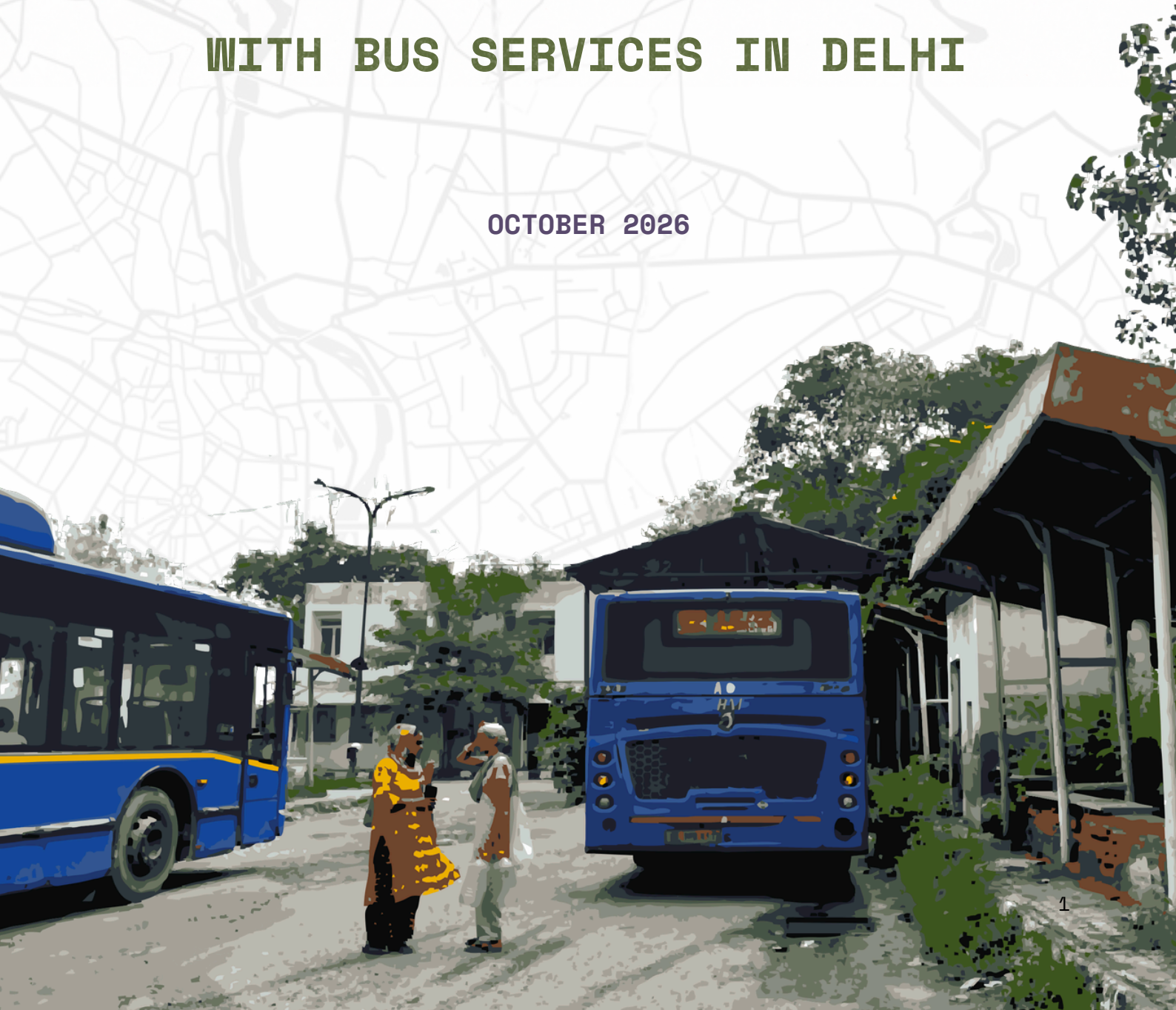
THE URBAN CATALYSTS

SURVEY AMALYSIS REPORT

UNDERSTANDING COMMUTERS' SATISFACTION

WITH BUS SERVICES IN DELHI

OCTOBER 2026



ACKNOWLEDGEMENT

The Women's Safety and Employment in Public Transport in Delhi project was led by Sonal Shah, Founder, The Urban Catalysts, with Manisha Sharma, Arish Amber, and Soumili Roy as the core research team, and expert guidance from Satyajit Ganguly.

We also acknowledge the support of the external survey organization that facilitated fieldwork and data collection for the study.

We extend our sincere gratitude to all the commuters who participated in the study and generously shared their time, experiences, perceptions, and perspectives on travelling by bus in Delhi.

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INTRODUCTION



Context

Delhi, also known as the National Capital Territory of Delhi, has an urban population of 16 million as per the Census 2011. Public transport in Delhi comprises an extensive network of metro rail and bus services. Delhi Transport Corporation (DTC) is now the primary agency responsible for operating and overseeing all bus services in Delhi, following the integration of bus operations previously managed under the Delhi Integrated Multi-Modal Transit System Limited (DIMTS).

DTC was set up in 1971 under Section 22 of the Road Transport Corporation Act, 1950, and functions under the administrative control of the Government of the National Capital Territory of Delhi (GNCTD) (DTC, 2023). DTC operates a mixed fleet comprising air-conditioned (AC) and non-air-conditioned (NAC) CNG buses, as well as low-floor electric buses.



5,477
BUSES



40.8 L
DAILY RIDERSHIP (2024-25)

As of January 2026, DTC operates and oversees a fleet of 5,447 buses, comprising 2,630 DTC-operated buses (including 41 AC CNG buses, 10 NAC CNG buses and 2,579 low-floor e-buses) and 2,817 buses previously overseen by the Transport Department (including 792 AC CNG buses, 1,069 NAC CNG buses and 956 electric buses, of which 473 are 12-metre and 483 are 9-metre buses) (DTC, 2026). In 2022-23, average daily bus ridership in Delhi was approximately 2.5 million (Planning Department, 2024). Further, there are ~4,000 bus stops in Delhi (Department of Transport & IIIT Delhi, 2024), managed and developed by Delhi Transport Infrastructure Development Corporation Limited (DIMTS), along with 36 bus terminals operated by DTC.



About the Project



Commuters' satisfaction surveys

2000+ *(with 70% women)*

This report draws on primary survey data to understand commuters' travel behaviour, perceptions of bus services, awareness of safety initiatives, and key challenges encountered during their journeys.



Focus Group Discussions (FGDs)



Assessment of bus stops from gender & climate lens



Assessment of bus terminals from gender & climate lens



METHODOLOGY



Data collection

A city-wide commuter perception survey was conducted among 2,183 commuters between August and October 2025 at selected bus terminals across Delhi. A structured questionnaire (see Annexure 4) was administered to collect data on travel behaviour, service quality, safety perceptions, awareness of grievance mechanisms, and overall satisfaction with bus-based public transport. Service quality was assessed across 36 attributes using a 7-point ordinal scale, complemented by three measures of overall satisfaction. Each interview lasted approximately 15 minutes.

2,183

RESPONDENTS

1,546 WOMEN (71%)

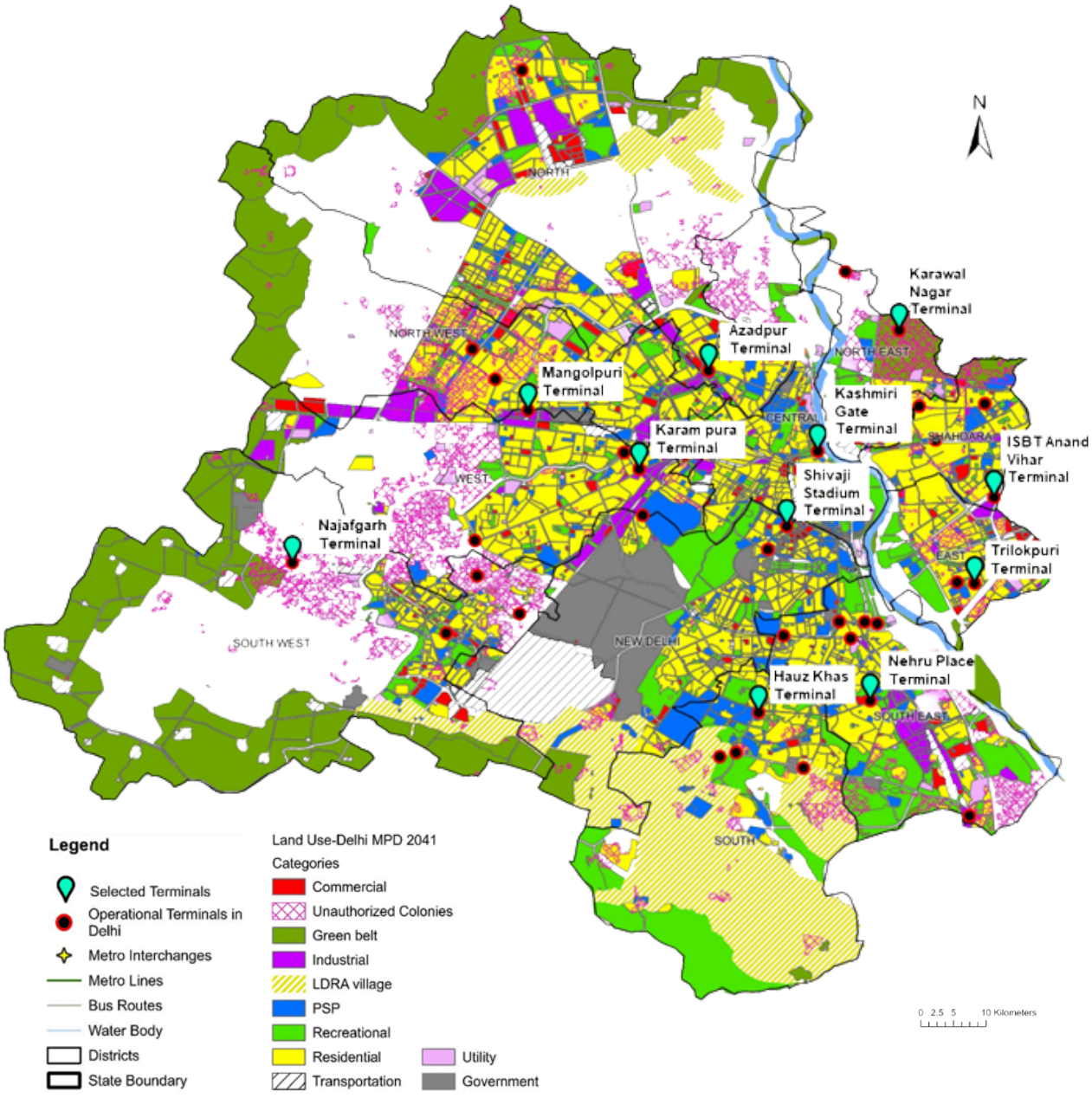
&

637 MEN (29%)

Delhi currently has 36 operational bus terminals across 11 districts, including 3 ISBTs (DTC, 2025). Survey locations were selected using a two-tier stratification approach, with districts as the primary strata and terminals ranked using bus route density, multimodal integration, and land-use diversity (Entropy Index) as proxies for passenger footfall. The highest-scoring terminal in each district was selected, with samples proportionally allocated across the 11 terminals and a 70:30 gender stratification applied. At ISBTs, surveys focused only on intra-city bus sections to ensure relevance to Delhi commuters. Further details on the methodology are provided in Annexure 1(A).



Figure 1: Bus terminals selected for commuter perception survey



11 **were selected using a stratification process based on-**

BUS TERMINALS

BUS ROUTE DENSITY SCORE + **ENTROPY SCORE** + **MULTIMODAL INTEGRATION SCORE**

Higher number of routes → higher expected passenger footfall

Higher entropy index → higher land-use mix & expected passenger footfall

Proximity to metro stations (particularly interchanges) within an 800m walkable catchment

Analysis

The analysis followed a two-stage approach. Descriptive statistics were used to examine respondents' socio-demographic characteristics, travel behaviour, service-quality perceptions, safety experiences, and awareness of grievance redressal mechanisms, with findings disaggregated by gender.

For inferential analysis, generalised ordinal logistic regression was employed to examine the relationship between the 36 service-quality attributes (rated on a 1–7 ordinal scale) and two outcome measures:
(i) overall satisfaction with bus services and
(ii) perceived safety while using bus services.

