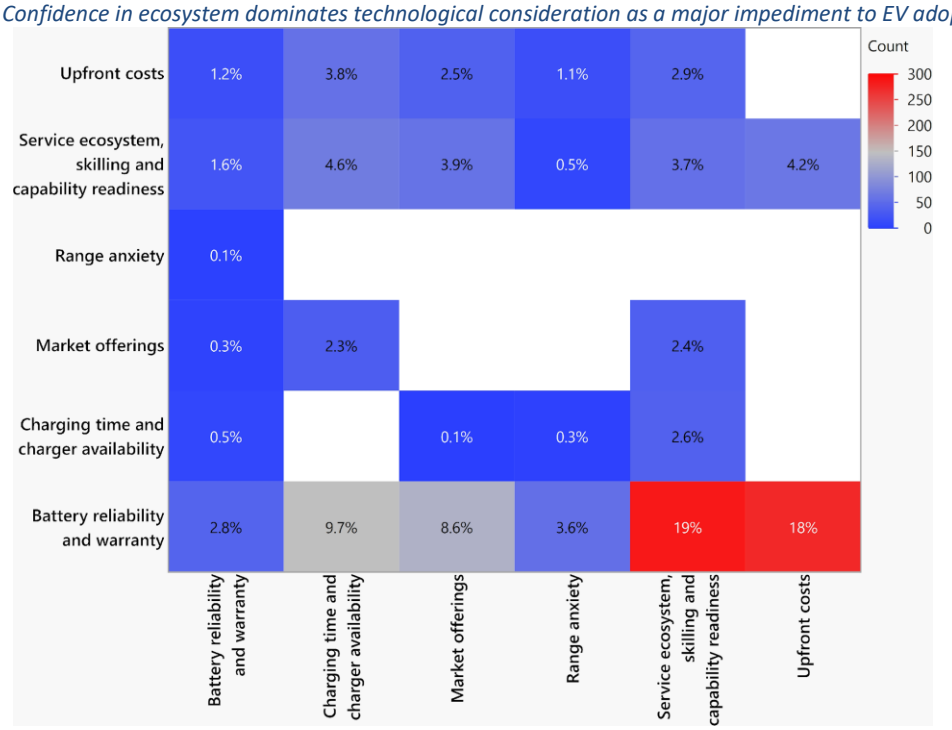
Source: Field survey conducted by CEEW, 2025

(b)Freight policy must distinguish between distribution-oriented LCV flows and bulk-oriented MHDV movements despite commonalities in type of goods transported



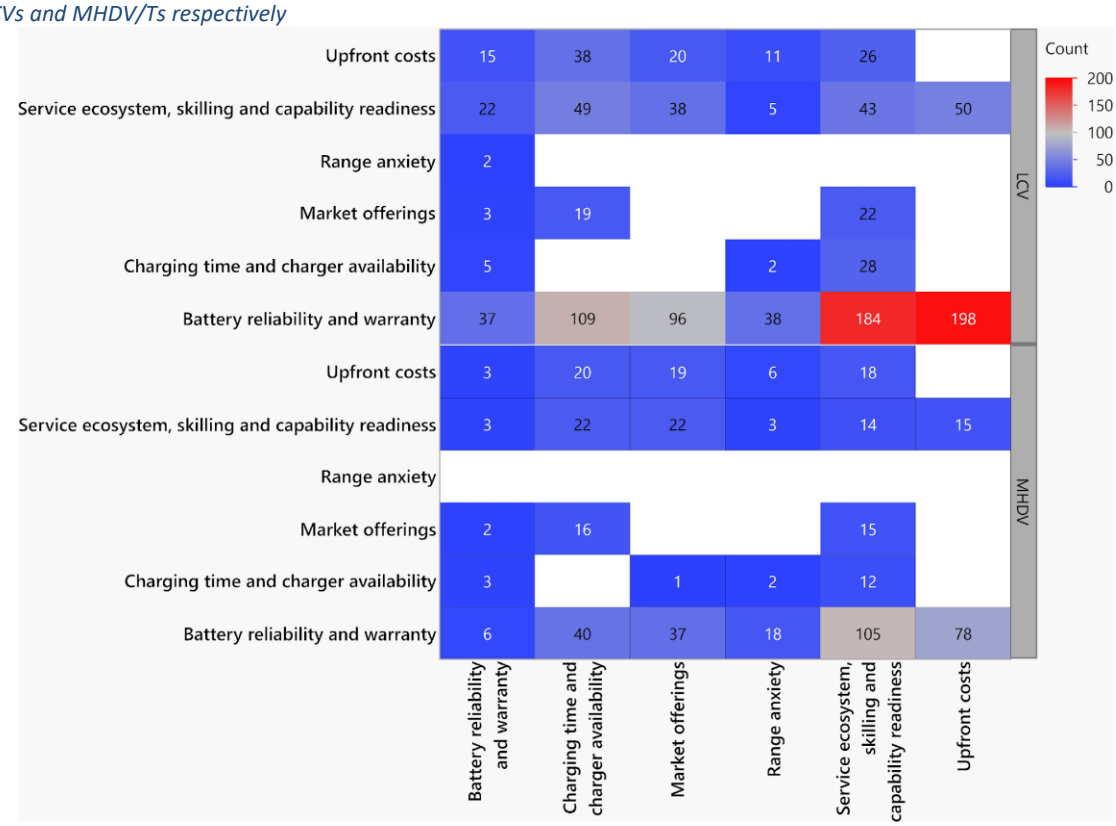
Source: Field survey conducted by CEEW, 2025