Variables measuring related constructs were combined where Cronbach's alpha ≥ 0.70 to improve model parsimony. In order to relax the assumption of proportional odds, a generalised ordinal logistic regression was carried out, with the dependent variable being overall satisfaction and independent variables including interactions among themselves based on the Cronbach's alpha value of variables measuring the same construct (Suman, Bolia, & Tiwari, 2016; Williams, 2006). Along with the combined variables, all other singular independent variables have been retained for the generalized ordinal regression model (see Annexure 2 for the estimation formula).

The regression results were used to identify service-quality factors significantly associated with overall satisfaction and perceived safety. These findings were subsequently combined with performance ratings through Importance–Performance Analysis (IPA) to identify priority areas for improvement. A Service Quality Index (SQI) was also calculated using statistically significant regression coefficients as importance weights and mean satisfaction ratings as performance measures.

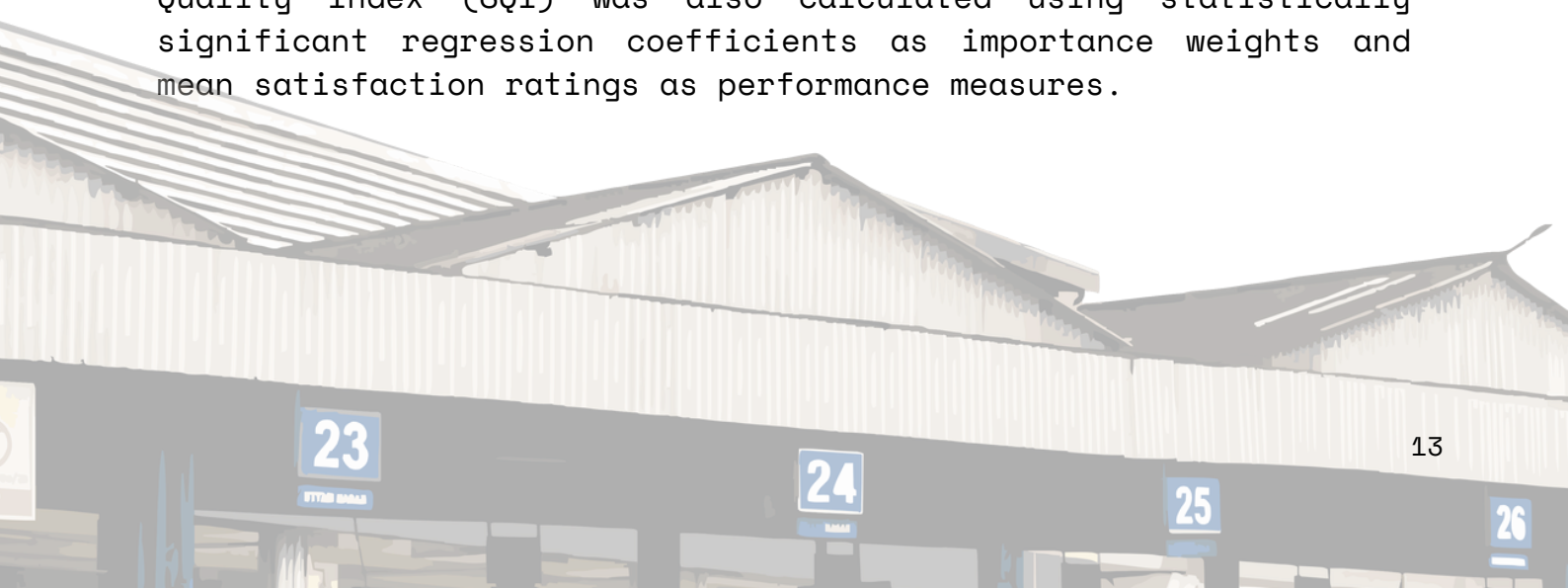


Table 1: Parameters for service quality of bus-based public transport

SNo	Service quality parameters
Travel time	
1	Punctuality of bus services
2	Frequency of bus services
3	Pre-trip information for journey planning
4	Real-time information of bus arrival at the bus stop
5	On-board travel time
6	Transfer time
7	Directness of travel
8	Access and egress time
Comfort	
9	Cleanliness in buses
10	Seat availability
11	Thermal comfort & ventilation
12	Availability of the space for wheelchair/stroller
13	Availability of hand support to move and stand in buses
14	Behaviour of conductors
Convenience	
15	Ease of purchasing a ticket
16	Network coverage (Availability of buses to travel within the city)
17	Operating hours of bus services
18	On-board information (name of the next bus stop, helpline numbers, how to receive help in case of safety-related issues)
19	Ease of boarding & alighting
20	Adequate stop time to allow boarding/alighting for women, elderly, PwD
Safety	
21	Crowding level within buses
22	Personal safety from theft, drunk people etc.
23	Safety from sexual harassment
24	Driving behaviour (rash driving, sudden jerks etc)
25	Information on the grievance redressal mechanism
26	Effectiveness of grievance redressal mechanism
Affordability	
27	Value for money with respect to distance travelled (for AC buses)
28	Value for money with respect to distance travelled (for non-AC buses)
29	Value for money for first- & last-mile connectivity
Bus stop infrastructure	
30	Availability of shelter from sun/rain
31	Availability of seating
32	Cleanliness of the bus stop area
33	Availability of information on bus stop name, routes and schedule
34	Lighting at the bus stops during the night
35	Availability of amenities near bus stops (drinking water, toilets, etc.)
36	Availability of universal accessible features at the bus stop (ramps, tactile pavement etc.)

FINDINGS



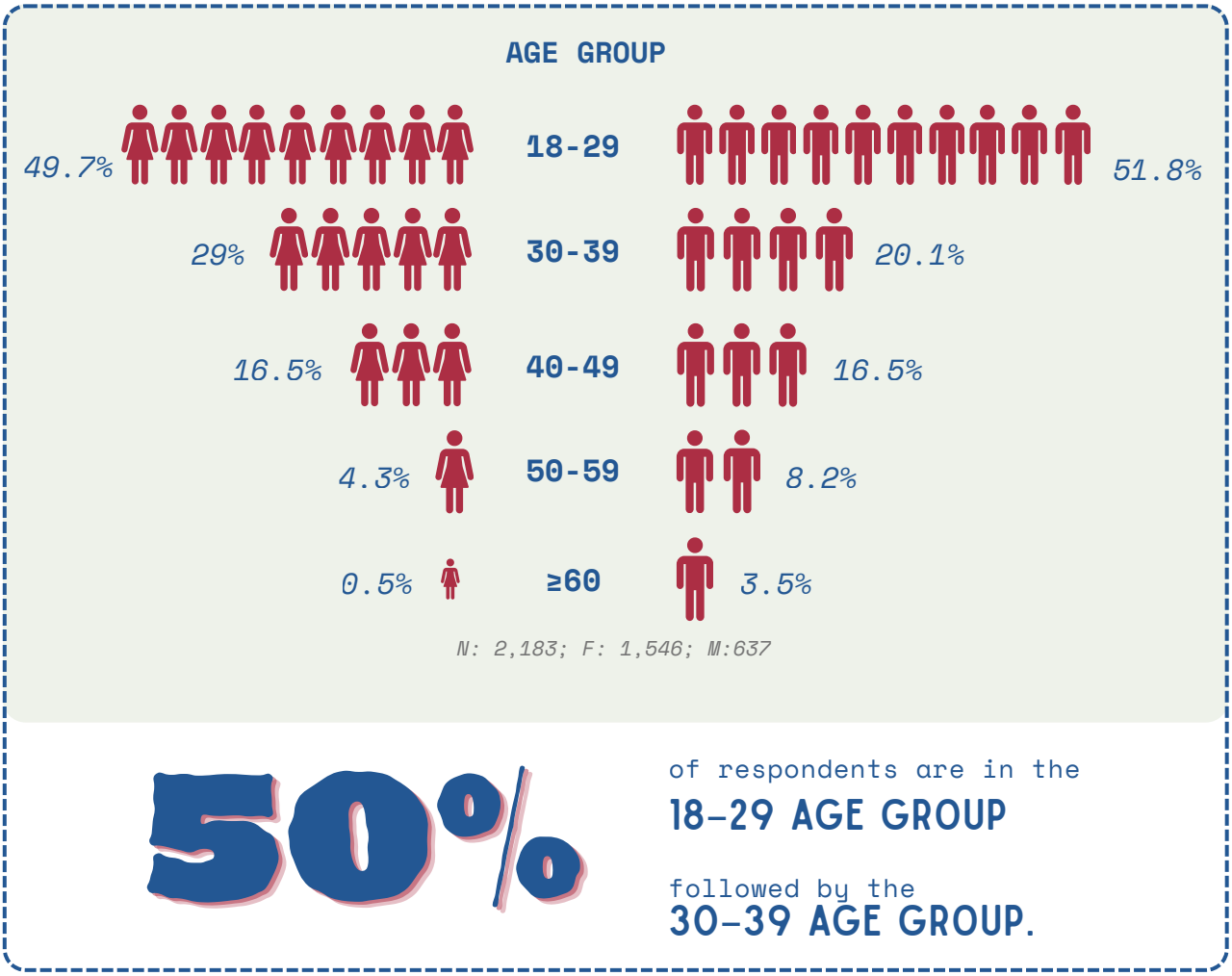
Descriptive Statistics

1. Demographics

Age and education profile of surveyed bus commuters

The age profile indicates that bus use is concentrated among younger commuters, with those aged 18–29 accounting for 50% of respondents, followed by the 30–39 age group at 26%. The sample shows a comparatively lower representation of older women: only 0.5% of female respondents are aged 50–59, compared with 3.5% of male respondents, contributing to the higher representation of men among commuters aged 50 and above. Educational attainment is relatively high across both genders, with 60% of women and 55% of men holding a diploma or undergraduate qualification or higher.

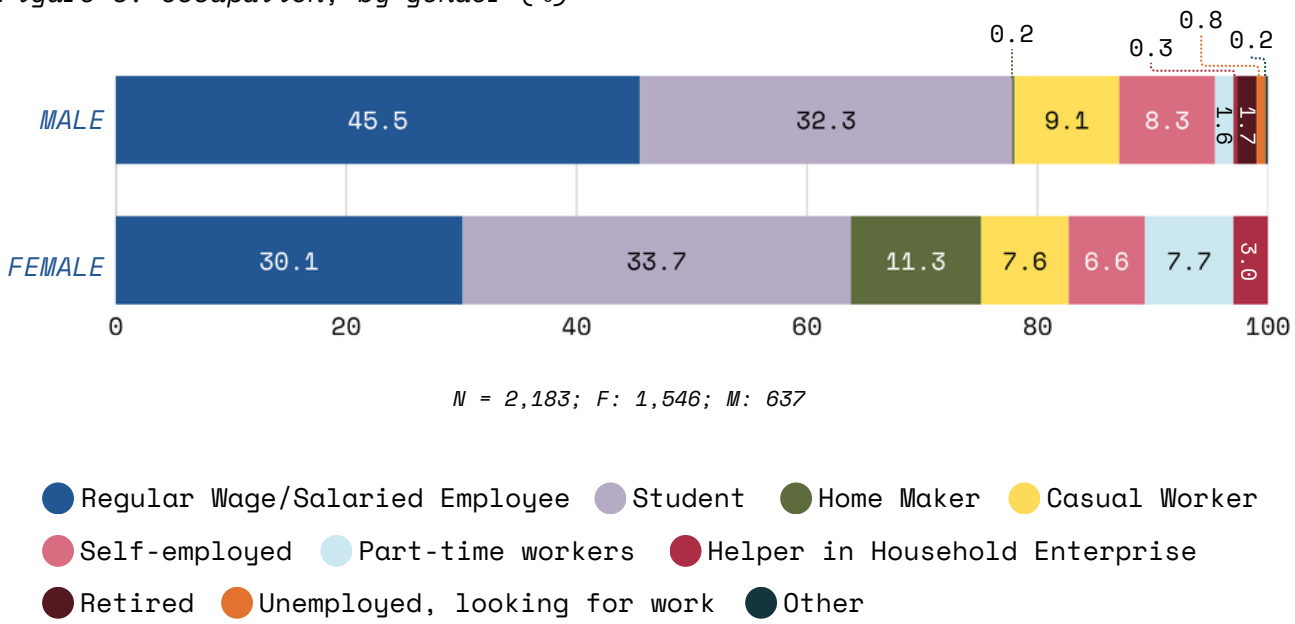
Figure 2: Age-sex structure (%)



2. Occupation

Among the surveyed respondents, the primary users are regular wage employees (35%) and students (33%), followed by casual workers (8%) and self-employed individuals (7%). 55% of female commuters are working, compared to 64% of men. A higher share of women are engaged in part-time work or as helpers in household enterprises (11% vs. 2%), while 11% of female commuters are homemakers, compared to none of the male respondents.

Figure 3: Occupation, by gender (%)

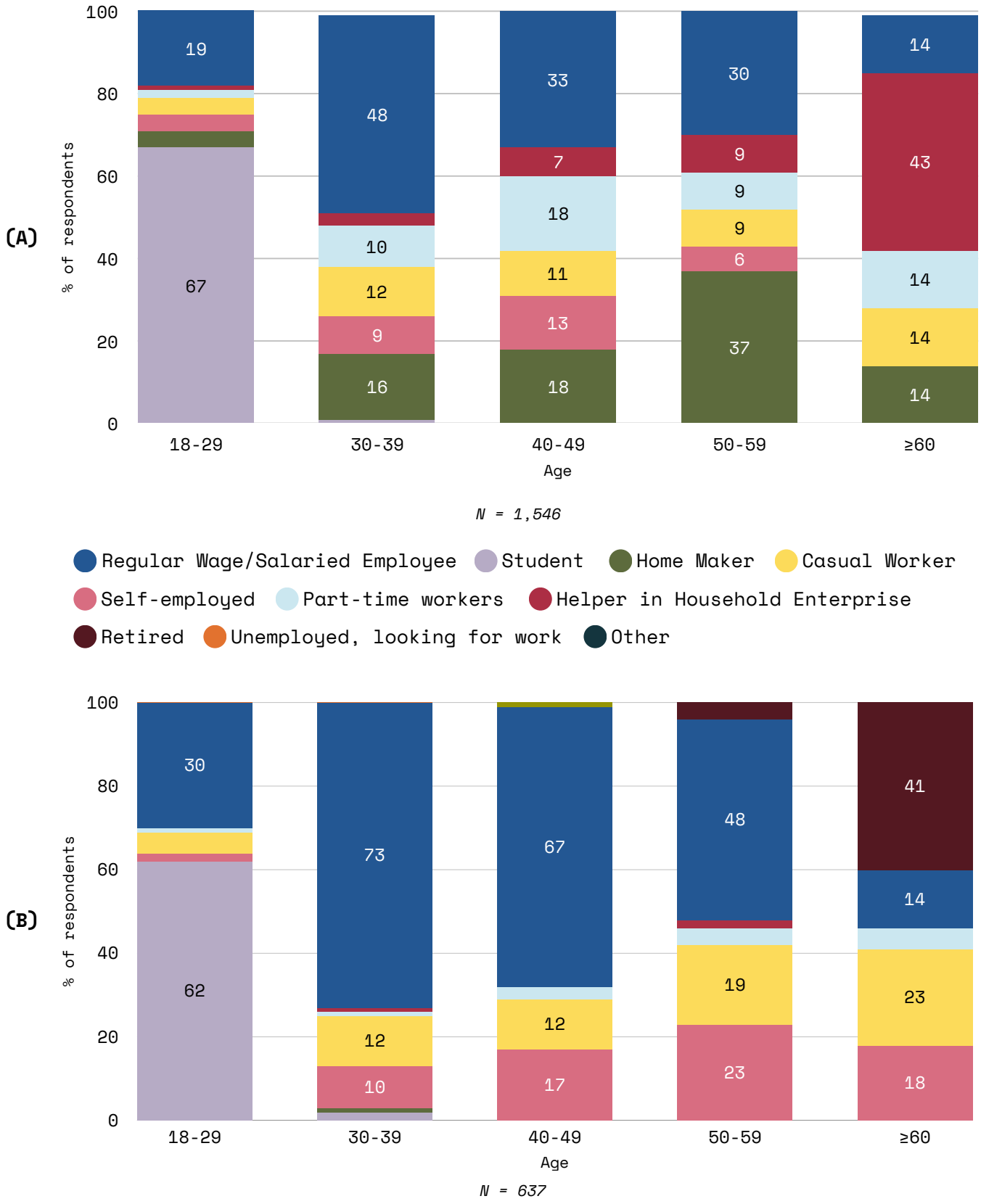


The age-wise employment pattern is broadly consistent with gendered labour-market participation in Delhi. Students dominate the 18–29 age group for both women and men; however, men transition earlier into regular wage or salaried employment, while women remain more concentrated in part-time work, household enterprises and domestic roles, with the gap widening with age.

This pattern points to a persistent disconnect between women's educational participation and labour-market participation. Despite female students accounting for 47.6% of higher education enrolment in Delhi in 2021–22 (Ministry of Education, 2024), the labour force participation rate of females aged up to 30 years remained low at 14.2% in 2022–23 (Govt. of NCT of Delhi, 2024), indicating that higher education has not translated proportionately into access to

regular wage employment for female commuters. Instead, females are more likely to be engaged in part-time work, household enterprises, or unpaid domestic roles, with this divergence widening with age as shown by the data.

Figure 4: Age and occupation (%) - (A) Women; (B) Men



3. Income

36% of surveyed bus commuters reported monthly household incomes below ₹30,000, 40% between ₹30,000–50,000, and 24% above ₹50,000.In the absence of official benchmarks, recent nationally representative research, such as the ICE360 "The Rise of India's Middle Class" study (2022) is used.

76%

bus commuters fall within **lower to lower-middle income segments.**

Based on a probability sample of over 60,000 households, it defines middle-class households as earning ₹5–30 lakh annually, with lower-income households below this range.

Based on this, around 76 % of bus commuters fall within the lower to lower-middle income segments. Gender-disaggregated analysis indicates that women primarily use buses when household income is up to ₹50,000 per month, with usage declining as household income exceeds this level. The average reported monthly individual income is ₹23,488 for female commuters and ₹20,908 for male commuters.

Figure 5: Monthly household income (INR) of sample (%)

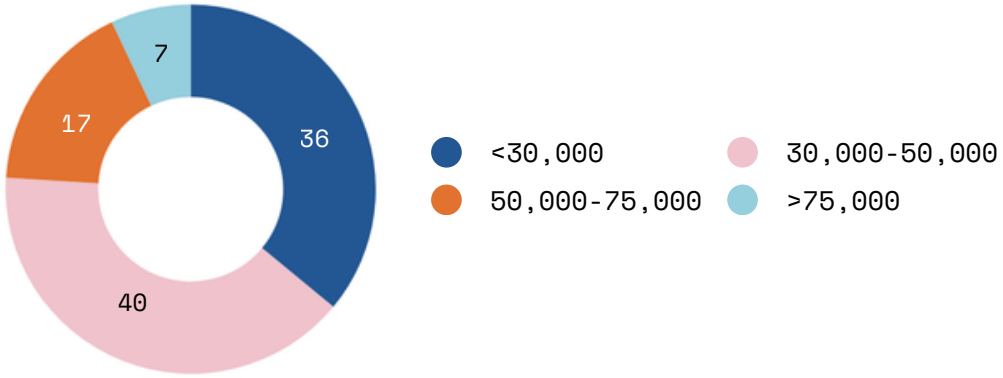
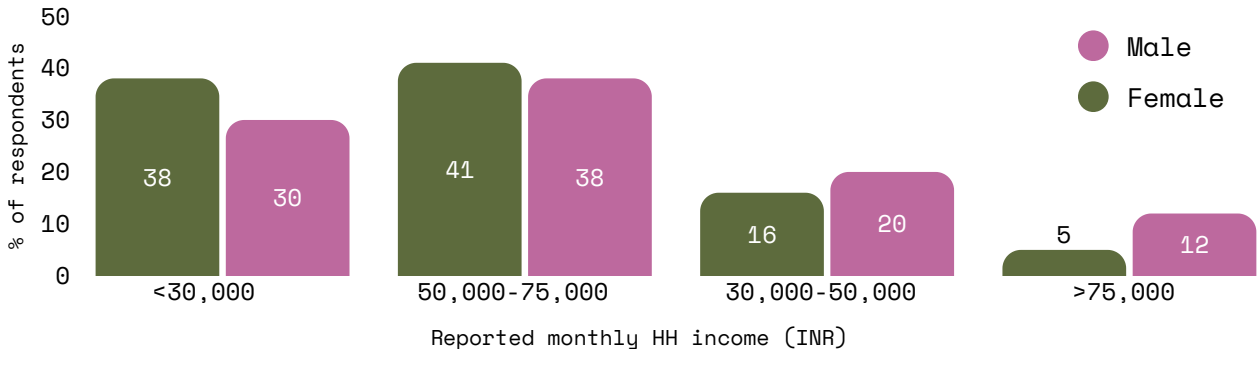


Figure 6: Monthly household income by gender



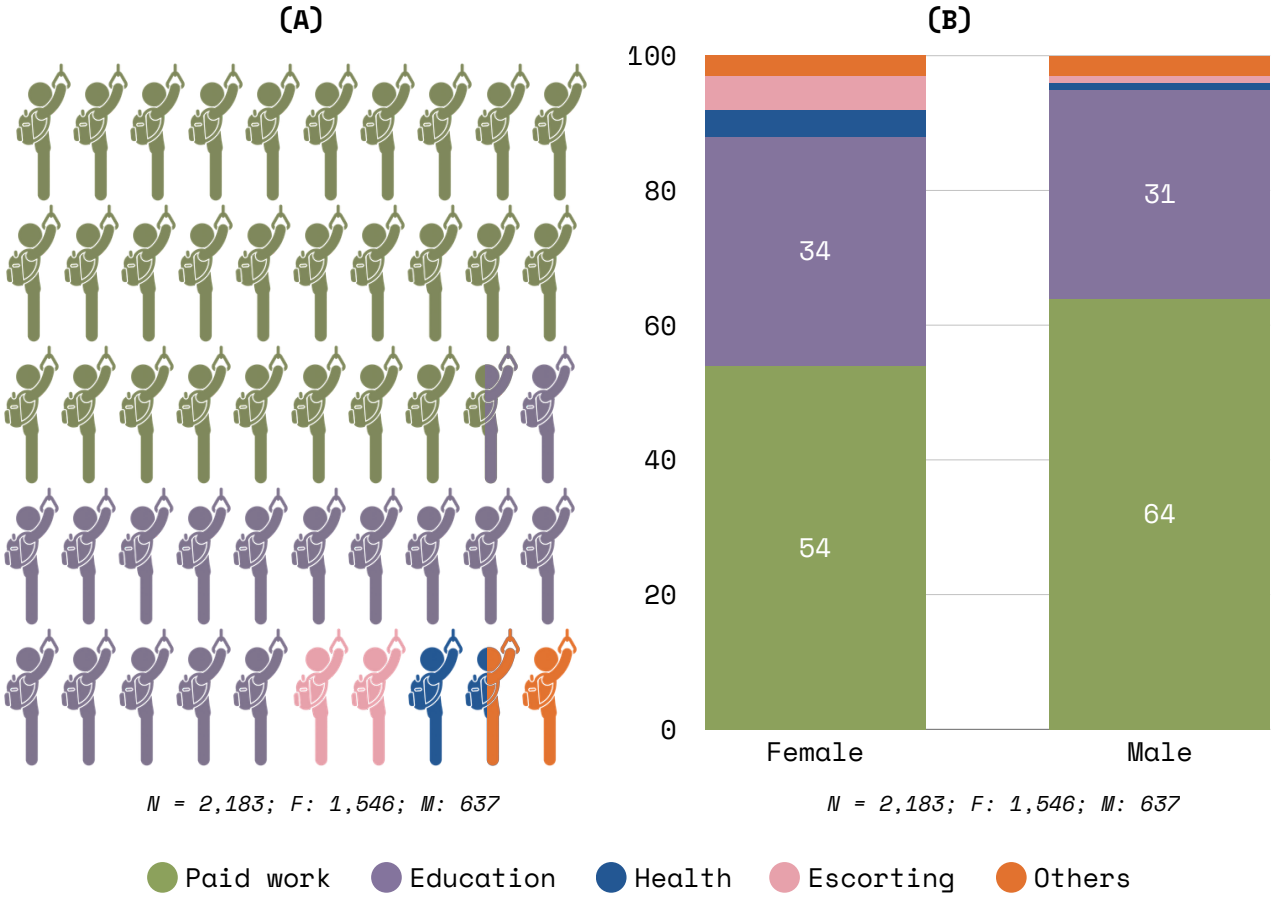
N = 2,183; F: 1,546; M: 637

4. Travel behaviour

Respondents typically travel by bus six days a week, making an average of two trips per day. Paid work is the primary purpose of travel (57%), followed by education (33%). Among female commuters, 11% travel for escorting, running errands, or health-related purposes, including accompanying a family member to a hospital, compared with 3% of male commuters.