Figure A15: Confidence in ecosystem dominates technological consideration as a major impediment to EV adoption



Source: Authors' analysis

Figure A16: Tactical operational risks and strategic technology-assurance are the main barriers to EV transition faced by LCVs and MHDV/Ts respectively



Source: Authors' analysis

Survey forms

1. *Fuel station user (FuSS) and Origin-Destination (OD) survey*

Section	Q.	Variable Name	Question Text	Response Type	Response Options	Notes
Vehicle Information	1	*plate_type*	Vehicle number plate - mark plate type	Single select	*Regular / Commercial or Permit*	*Note registration plate category*
	2	*vehicle_type*	Type of vehicle (exclude govt, utility, and service vehicles)	Single select	*2W; 3W; 4W; LCV; Bus; Truck*	*Use same format for all entries*
	3	*fuel_type*	What fuel does your vehicle use?	Single select	*Petrol; Diesel; CNG; LNG; LPG; Petrol-Hybrid (Dual/Flex); Diesel-Hybrid (Dual/Flex); EV*	
	4	*vehicle_make*	Vehicle manufacturer (OEM)	Text		
	5	*vehicle_model*	Vehicle model name	Text		*Maintain consistent naming*
	6	*vehicle_trim*	Vehicle trim/variant	Text		*Use same format for all entries*
	7	*occupancy*	Occupancy (excluding driver)	Numeric		
Ownership & Utilization	1	*ownership_type*	Vehicle ownership	Single select	*First-hand (RC in my name); Second-hand; Company/Operator owned or leased; Rental*	*Any other, please specify*
	2	*usage_type*	Vehicle mainly used for	Single select	*Personal; Commercial; Both*	
Trip Purpose & Characteristics	1	*trip_origin*	Origin category/purpose	Single select	*Home; School/College; Office/Work; Market/Shopping; Recreation; Delivery (goods/e-com); Ride-hailing*	*Any other, please specify*
	2	*trip_destination*	Destination category/purpose	Single select	*Home; School/College; Office/Work; Market/Shopping; Recreation; Delivery (goods/e-com); Ride-hailing*	*Any other, please specify*
	3	*trip_distance*	Trip distance (km)	Numeric		
	4	*trip_departure_time*	Departure time	Time		*24-hour format*
	5	*daily_distance*	Average daily distance (km)	Numeric		
	6	*daily_trips*	Average number of daily trips	Numeric		
	7	*mileage*	Mileage (km/litre, km/kg, or km/charge)	Numeric		*Specify units properly*