2.01 Per capita bus trip rate **2.04**

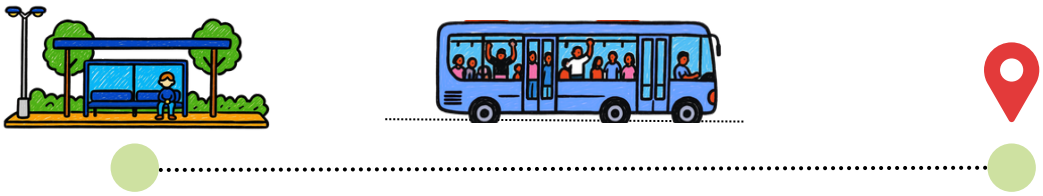
Figure 7: Primary travel purpose - (A) Total; (B) By gender



Women make **68% more** household and care-related trips than men

TRAVEL TIME AND DISTANCE

On average, door-to-door travel time by bus in Delhi is 90 minutes (1.5 hours), with an on-board travel time of 55 minutes and an average waiting time of 21 minutes. Travel time is higher in the evening, with an average increase of 7 minutes. Female commuters reported longer waiting time, averaging 23 minutes, compared to 16 minutes reported by male commuters.



21 mins
waiting at the bus stops

55 mins
on-board

However, the experience is not the same for everyone. Women (23 mins) reported longer waiting time than men (16 mins).

The average bus travel distance in Delhi by bus is 18 km, with no overall gender difference. However, age-specific patterns show that women aged 18–29 travel marginally farther than men (19 km vs. 18 km), while the pattern reverses among older commuters, with men travelling 21 km on average at ages 40–59, compared with 18 km for women.

Across trip purposes, women's travel distances for education (19.4 km), health-related trips (19.2 km), and paid work (18.2 km) remain broadly comparable to men's, indicating substantial reliance on bus services to access employment, education, and essential services across the city. The most pronounced gender difference is observed in travel for recreational and social trips averaging 19.9 km for women compared with 22.5 km for men.

Walking is the dominant access mode to bus stops, accounting for 84% of onward trips and increasing to over 91% during return journeys for both women and men.

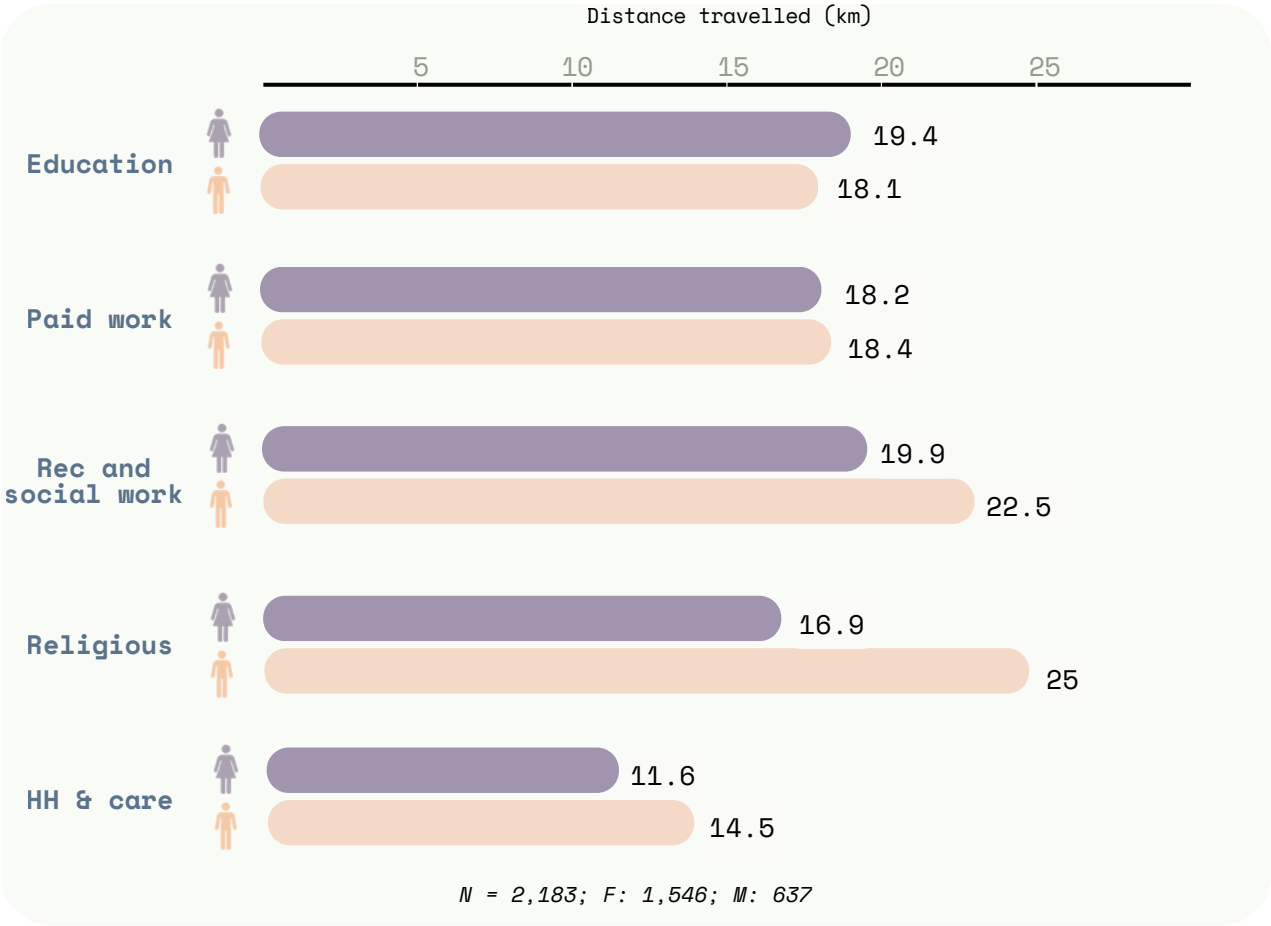
Men travel

↑ **7%** *for education*

↑ **13%** *for social & recreational purpose*

↑ **49%** *for religious purpose*

Figure 8: Distance travelled by buses - by gender and trip purpose

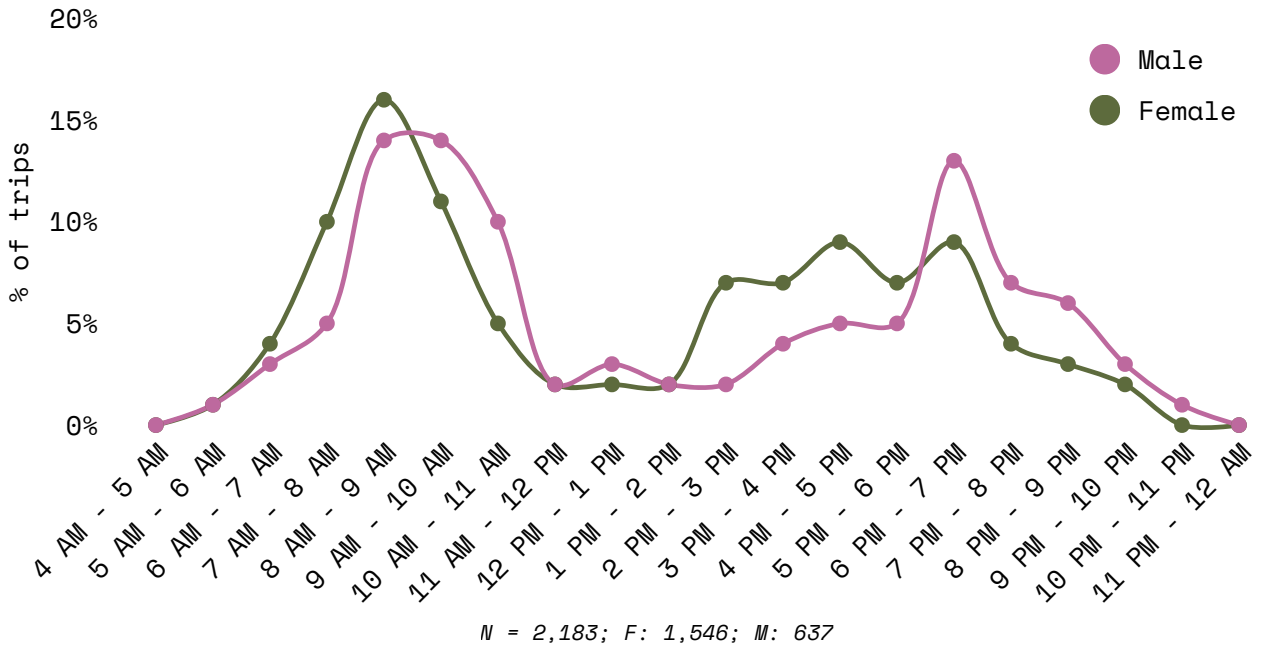




TIME OF TRAVEL

The overall morning peak occurs between 8:00 and 10:00 AM, while the evening peak is concentrated between 6:00 and 7:00 PM, accounting for 17% of all trips. Gender differences are evident in the timing of travel: women's trips are more concentrated across the morning and afternoon, with 37% occurring between 7:00 and 10:00 AM and 30% between 2:00 and 7:00 PM. Men, by contrast, show a sharper evening peak, with 13% of trips occurring between 6:00 and 7:00 PM and 17% when the 7:00–8:00 PM period is included.

Figure 9: Time of travel, by gender

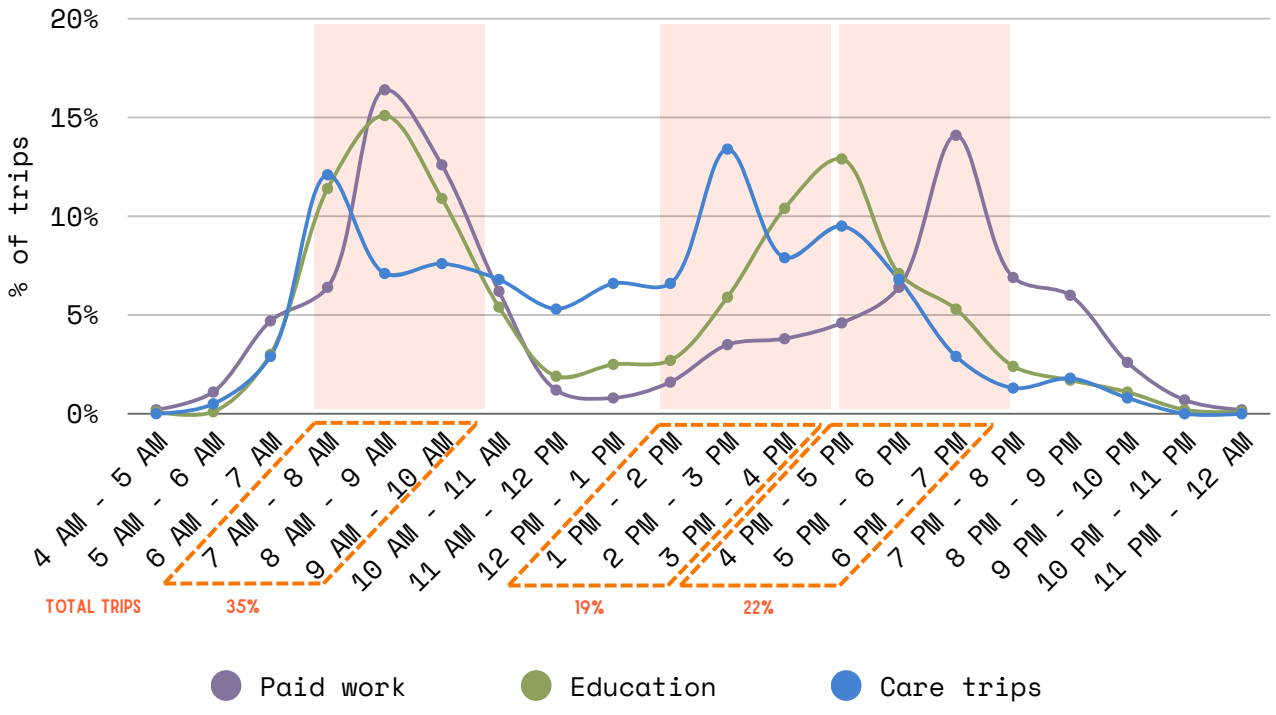


N = 2,183; F: 1,546; M: 637

The distribution of trips across the day reveals distinct temporal patterns by purpose. Paid work and education trips are concentrated in the morning, peaking at 8:00 AM (16% and 15%, respectively), with secondary peaks at 7:00 PM for work (14%) and 5:00 PM for education (13%). Care-related trips follow a different pattern, peaking at 7:00 AM (12%) and again at 2:00–3:00 PM (13%), reflecting time-specific care responsibilities. 91% of these care trips are undertaken by women

These patterns also vary by gender. Women's paid-work and education trips are more concentrated during the 8:00–10:00 AM morning peak, while their care-related travel peaks earlier, at 7:00–9:00 AM, and again at 2:00–4:00 PM. Men show a stronger concentration of paid-work trips in the evening.