2. *Bus user survey*

Section	*Q.*	*Variable Name*	*Question Text*	*Response Type*	*Response Options*	*Notes*
Socio-economic characteristics	**1**	*age_group; gender; educ_level; profession*	Age, Gender, Education, Profession	Single select		
	2	*hh_inc*	Monthly household income	Single select		
	3	*month_exp_pt*	Monthly expenditure spent on commuting via buses	Single select		Bus only
	4	*disability*	Any disability, mention type	Single select	Yes; No, if yes select one: Mobility; Visual; Speech/Hearing	Observe & note
	5	*hh_veh; hh_veh_type*	Number and type of vehicles in household	Single select	0; 1; 2; 3+ Type: No vehicles; Bicycle; Motorcycle/Scooter; Car; Two vehicles; Three+ vehicles	Most appropriate
Daily commute & bus usage	**1**	*bus_use_type*	Bus service type	Multi select	Intracity; Intercity; Interstate; Mini/Omni bus	
		mode_find; bus_stop_access	access, mode used to reach bus stop	Multi select		
	2	*daily_use_freq*	Frequency per day	Numeric		Count of trips/day
	3	*trav_hours*	Usual travel time	Numeric		
Travel behaviour and pattern	**1**	*trav_time; trav_dist; trip_cost*	One-way travel time, distance, cost	Numeric		
	2	*walk_dist; access_time_stop; wait_time*	Walking distance to bus stop, time to reach bus stop, waiting time	Numeric		
Origin-Destination places and Use case	**1**	*origin; destination*	Usual boarding point, drop-off point	Landmark, PoI with category	Home; Education; Market; Hospital; Recreational; Transit stop; Work	
	2	*trip_purpose*	Most frequent trip purpose	Single select	Work; Education; Shopping; Care-related; Social/Recreation	
Perception, barriers & improvements of existing bus services	**1**	*modechoice_reason; barriers_pt; pt_improv*	Motivation, Barrier, Preferred improvements	Multi select		Select up to 3
	2	*pt_rating*	Rating perception of bus service attributes	Numeric (1-10)	Affordability; Travel time; Waiting time; Availability; Safety; Comfort; Seating; Luggage; Reliability; Weather service	
Perception of electric bus services	**1**	*electric_pt_rating*	Rating of e-bus attributes	Numeric (1-10)	Affordability; Accessibility; Speed; Comfort; Convenience; Safety; Reliability; Environment-friendly; Driver behaviour	

3. *Intermediate Public Transport (IPT) user survey*

Section	Q.	Variable Name	Question Text	Response Type	Response Options	Notes
Socio-economic characteristics	**1**	*age_group; gender; educ_level; profession*	Age, Gender, Education, Profession	Single select		
	2	*hh_inc*	Monthly household income	Single select		
	3	*month_exp_ipt*	Monthly expenditure on auto/tempo	Single select		IPT only
	4	*disability*	Any disability, mention type	Single select	Yes; No, if yes select one: Mobility; Visual; Speech/Hearing	Observe & note
	5	*hh_veh; hh_veh_type*	Number and type of vehicles in household	Single select	0; 1; 2; 3+ Type: No vehicles; Bicycle; Motorcycle/Scooter; Car; Two vehicles; Three+ vehicles	Most appropriate
Daily commute & IPT usage	**1**	*ipt_use_type; mode_find; first-and-last-mile access*	IPT mode type, access, modes combined with auto	Multi select		
	2	*daily_use_freq*	Frequency per day	Numeric		Count of trips/day
	3	*trav_hours*	Usual travel time, time to reach pick-up point, waiting time	Numeric		
Travel behaviour and pattern	**1**	*trav_time; trav_dist; trip_cost*	One-way travel time, distance, cost	Numeric		
Origin-Destination places and Use case	**1**	*origin; destination*	Usual boarding point, drop-off point	Landmark, PoI with category	Home; Education; Market; Hospital; Recreational; Transit stop; Work	
	2	*trip_purpose*	Most frequent trip purpose	Single select	Work; Education; Shopping; Care-related; Recreation; Access PT	
Perception, barriers & improvements of existing IPT services	**1**	*modechoice_reason; barriers_ipt; ipt_improv*	Motivation, Barrier, Preferred improvements	Multi select		Select up to 3
	2	*ipt_rating*	Rating perception of IPT service attributes	Numeric (1-10)	Affordability; Travel time; Waiting time; Availability; Safety; Comfort; Seating; Luggage; Reliability; Weather service	
Perception of electric IPT services	**1**	*eipt_rating*	Rating of e-IPT attributes	Numeric (1-10)	Affordability; Accessibility; Speed; Comfort; Convenience; Safety; Reliability; Environment-friendly; Driver behaviour	