Figure 10: Time of travel and travel purpose (sample)



N = 2,183; F: 1,546; M: 637

Travel cost

Women report substantially lower travel expenditure than men, at ₹4.1 per trip compared with ₹23.8. This is primarily due to fare free travel scheme for women.

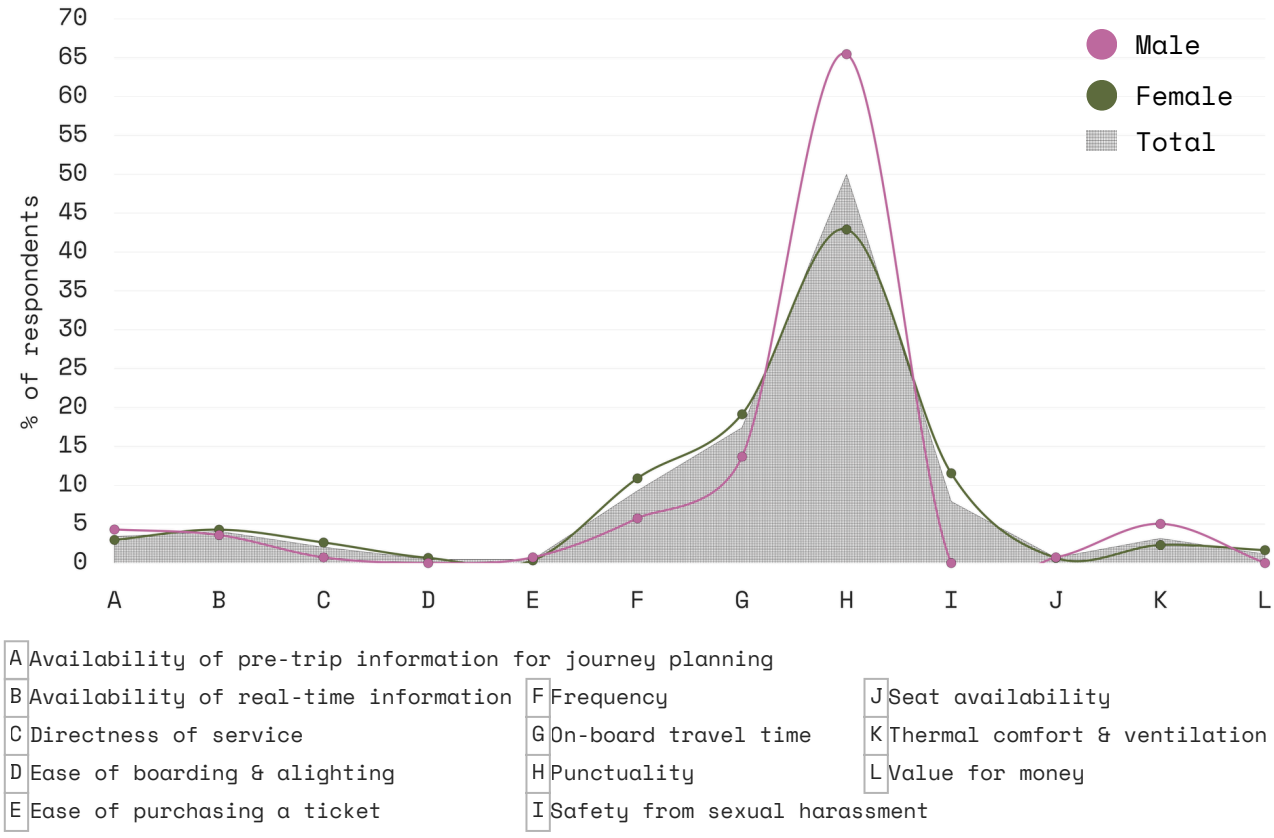
Use of metro

20% of surveyed commuters report using the metro, with broadly similar adoption among women and men (20% and 22%, respectively). However, frequency of use differs considerably: women make an average of 5 metro trips per month, compared with 9 among men, indicating greater reliance on the metro among male commuters.

Metro use also differs by trip purpose. Women's metro travel is more diverse, with 50% of trips for paid work and education, alongside recreational/social (24%) and health-related trips (12%). Among men, 82% of metro trips are concentrated on paid work and education (43% and 39%, respectively).

Metro journeys are relatively time-efficient, with an average door-to-door travel time of 42.9 minutes and a low waiting time of 3.8 minutes. Men report slightly longer journeys than women (45 vs. 42 minutes), consistent with their longer average travel distances.

Figure 11: Primary reasons for using metro - by gender



Punctuality is the dominant driver of metro use in Delhi (50%), followed by onboard travel time (17%) and service frequency (9%). However, the factors influencing metro choice differ by gender: men place greater emphasis on punctuality (65% vs. 43%), while women place relatively greater importance on travel time (19% vs. 14%) and frequency (11% vs. 6%). Safety from sexual harassment is also cited more frequently by women (12% vs. men), indicating that alongside operational efficiency, service reliability, journey time, frequency, and personal safety shape women's choice of metro.

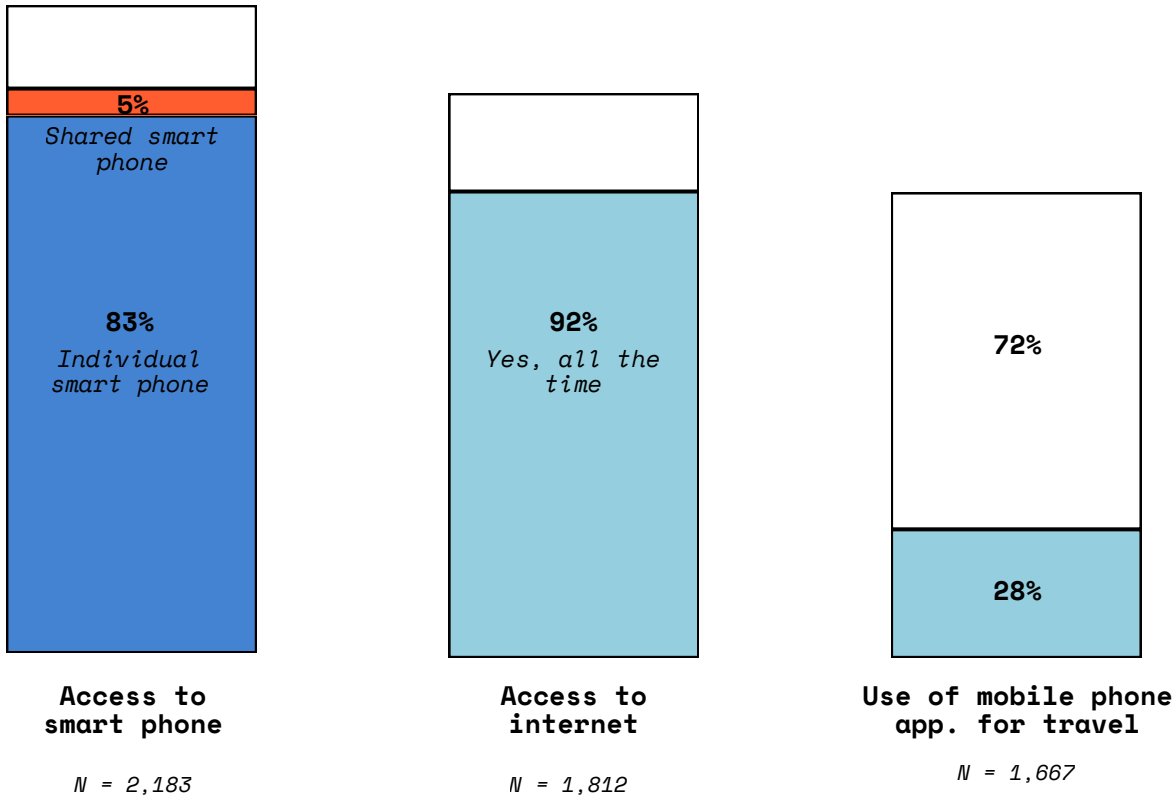


Source: Photo by Shivansh Singh on Unsplash

Digital access and literacy

83% percent of surveyed commuters have access to a personal smartphone and 5% have access to a shared smartphone, with similar proportions reported among both men and women. Among those who have a smart phone, 92% of respondents have access to internet all the time (F: 92%; M:90%) and 7% reported that they have internet issues while travelling.

Figure 12: Access and use of mobile phone and internet



83% percent of surveyed commuters have access to a personal smartphone and 5% have access to a shared smartphone, with similar proportions reported among both men and women. Among those who have a smart phone, 92% of respondents have access to internet all the time (F: 92%; M:90%) and 7% reported that they have internet issues while travelling.

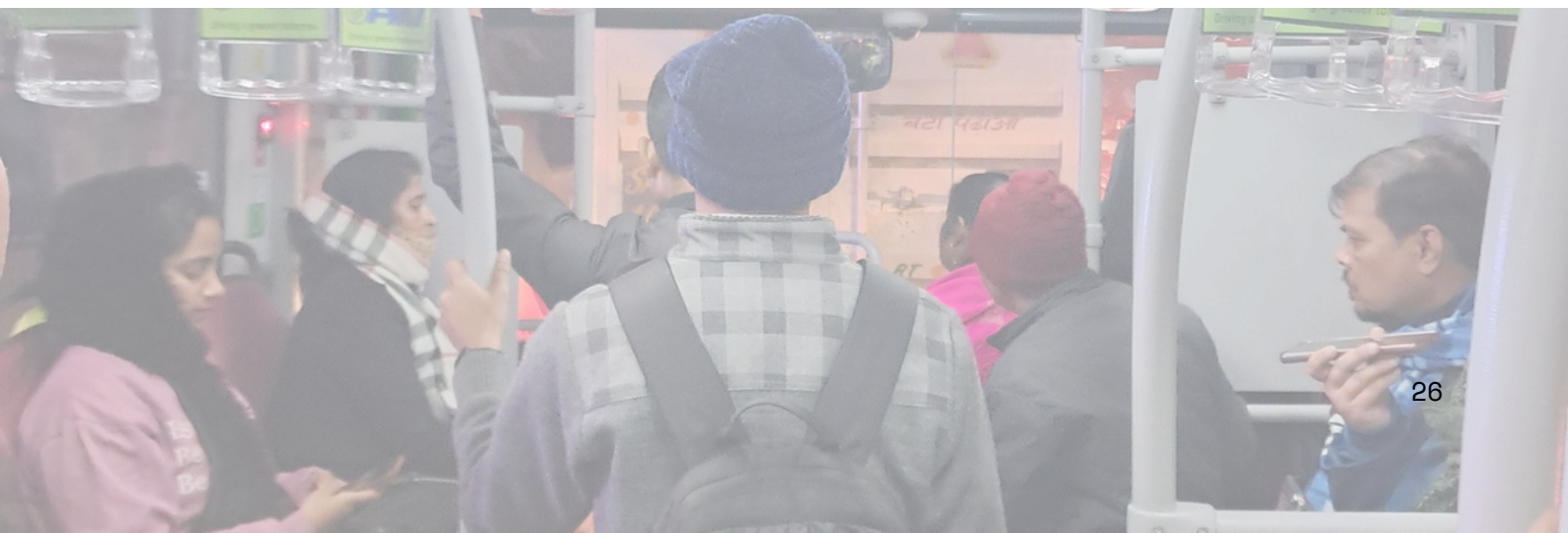
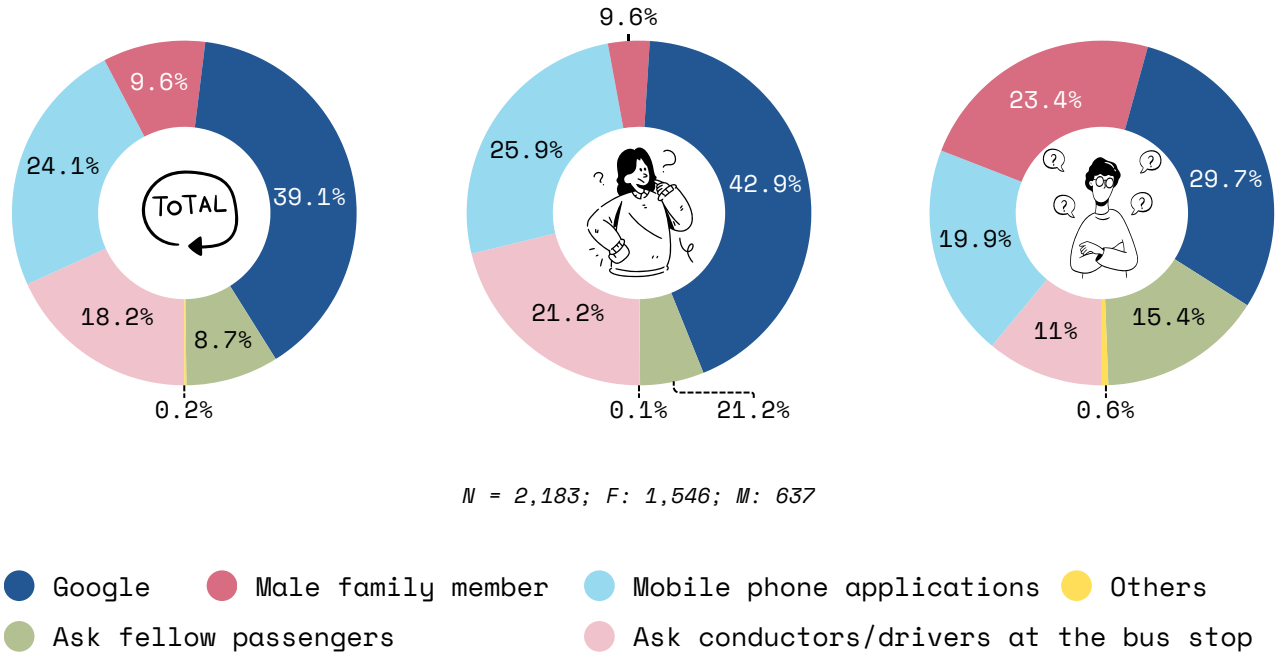


Figure 13: How do people get information about bus services?



N = 2,183; F: 1,546; M: 637

Among surveyed bus commuters, 39% reported using Google (Maps) to access bus-related information, such as route numbers, route details, or required interchanges. Despite widespread smartphone access, 52% of the passengers still depend on the word of mouth – either by conductors (24%), a male family members (18%) and fellow passengers (10%).

Only 8% reported using any dedicated mobile application. This is primarily because of the **lack of awareness on the available mobile phone application among passengers and limited knowledge of how to use them.** A higher share of male commuters (15%) use a mobile phone application compared to female commuters (6%). Commuters reported using three mobile applications for bus-related information and services: One Delhi, Chartr, and TUMMOC.

Among surveyed commuters who use mobile applications, the primary uses are purchasing bus tickets (35%), accessing real-time information, and obtaining information for planning bus journeys, with similar patterns observed among both male and female commuters. **A higher share of female commuters (17%) reported using mobile phone applications to provide feedback or register complaints, compared to 5.5% of male commuters.**

In 2024, TUC conducted a Safe City awareness campaign through on-board bus outreach, educational institutions, and membership-based women's organisations, reaching over 1,000 female commuters. The campaign disseminated information on available mobile applications and provided hands-on guidance to women on downloading and using them for ticketing, real-time bus and route information, and feedback.



Safety

57% of female commuters and 22% of male commuters reported experiencing at least one safety issue in the past six months. While jerks inside buses, theft, and safety while boarding and alighting were among the most commonly reported concerns for both genders, sexual harassment emerged as a particularly significant safety concern for women.

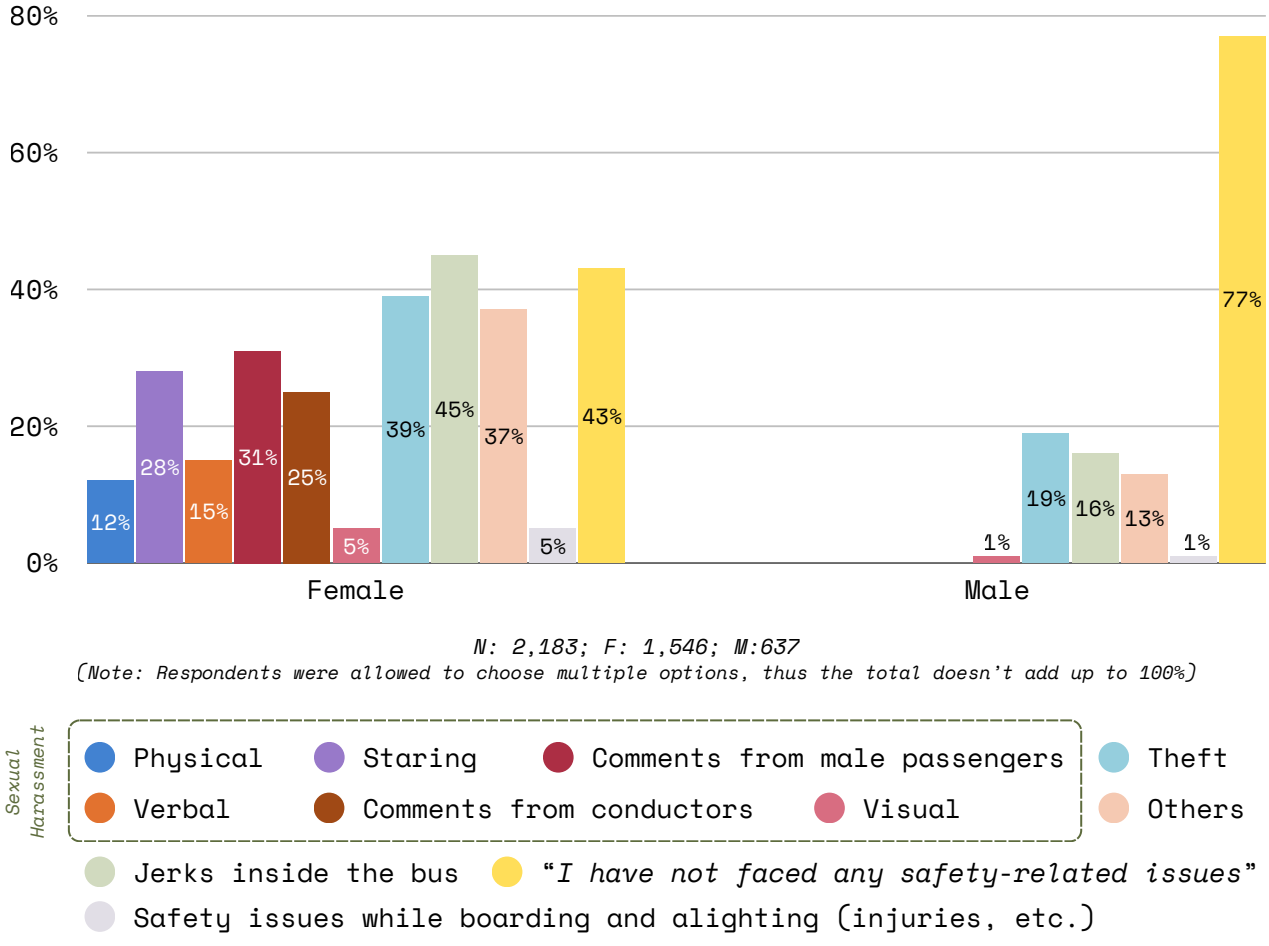
46.6%

of surveyed women reporting at least one instance of sexual harassment in the past 6 months.

Harassment is rarely a single, isolated incident: among women reporting any issue, roughly 84% report three or more concurrent forms of harassment, indicating compounded rather than one-off exposure.

Women also reported comments (taunts) from conductors (31%) and male passengers (25%) related to the fare-free travel scheme, highlighting the gendered nature of safety concerns beyond physical harassment.

Figure 14: Safety issues reported by commuters



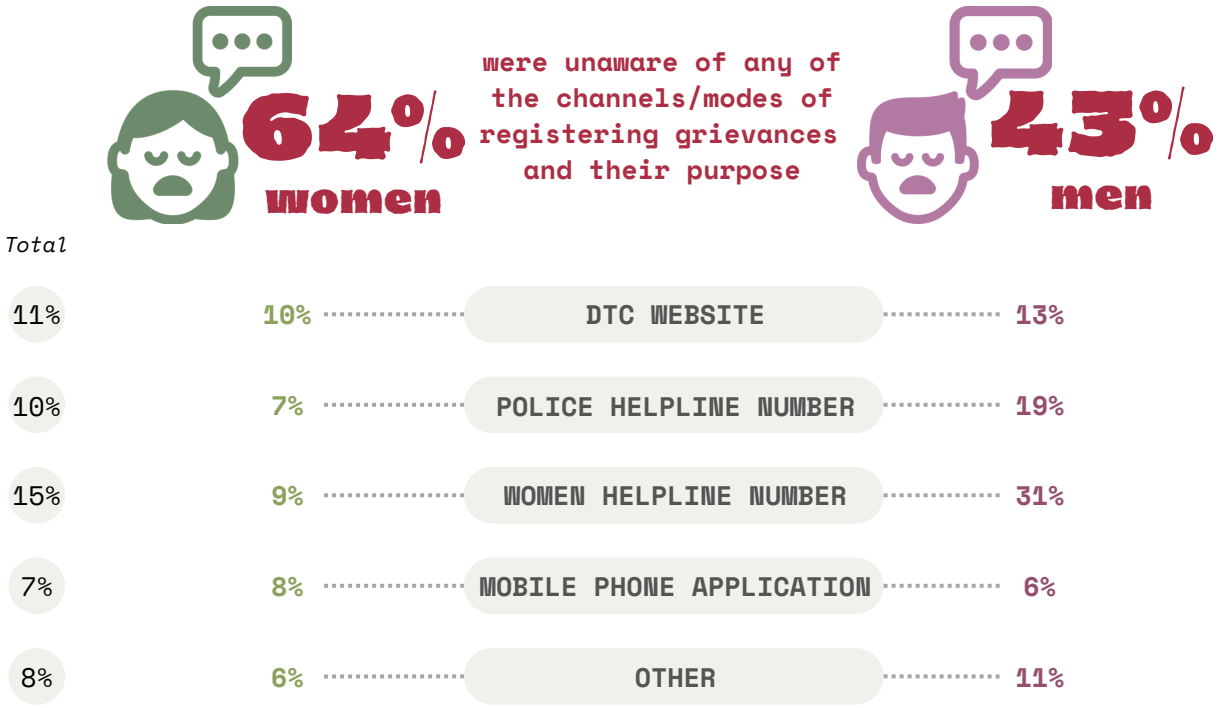
N: 2,183; F: 1,546; M:637

(Note: Respondents were allowed to choose multiple options, thus the total doesn't add up to 100%)

Only 6% of respondents who experienced safety issues had filed a formal complaint, with women reporting complaints just one percentage point more than men. The issues for which complaints were filed primarily relate to ticketing, bus-related issues, and conditions at bus stops. Women primarily reported ticketing and bus-stop infrastructure issues, while men more often reported ticketing, bus-stop conditions, and conductor behaviour.

Among commuters who experienced safety issues, 67% of women and 57% of men did not file a complaint because they believed it would not lead to any change. Limited awareness of the complaint resolution process and expected response time was also a key barrier to reporting.

Figure 15: Access and use of mobile phone and internet



N: 1,765, M: 456, F: 1309
Note: Some responses were missing for this variable.