4. *Intermediate Public Transport (IPT) operator survey*

Section	Q.	Variable Name	Question Text	Response Type	Response Options	Notes
Socio-economic characteristics	1	*age; gender; educ_level; drv_exp*	Age, Gender, Education, Driving experience	Single select		
	2	*veh_own*	Vehicle ownership type	Single select	Owned; Rented; Leased	
	3	*mlg; daily_earn*	Mileage, Net daily earnings	Numeric	km/litre or km/kg; INR respectively	
	4	*hh_size; hh_earn_members*	Household size, No. of earning members	Numeric		
Vehicle Details	1	*veh_type; veh_make; veh_model; veh_age_yrs; fuel_type*	Type of vehicle driven, Vehicle manufacturer, Vehicle model, Vehicle age, Fuel type	Single select + Text	Auto/Tempo options; OEM name; Model name; Age (in years); Petrol/Diesel/CNG/LPG/EV	Keep consistent naming format
Operational details	1	*pickup_point; dropoff_point*	Usual pickup/drop locations	Text		Landmark PoI
	2	*fuel_use_day_ltr; work_hrs; idle_hrs*	Daily fuel consumption, Work hours, idle hours per day	Numeric		Fuel consumption in litres or kg
	3	*maint_freq*	Vehicle maintenance frequency	Single select	Weekly; Monthly; Quarterly	
	4	*peak_hrs; offpeak_hrs*	Peak and off-peak hours	Text		
	5	*dist_day; trips_day; empty_trips; avg_occup*	Daily distance, daily trips, empty trips, occupancy	Numeric		
	6	*demand_source*	Main source of trip requests	Single select	App bookings; Street hails; Direct calls/messages	
Challenges, perception & preferred improvements	1	*barrier_ipt; improv_ipt*	Barriers, priority improvements for IPT system	Multi select		Select up to 3
Perception of e-auto transition	1	*eipt_willingness; eipt_motivation; eipt_barrier*	Wllingness to shift, motivators, barriers to e-IPT	Multi select		Select up to 3
	2	*operator_eipt_rating*	Rating of e-IPT attributes	Numeric (1-10)	Performance; Operational ease; Physical wellbeing; Social/economic wellbeing	

5. Freight driver survey

Section	Q.	Variable Name	Question Text	Response Type	Response Options	Notes
Socio-economic characteristics	1	*age; gender; educ_level; drv_exp*	Age, Gender, Education, Driving experience	Single select		
	2	*veh_own*	Vehicle ownership type	Single select	Personal; Rented/Leased; Private/Company (3PL, Fleet operator); Government	
	3	*mlg; daily_earn*	Mileage, Net daily earnings	Numeric	km/litre or km/kg; INR respectively	
	4	*hh_size; hh_earn_mem*	Household size, No. of earning members	Numeric		
Vehicle Details	1	*veh_class; veh_type; veh_make; veh_model; fuel_type*	Type of vehicle driven, Vehicle manufacturer, Vehicle model, Fuel type	Single select + Text	LCV/MHDV/Bullock cart; OEM name; Model name; Petrol/Diesel/CNG/LPG/EV	Keep consistent naming format
Trip pattern and Origin-Destination	1	*trip_type*	Trip movement pattern	Single select	I-I; I-E; E-I; E-E where I - Internal (inside city limits), E - External (outside city limit)	
	2	*origin; destination*	Origin, Destination	Landmark with Text		Landmark PoI
Operational details	1	*oper_hrs; trip_dist; trip_freq*	Average operational hours, average trip distance, trips per day	Numeric	hrs; km	
	2	*dist_day; idle_hrs*	Total daily distance travelled, idle hours per day	Numeric	km; hrs	
	3	*rest_stops; rest_time*	Number of rest stops and average time per rest stop	Numeric		Excluding loading/unloading
	4	*load_time*	Average loading/unloading time per trip	Numeric	minutes	
	5	*tolls_day*	Number of tolls per day	Numeric		
Challenges, perception & preferred improvements	1	*barrier_freight; improv_freight*	Barriers, priority improvements for freight ecosystem	Multi select		Select up to 3
	2	*freight_drv_rating*	Rating of freight driving aspects	Numeric (1-10)	Accessibility; Income; Safety; Reliability; Stability; Recognition; Efficiency; Comfort; Infrastructure; Regulation	
Perception of electric transition	1	*ev_willingness; ev_motivation; ev_barrier*	Wllingness to shift, motivators, barriers to ev transition	Multi select		Select up to 3