A significant proportion of commuters remain unaware of existing complaint mechanisms, with 59% reporting that they do not know about them. This gap is more pronounced among women (64%) than men (43%). Awareness of specific helplines is also limited: only 10% of commuters are aware of the DTC helpline (19% men; 7% women), while awareness of the police helpline is 31% among men and only 9% among women. Only 9% of female commuters are aware of the women's helpline.

Inferential statistics

To examine the relationship between bus service quality and overall commuter satisfaction, a generalised ordinal logistic regression is employed, given that satisfaction is measured on an ordered scale. The analysis identifies which service attributes are significantly associated with satisfaction while accounting for the effects of multiple factors simultaneously.

To improve model parsimony while retaining the explanatory value of the service-quality measures, conceptually related variables with Cronbach's alpha ≥0.70 are combined into composite constructs. This reduces redundancy among highly related measures while preserving their underlying construct. Following this consolidation, 26 independent variables, including the composite constructs, are included in the regression model.

The model is statistically significant (Likelihood Ratio χ^2 = 2799.533, $p < 0.001$), indicating that the service-quality variables collectively have a significant association with overall satisfaction. The Pearson chi-square statistic is 13,148.724 (df = 13,060; χ^2/df = 1.007), while the deviance statistic is 5,435.178 (df = 13,060; deviance/df = 0.416). Detailed regression analysis is presented in Annexure 3.

The regression results are subsequently used to identify service attributes that are both important to overall satisfaction and underperforming. Figure 16 plots estimated importance against observed performance, allowing priority areas for service improvement to be identified.

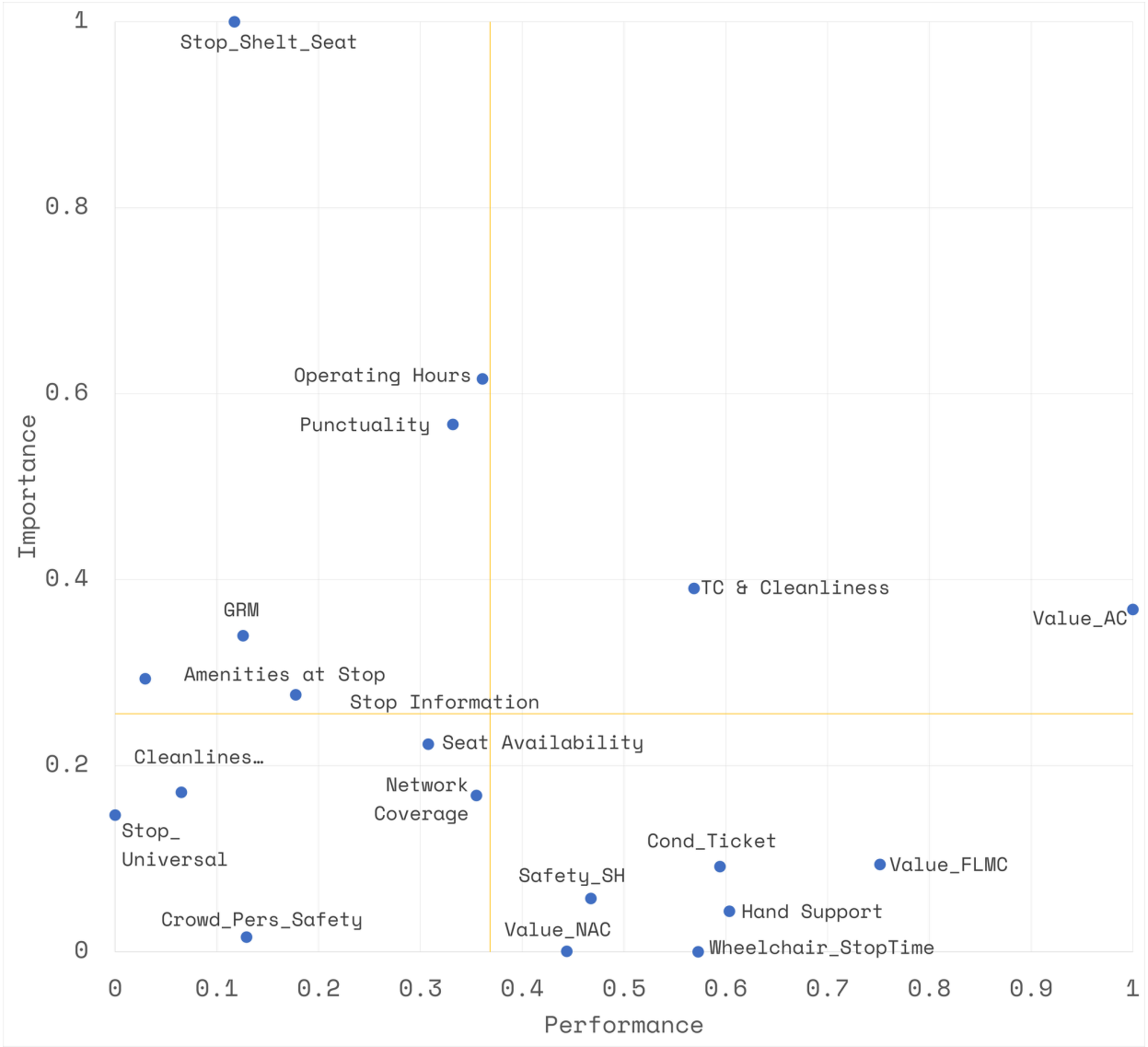
The regression results indicate that several service attributes have a significant positive association with overall satisfaction. The strongest association is observed for stop infrastructure (OR = 1.52), followed by operating hours (1.35) and punctuality (1.33). Other significant positive associations are observed for thermal comfort and cleanliness (1.27), value for money on AC buses (1.26), GRM (1.25), amenities at stops (1.23), information at stops (1.22), network coverage and cleanliness at stops (1.19 each), universal access features (1.18), and conductor behaviour/ease of ticket purchase (1.16). These results indicate that both core service reliability and the quality of the passenger environment contribute meaningfully to satisfaction.

IMPORTANCE-PERFORMANCE ANALYSIS

The statistically significant regression results are subsequently used to conduct Importance-Performance Analysis (IPA), linking the relative importance of each attribute to its observed performance. The analysis identifies attributes that are important to satisfaction but currently perform below the overall average, thereby highlighting priority areas for intervention.

As shown in Figure 16, shelter and seating at stops, operating hours, punctuality and frequency, GRM, bus-stop amenities, and information at stops fall within the high-importance/low-performance quadrant. These attributes therefore represent the key service-improvement priorities, as improvements in these areas are likely to generate the greatest gains in overall commuter satisfaction.

Figure 16: IPA graph based on regression model



SERVICE QUALITY INDEX

The regression results are further used to construct the Service Quality Index (SQI) by combining the relative importance of statistically significant attributes with their observed mean satisfaction ratings. The overall SQI is 4.50 out of 7.

4.23

for women

*Women reported lower overall satisfaction with bus services compared with men.***

4.97

for men



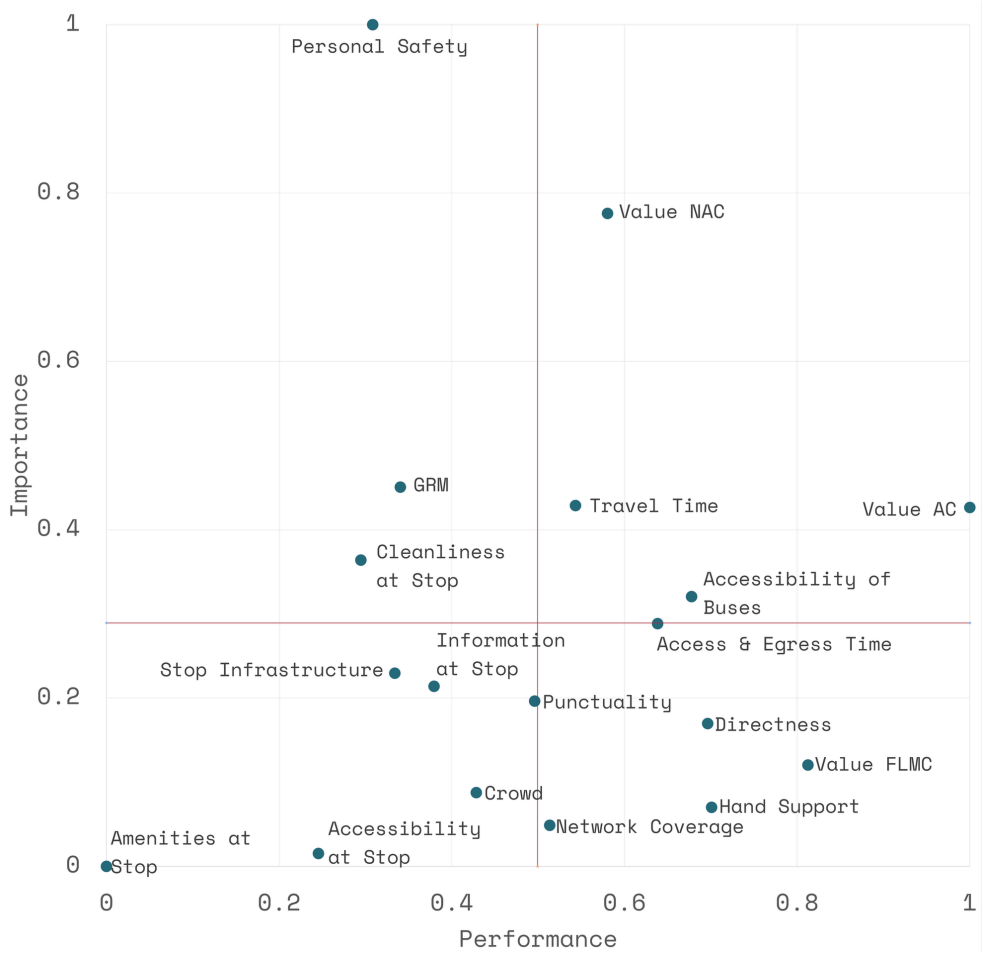
GENERALISED ORDINAL LOGISTIC REGRESSION FOR OVERALL SAFETY

Building on the analysis of overall satisfaction, the same modelling approach is applied to perceived safety while using bus services, measured on a 1–7 ordered scale. The analysis identifies which service attributes are most closely associated with commuters' perceptions of safety. The model shows an adequate fit, with a Pearson chi-square/df ratio of 0.916 and a deviance/df ratio of 0.428.

The model indicates that safety is not determined solely by direct security-related factors. Travel time, access and egress, seat availability, network coverage, hand support, crowd and personal safety, GRM, non-AC value for money, first- and last-mile connectivity, and bus-stop conditions are positively associated with perceived safety. This suggests that commuters' sense of safety is closely linked to the quality and predictability of the wider journey experience, including ease of movement, crowding, access to support, and conditions at stops.

Crowding and personal safety, GRM, and cleanliness at bus stops emerge as the key high-importance, low-performance priorities. Travel time lies close to the performance threshold, suggesting scope for further improvement.

Figure 17: IPA graph for overall safety



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ANNEXURES

1(A) METHODOLOGY FOR SELECTING BUS TERMINALS AS SURVEY LOCATIONS

Table 2: Parameters considered for stratification

Parameter	Description	Data Source
Administrative zones	District boundaries	Delhi comprises 11 administrative districts, which have been used as the primary spatial strata to ensure geographic representation across the city.
Bus Route Density	Number of unique bus routes passing through the terminal: This was used as a proxy for expected passenger footfall within the network. Terminals serving a higher number of routes were assumed to attract greater volumes of passengers. Terminals with higher number of routes passing are prioritized.	Bus routes intersecting a 150-meter buffer around each terminal are considered to be passing through the terminal. This analysis was conducted in ArcGIS pro. This classification has been validated through spatial analysis of the 2024 General Transit Feed Specification (GTFS) data, using both stop locations and route geometries.
Multimodal integration	Multimodal integration is assessed based on the proximity of metro stations within a ped shed[1] of 800m around each terminal. The 800-meter radius is considered as the influence zone as per Transit-Oriented Development (TOD) guidelines (DDA, 2019). Terminals located within close proximity to metro stations—particularly interchange stations—are prioritised.	Location of metro stations have been downloaded from GTFS 2024 and subsequently verified against the latest Delhi Metro network map published by DMRC.
Entropy Index	The Entropy Index is commonly used for representing the land use mix. It measures the number of land uses present in an area with the total number of land uses found in the area. (Refer Annexure 1(B) to understand the calculation method). A higher entropy index indicates the presence of a mix of land uses—such as residential, commercial, institutional, and recreational—which tends to support higher and more consistent footfall throughout the day. Terminals located in areas with higher entropy are prioritized.	Land use analysis was conducted using the Delhi Master Plan 2041 land use plan.

Survey samples were proportionally allocated across the 11 selected terminals to ensure balanced representation, thereby facilitating intra-district analysis and comparative assessment (see Table 3).

[1] Ped shed refers to the walkable distance based on on-ground street conditions.

Table 3: Sample size of survey per terminal

Terminal	Female	Male	Total
Azadpur Terminal	162	64	226
ISBT Anand Vihar	136	55	191
Karampura Terminal	142	63	205
Karawal Nagar Terminal	142	54	196
Maharana Pratap ISBT Terminal/Kashmere Gate	130	54	184
Mangolpuri Terminal	129	56	185
Najafgarh Terminal	135	60	195
Nehru Place Terminal	140	60	200
Hauz Khas Terminal	143	58	201
Shivaji Stadium Terminal	149	57	206
Trilokpuri 13 Block Terminal	138	56	194
Total	**1,546**	**637**	**2,183**

1(B) CALCULATION OF ENTROPY INDEX FOR LAND USE MIX

The Entropy Index is a widely used measure to quantify land use mix in urban areas. It captures the distribution and relative balance of different land use categories—such as residential, commercial, institutional, and recreational—within a defined spatial unit. This index has been extensively applied in urban studies to evaluate neighbourhood walkability, transit accessibility, and overall spatial diversity ((Jiao, Rollo, & Fu, 2021); (Im & Choi, 2019); (Mavoa, et al., 2018)).

Entropy is calculated using the following formula:

$$\mathrm{LUM} = -\sum_{i=1}^{k} \frac{P_i \times ln(P_i)}{ln(k)}$$

where:
· P_i is the proportion of land area allocated to land use type i,
· k is the total number of land use categories considered.

This formulation, adapted from Shannon's diversity index, normalizes the entropy score between 0 and 1. A value of 0 indicates the dominance of a single land use (complete homogeneity), while a value closer to 1 suggests an even distribution across all considered land use types (high heterogeneity).
Areas with higher entropy scores signify a greater degree of mixed-use development, which typically supports higher and more consistent footfall throughout the day by co-locating diverse urban functions. This association has been empirically validated in several studies linking entropy-based indices with pedestrian volume and non-motorized travel behavior ((Im & Choi, 2019); (Jiao, Rollo, & Fu, 2021)).

A statewide study in Maryland (Chakraborty & Mishra, 2013) further substantiates this linkage by showing that transit ridership was significantly and positively associated with a diversity of land use types, especially residential, housing, recreation, and employment-related development. The study found that zones with higher household and employment densities, lower car ownership, and greater land use intensity—particularly for housing and offices—were strong predictors of commuter transit volume. Recreation-related land use, however, showed a negative association, suggesting context-specific effects on ridership.

Supporting this, a study in Santiago de Chile (Urrutia-Mosquera, Florez-Calderon, Cortes, Troncoso, & Lufin, 2024) found that a 1% increase in land use mix, as measured by entropy, was associated with an 8.2% increase in public transport trips and a 20.5% increase in non-motorised trips. The same study also observed a strong positive relationship between land use diversity and the number of maintenance trips made using sustainable modes, reinforcing the importance of spatial diversity in influencing everyday travel behavior.
In this study, land use entropy was calculated within an 800-meter buffer[2] around each terminal based on the proposed land use map of Delhi (2041). This radius reflects a common threshold for pedestrian catchments in urban mobility planning. For the purpose of this study, land use categories selected for calculating entropy were residential, commercial, government[3], public/semi-public (PSP[4]) areas, recreational, industrial, transportation, Low Density Residential Area (LDRA) villages and unauthorized colonies[5]. Terminal locations in zones with higher land use entropy were prioritized for further analysis and intervention planning. The land use classifications were derived from the Delhi Master Plan 2041, using GIS-based analysis.

[2] Based on Transit Oriented Development (TOD) Guidelines by DDA
[3] As per Master Plan for Delhi-2041 (MPD-2041), land use zones under Government category are: G1 President Estate and Parliament House; G2 Government Office Complex / Courts/ PSUs; G3 Government Land (Use undetermined).
[4] As per Master Plan for Delhi-2041 (MPD-2041), land use zones under PSP category are: PS1 Health, Education and Research University/ University centre, College, Social - Cultural, Socio-Cultural Complex/ Centre, Police / Police Headquarter / Police Lines, Fire stations / Disaster Management Centres, Religious, Burial Ground /Cemetery/ Cremation; PS2 Transmission Site/Centre.
[5] As per Master Plan for Delhi-2041 (MPD-2041), unauthorized colonies in Delhi are unplanned, yet to be regularized areas which also emerge as high density, mix-use hubs.

2. FORMULA FOR ESTIMATING GENERALIZED ORDINAL REGRESSION MODEL

$$Ln\,(Y_i) = \alpha + \beta_1 Punctuality + \beta_2 Information + \beta_3 Travel\ Time + \beta_4 Onboard\ Information + \beta_5 Comfort + \beta_6 Directness + \beta_7 Access\ EgressTime + \beta_8 Network\ Coverage + \beta_9 Operating\ Hours + \beta_{10} ConductorTicket + \beta_{11} Crowd + \beta_{12} Ease\ of\ Boarding\ \&\ Alighting + \beta_{13} Hand\ Support + \beta_{14} Wheelchair\ Space\ \&Stop\ Time + \beta_{15} Personal\ Safety + \beta_{16} Safety\ SH + \beta_{17} GRM + \beta_{18} VFMAC + \beta_{19} VFMNAC + \beta_{20} VFMFLMC + \beta_{21} ShelterSeating\ at\ Stop + \beta_{22} Cleanliness\ at\ Stop + \beta_{23} Information\ at\ Stop + \beta_{24} Stop\ Lighting\ Night + \beta_{25} Amenities\ at\ Stop + \beta_{26} Universal\ Access\ Features + \varepsilon \qquad \text{(eq. 1)}$$

3. DETAILED REGRESSION ANALYSIS

(a) Results of generalized ordinal logistic regression

Sets of variables, measuring the same construct along with a Cronbach's Alpha of 0.7, have been combined in order to make the model parsimonious while retaining the effect of each variable. All 36 independent variables have been considered in the model – either as interactions or separate independent variables. The combinations of variables used in the generalized ordinal logistic regression with their corresponding Cronbach's alpha values are listed below:

Table 4: List of combined variables - Generalized Ordinal Logistic Regression

Combined Variables	Cronbach's α	Renamed Variable
Punctuality & Frequency	0.8293	Punctuality
Pre-trip Information & Real-time Information	0.7994	Information
Onboard Travel Time & Transfer Time	0.8072	Travel Time
Seat Availability & Crowd	0.7609	Seat & Crowd
Wheelchair Space & Adequate Stop Time for PwD and Elderly	0.7467	Wheelchair_StopTime
Behaviour of Conductor & Ease of Purchasing Ticket	0.742	Cond_Ticket
Crowd and Personal Safety	0.7958	Crowd & Pers_Safety
GRM Information & GRM Effectiveness	0.8691	GRM
Shelter at Stop & Seating at Stop	0.8684	Stop_Shelt_Seat

Using equation 1 and 26 independent variables including combinations listed in table 4, the effect of these variables on overall satisfaction was calculated using generalised ordinal logistic regression. Its goodness of fit statistics are listed below:

Table 5: Goodness of Fit Statistics - Generalized Ordinal Logistic Regression

Tests	Value	df	Value/df
Deviance	5435.178	13060	0.416
Scaled Deviance	5435.178	13060	
Pearson Chi-Square	13148.724	13060	1.007
Scaled Pearson Chi-Square	13148.724	13060	
Log Likelihood	-2717.589		
Akaike's Information Criterion (AIC)	5499.178		
Finite Sample Corrected AIC (AICC)	5500.161		
Bayesian Information Criterion (BIC)	5681.209		
Consistent AIC (CAIC)	5713.209		

The likelihood ratio chi square value of 2799.533 is significant ($p<0.001$), allowing us to draw inferences from the model. Table 6 provides the detailed regression table.

Table 6: Results of Generalized Ordinal Logistic Regression

Parameters		B	Std. Error	Wald Chi-Square	Sig.	Odds Ratio
Threshold	[Overall Satisfaction=1]	4.196	0.278	227.883	0	
	[Overall Satisfaction=2]	6.801	0.2854	567.856	0	
	[Overall Satisfaction=3]	8.544	0.2998	811.9	0	
	[Overall Satisfaction=4]	10.053	0.3174	1003.292	0	
	[Overall Satisfaction=5]	11.9	0.3465	1179.604	0	
	[Overall Satisfaction=6]	14.553	0.3923	1376.398	0	
Punctuality		0.288	0.0575	25.068	0.000***	1.33
Information		-0.021	0.0613	0.116	0.733	0.98
Travel Time		-0.066	0.0661	0.988	0.32	0.94
Onboard Information		0.046	0.0436	1.109	0.292	1.05
Thermal Comfort and Cleanliness		0.236	0.0616	14.62	0.000***	1.27
Directness		-0.033	0.0407	0.667	0.414	0.97
Access and Egress Time		0.066	0.0496	1.773	0.183	1.07
Seat Availability		-0.186	0.046	16.389	0.000***	0.83
Network Coverage		0.17	0.0481	12.472	0.000***	1.19
Operating Hours		0.302	0.0496	37.165	0.000***	1.35
Conductor’s Behaviour and Ease of Purchasing Ticket		0.147	0.0618	5.669	0.017**	1.16
Ease of Boarding and Alighting		0.057	0.0482	1.387	0.239	1.06
Hand Support		-0.133	0.0503	6.986	0.008**	0.88
Wheelchair Space and Stop Time		-0.12	0.0547	4.82	0.028**	0.89
Crowd & Personal Safety		0.125	0.0547	5.201	0.023**	1.13
Safety from Sexual Harassment		-0.137	0.0414	10.928	0.001***	0.87
GRM		0.221	0.0561	15.465	0.000***	1.25
Value_AC		0.229	0.0483	22.41	0.000***	1.26
Value_NAC		0.12	0.0428	7.888	0.005**	1.13
Value_FLMC		-0.148	0.0442	11.202	0.001***	0.86
Stop Infrastructure		0.416	0.0565	54.217	0.000***	1.52
Cleanliness at Stop		0.171	0.0455	14.096	0.000***	1.19
Information at Stop		0.202	0.0473	18.221	0.000***	1.22
Stop Lighting at Night		-0.009	0.0355	0.07	0.792	0.99
Amenities at Stop		0.207	0.0378	30.021	0.000***	1.23
Universal Access Features at Stop		0.164	0.0381	18.4	0.000***	1.18

***p<0.001; **p<0.05

(b) Generalized ordinal logistic regression for overall safety

As respondents were asked to rate overall safety while using bus services in Delhi on a scale of 1-7, the same has been used as an independent variable to assess the factors influencing safety. The goodness of fit statistics of the model for overall safety are listed below:

Table 7: Goodness of fit statistics of the model for overall safety

Tests	Value	df	Value/df
Deviance	5589.295	13060	0.428
Scaled Deviance	5589.295	13060	
Pearson Chi-Square	11962.411	13060	0.916
Scaled Pearson Chi-Square	11962.411	13060	
Log Likelihood	-2794.648		
Akaike's Information Criterion (AIC)	5653.295		
Finite Sample Corrected AIC (AICC)	5654.277		
Bayesian Information Criterion (BIC)	5835.326		
Consistent AIC (CAIC)	5867.326		

From the emerging model, travel time (onboard and transfer), access and egress time, availability of seats, network coverage, hand support, crowding and personal safety, grievance redressal mechanism (information and effectiveness), value for money in non-AC buses, value for money in first-and-last-mile connectivity, shelter and seating at the bus stop, cleanliness at the bus stop and information at the bus stop emerge as variables that positively influence overall safety. An improvement in these factors is likely to lead to an improvement in overall safety satisfaction.

4. SURVEY TOOL

The questionnaire for the commuter perception survey can be accessed **here** or by scanning the QR code below.

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